OCEAN TRANSPORTATION

Based on a research project of the
MIT Sea Grant Program 1970-1972

by
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PREFACE

Ocean transportation accounts for the bulk of commodity movement in the world today. Ocean transportation tonnage has more than doubled in the last 20 years and is expected to double again in the next decade. At the same time, we are experiencing a revolution in ocean transportation technology which affects not only the cost of the transportation, but also the physical form and type of commodities transported. Nearly 7% of the world's GNP is spent for international commodity transportation including ocean transportation activities, while more than 15% is expended for commodity transport in general. As a result, it can easily be shown that the effectiveness and cost of integrated ocean transportation have a major influence on economic development and growth, standard and cost of living, development and effectiveness of foreign trade, and progress in general.

This nation, while historically deeply involved in ocean transportation, has experienced a severe degradation of its rightful participation in this industry, while at the same time many of the new developments in modern ship production and ship technology originated in the United States. For some reason we have often been unable to benefit from our ingenuity, and even the most recent enactment of modified maritime laws appears to be getting off to an unfortunately slow start in revitalizing this essential component of the U.S. transportation industry and U.S. economy.

Ocean transportation comprises more than ships, and forms an integral part of commodity transportation in all its various modes. Increasingly, ports and terminals assume additional or modified functions and ships are designed to perform more specialized services. As a consequence, it is increasingly recognized that the various components of ocean transportation and supporting elements must be designed as part of an integrated overall system. Similarly, benefits often accrue from systems which perform one function effectively instead of multiple functions inefficiently. As a result, it is not enough to incorporate new technology into the transport vehicle alone; terminal and feeder systems must be designed to take advantage of such new capabilities.

As in all endeavor, there are major technological and operational voids in ocean transportation which often prevent the effective use of progress. Ocean transportation, for example, is unable to take advantage of all the available ship technological developments because similar developments lag in the fields of port design and use, labor relations and applications, management, and transportation systems control.

Similarly, the effects on the social and physical environment must be considered as part of the total system design and operation before real and meaningful progress can be made. Ocean transportation is a major key to continued prosperity and growth and plays a particularly important role in the economic emergence of developing countries. It is largely an international industry subject to a variety of national and international laws, regulation and agreements.

On the other hand, it offers larger potential risks and/or incentives as well as penalties or rewards than most industries. Similarly, ocean transportation is often subjected to political and military considerations, and is therefore influenced by many non-economic or operational decisions or by terms imposed or offered for policy or strategy reasons. It is at the same time among the most protected and unprotected industries operationally, economically and politically. Integrated ocean transportation costs traditionally comprise a larger percentage of the GNP of developing nations than of developed nations. In fact, for some of these nations they often assume as much as 15% of GNP, 40% of the value of foreign trade, and 60% of foreign trade earnings. As a result, ocean transportation offers generally the largest single opportunity for the improvement of economic health and growth for such nations. On the other hand, control of ocean transportation costs seldom rests with such nations even if they own and/or operate a meaningful proportion of their required capacity. Recent developments in ocean transportation technology, operating procedures, financing methods, policy and others offer interesting opportunities.

It is the purpose of this work to analyze the development and status of ocean transportation and develop projections of future trends. This analysis starts with a review of ocean transportation demand and supply including projections of ship capacity demand and world shipbuilding capacity under various economic and political assumptions. The study next reviews ocean transportation technology and reviews trends and voids in technology development. The discussion of technology considers the ocean transportation system as a whole, and the composite subsystems such as hull, outfit, propulsion, cargo handling, automation, and control and interface technology. In ocean transportation economics we present investment and operating costs as well as the results of a study of financing of shipping. Similarly, a discussion of government aid to shipping is presented.

Maritime labor aspects are covered by a review of the development and status of U.S. maritime labor relations, costs and training. Classification and regulation of ocean transportation is reviewed and insurance is discussed with emphasis on foreign investment in the U.S. vessel and cargo insurance market.

The study evaluates various measures of effectiveness or productivity of ocean transportation specifically as affected by changing ship technology, cargo handling technology, operational and economic integration of ocean and feeder transport modes, and financial structure of the transportation companies.

To put this study in its proper perspective we may first want to consider the role of ocean transportation in world trade. It is noted that over 60% of the value, and about 58% of the volume (in tons) of international trade is moved by ocean transportation.

The largest increase in seaborne trade is in the carriage of oil, and while available tonnage of general cargo shipping increased about 20% worldwide during the last decade, tanker tonnage increased by more than 100%. Trade forecasts based on averaging predictions presented by various researchers show that the trend of growth in international seaborne trade will continue. In some commodities such as oil and dry bulk the growth rate is expected to accelerate.

The total revenues of U.S. ocean shipping during 1970 were nearly 2 billion dollars, while revenues of world ocean shipping exceeded 40 billion dollars. The current replacement value of the U.S. merchant marine is estimated at six billion dollars, while the replacement value of world shipping exceeds 100 billion dollars. Considering the age distribution of ocean shipping, we find that the current value of U.S. ocean shipping is approximately 2.8 billion dollars, while that of world shipping is approximately 70 billion dollars.

It must therefore be recognized that integrated ocean transportation is a major economic activity whose health and growth has an impact on national and world economics out of proportion to its economic size.

The distribution of the fleet of world seagoing ships is changing such that a decreasing number of large ships now carry the bulk of the major commodities in world trade. This development is expected to continue as advancing technology becomes more accepted and terminal or interface facilities are constructed which are capable of accommodating the rapidly advancing shipping technology in size as well as cargo transfer and other operating characteristics.

PART 1

DEMAND AND SUPPLY
OF SHIPPING:
A WORLD REVIEW

by

E. G. Frankel

INTRODUCTION

This report provides projections of the supply and demand for worldwide oceanborne shipping up to 1985. Demand and supply are broken down into categories of tanker, dry bulk, and general cargo demand. The demand forecasts are presented in both ton-miles as well as in deadweight and gross registered tonnage of ships required.

Shipping supply projections are based on forecasts of available shipping and new building supply. The latter was computed on the basis of shipyard capacity and utilization, where utilization was determined from expected price/cost relationships. Future ship construction prices for general cargo and dry bulk vessels are obviously a function of short term demand/supply ratios, while for tankers medium term demand/supply relationships appear to be more important. The relative importance of medium term effects on tanker demand/supply was estimated to be in proportion to the ratio of spot to charter contracts.

The future of developments on the North Slope of Alaska, at the Suez Canal and elsewhere will have a significant effect on oceanborne shipping. Consequently, various assumptions concerning various world economic and political conditions were tested to determine their effect on shipping supply and demand.

Chapter I

DEMAND AND SUPPLY OF SHIPPING

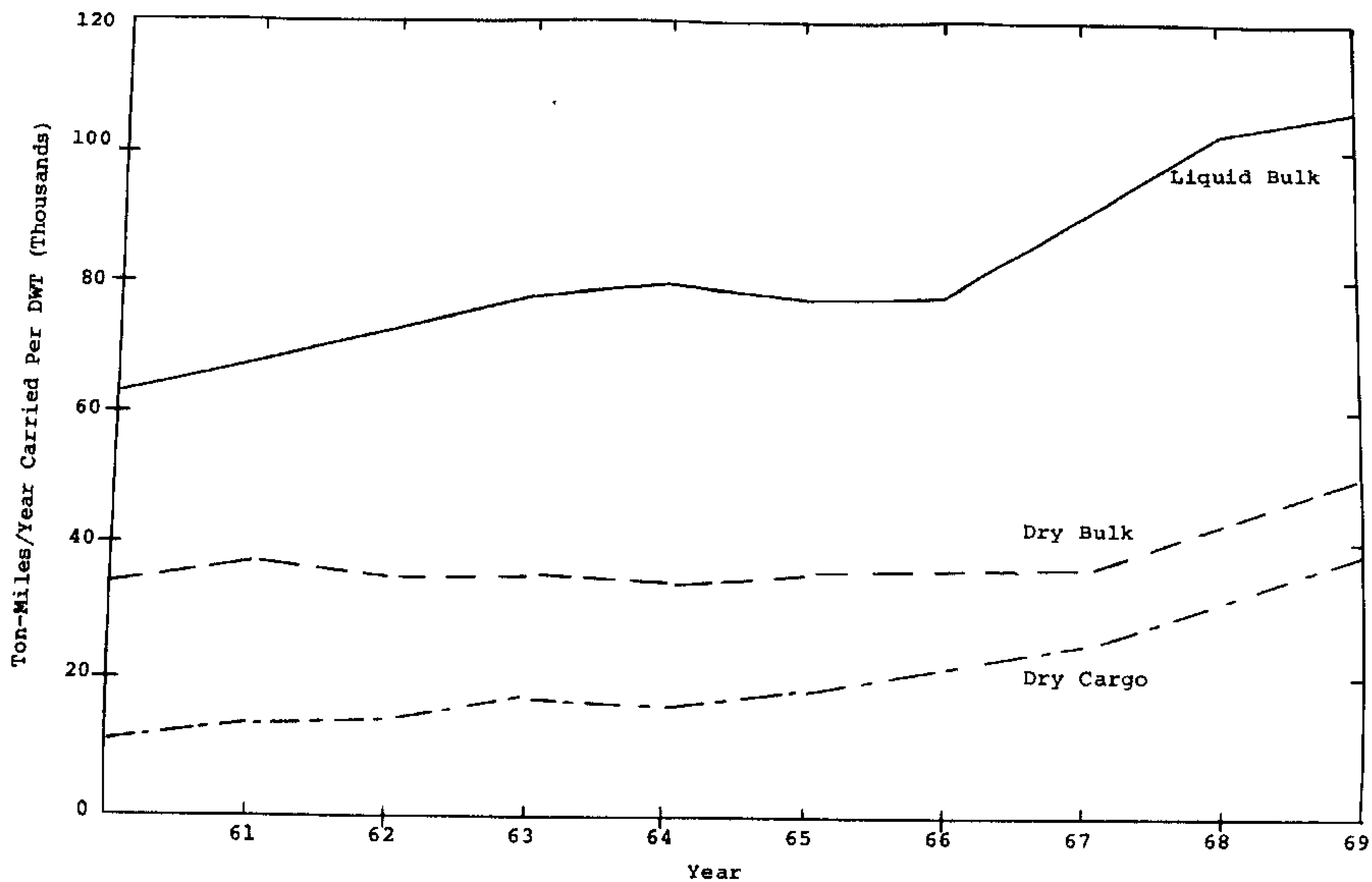
The purpose of this study is to evaluate the demand for different types of ships and the supply of tonnage to meet this demand. The basic approach for the establishment of shipping demand frequently is by determining the ton-mile transportation effort that must be performed by particular types of ships and dividing this by the productivity of a particular ship type expressed in ton-miles per deadweight ton as shown in Figure I-1. It will be noted that the various types of ships divided into general categories of liquid bulk, dry bulk and dry cargo had a fairly constant productivity in ton-miles per year carried per deadweight ton from 1960 to 1966/67. At that time tanker size started its rapid increase which resulted in practically doubling tanker productivity in a 3-year period. This was largely due to greatly reduced port time as a function of cargo tonnage transferred and not speed. It was also affected by utilization of tonnage, scheduling, and routing. Tanker productivity in 1972, on the other hand, would show a decreasing trend and is currently at a level of about 110 ton-miles per year carried per deadweight ton as a result of an increasing amount of laid up tonnage or tonnage not fully employed. Another factor influencing productivity of tankers is an increase in the average length of route.

Dry bulk shipping had level productivity until about 1967, when the increasing use of larger bulk carriers with more effective cargo loading and unloading facilities resulted in an increase in productivity of nearly 10% per year averaged over the world fleet, which is continuing. Dry or general cargo shipping showed an accumulative increase in productivity of about 6% starting with 1965. This was largely due to the increased participation of faster containerships with vastly reduced turnaround time.

The supply of shipping is established by evaluating available shipping capacity in various categories of ships and available or projected shipbuilding capacity. These two factors are then combined to develop a shipping supply forecast.

Traditionally, demand and supply of shipping are subject to major fluctuations of oversupply and limiting availability. Although the cycles are functions of political, economic and military or strategic factors, a study of shipping rates, which usually respond to the supply/demand relationship, indicates a periodicity of about four to five years. During 1970-71 a major boom in shipping demand resulted in driving most shipping costs to a historic high and had as a secondary effect the placement of enormous orders for new construction.

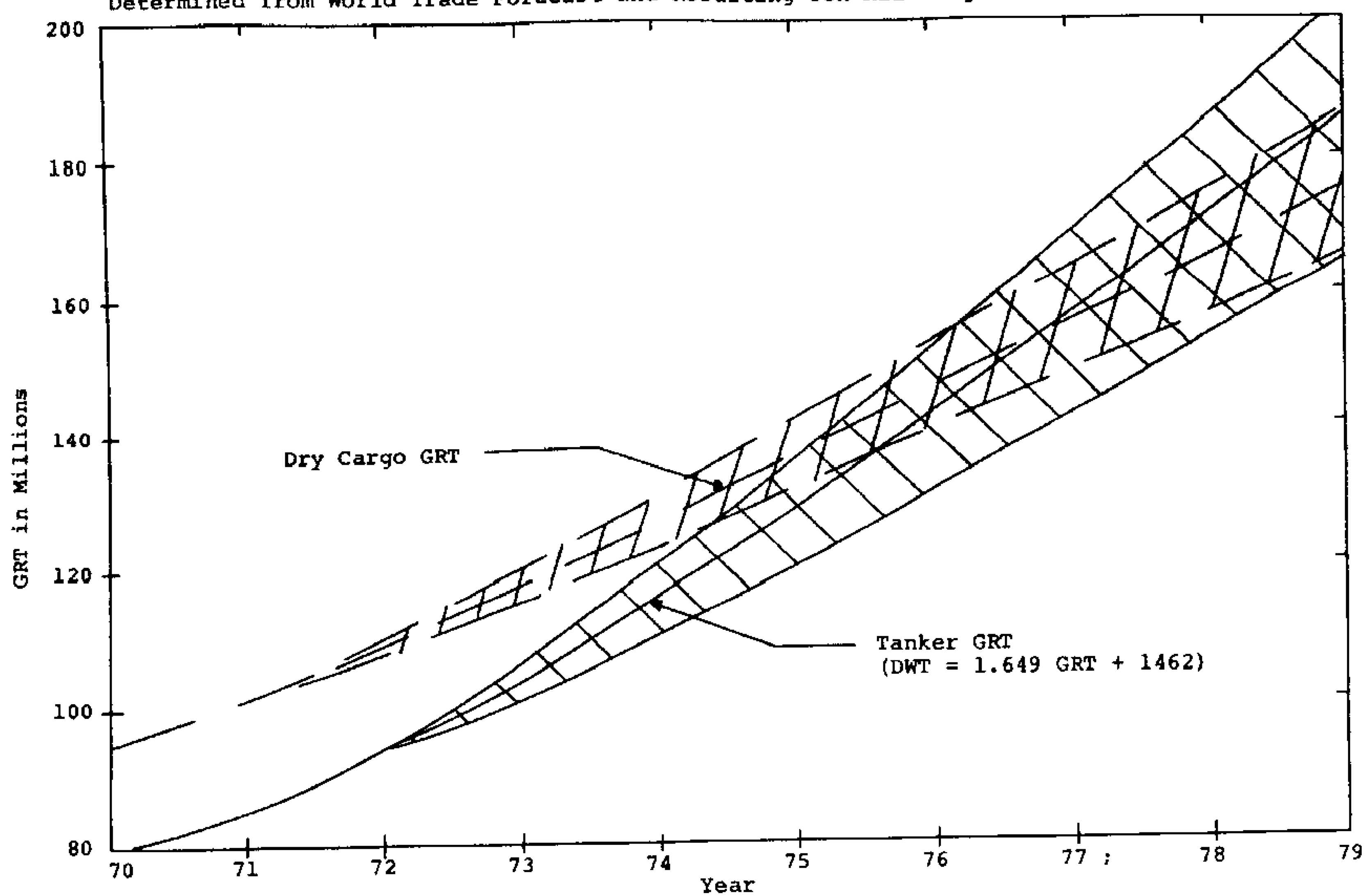
Figure I-1
Productivity of Ships in Ton-Miles/Annum DWT (Including
Ballast Trip for Bulk Carriers



This large increase in tonnage ordered, in turn, resulted in major expansion programs by the world shipping industry. Yet, by 1972 shipping rates returned to their lowest level of nearly a decade with the result that new building orders were greatly reduced and a large percentage of tonnage was prematurely scrapped, laid up, or underemployed. The total demand for shipping capacity worldwide is presented in Figure I-2, while Figure I-3 presents the projected total supply of shipping in the two major categories of liquid bulk and dry cargo.

The large variations in methods of shipping dry bulk cargo in tramps or dry bulk cargo ships makes it difficult to separate the dry bulk cargo component from the total dry cargo shipping demand and supply predictions.

Figure I-2
Projected Demand for Shipping Capacity (World)
Determined from World Trade Forecast and Resulting Ton-Mile Requirements



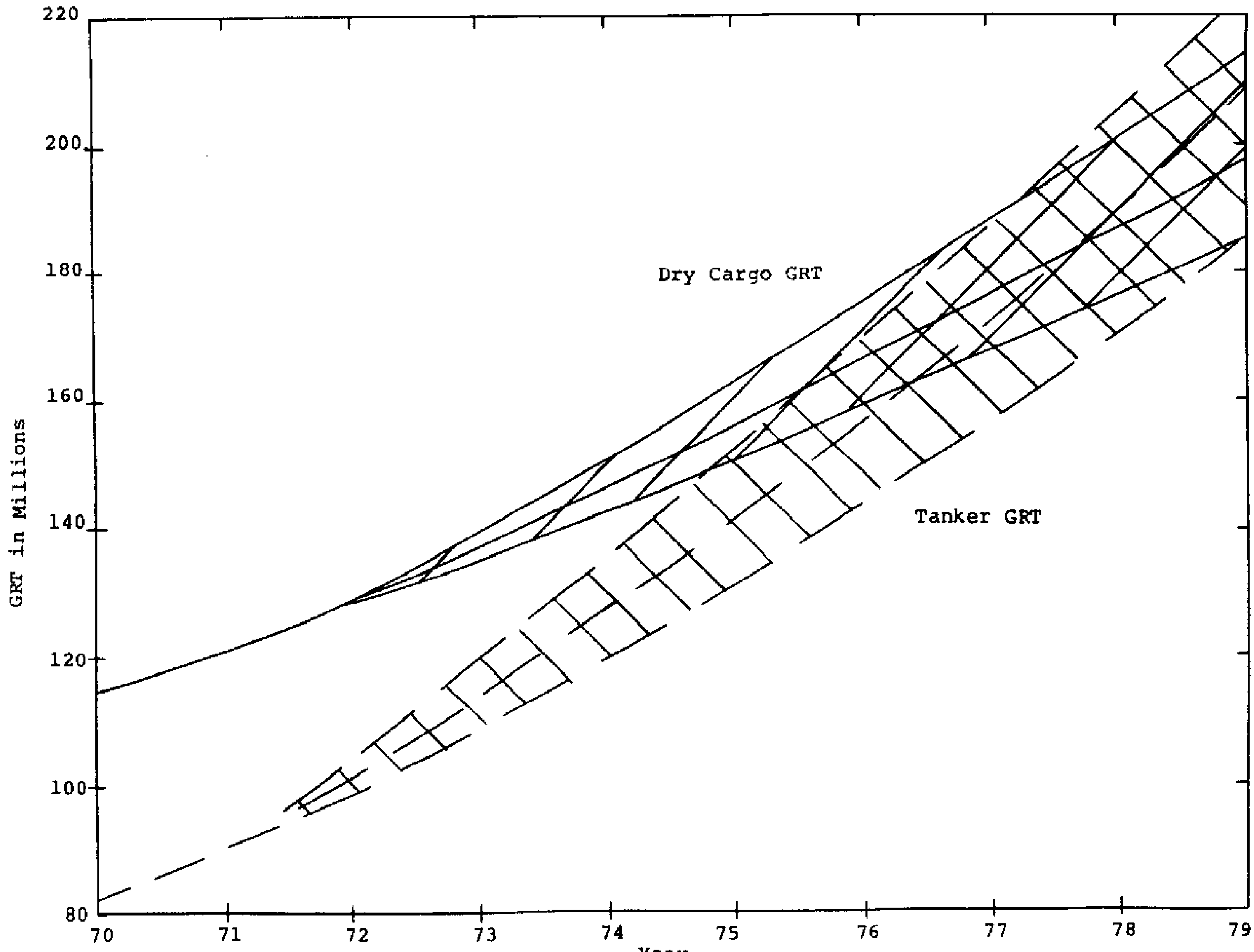


Figure I-3: Projected Supply of Shipping Capacity (World)

Chapter II

SHIPPING DEMAND

Tanker Demand

The demand for ton-miles of large crude carriers depends both on the growth in demand for oil in the major markets of the world - a fairly stable parameter tied directly to population and real wealth - and the sources of the oil - a considerably less predictable set of variables dependent on the vagaries of future oil finds and the political policies of less-than-completely stable governments. In order to obtain some insight into this complex set of interactions, the following set of analyses was performed.

The world was divided into the 15 oil producing/consuming regions listed below in Table II-1.

Table II-1

1970 SUPPLY AND DEMAND OF OIL

CODE		1970 DEMAND (Millions of long ton/quarter)	1970 SUPPLY
USA	North America	189.90	139.86
SA	South America (excl. Venezuela)	21.30	7.85
NEUR	Northwest Europe	92.96	4.03
MED	Mediterranean Europe	45.09	.30
JAP	Japan/Aust./N.Z.	55.84	.20
IND	India/Pakistan	5.90	2.58
SAF	South Africa	4.57	.00
CAR	Caribbean (incl. Venezuela)	9.48	52.53
NAF	North Africa	3.62	56.34
WAF	West Africa	1.53	12.03
PG	Middle East	14.39	166.55
INDO	Indonesia	6.51	12.33
SEA	North Sea	0.00	0.00
SIDON			
SUEZ			

The last two regions are dummy variables representing the Persian Gulf-Mediterranean Pipelines and the Red Sea-Mediterranean Pipelines/Canal respectively. Having divided the world into the major producing/consuming regions, growth rates for supply and demand in each of these regions through the next 15 years were assumed. The growth rates that were used in the following analyses were as shown in Table II-2.

Table II-2

PREDICTED OIL GROWTH RATES

REGION	ANNUAL GROWTH RATE-DEMAND			ANNUAL GROWTH RATE-SUPPLY		
	70-74	75-79	80-85	70-74	75-79	80-85
SA	6	4.5	3.0	3	1	-2
NEUR	8	6.5	4.5	15	5	3
MED	8	6.5	4.5	-4	-4	-4
JAP	12	6.5	4.5	-4	-4	-4
IND	12	8	6	15	10	5
SAF	10	10	10	0	5	5
CAR	12	8	6	0	0	0
NAF	8	6.5	4.5	3	0	-1
WAF	10	10	10	10	5	3
PG	10	10	10	15	10	5
INDO	10	10	10	(VARIABLE-SEE BELOW)		
SEA	(LINEAR GROWTH TO 2 MBPD IN 1975-CONSTANT THEREAFTER)					

These growth rates represent our present best estimates of the future growth of supply and demand in the world oil markets. They have been culled from a number of sources including the industry periodical OIL AND GAS JOURNAL and WORLD OIL, TWENTIETH CENTURY PETROLEUM STATISTICS prepared by DeGolyer and MacNaughton and PETROLEUM STATISTICS prepared by the OECD.

Other growth rates could of course be analyzed. Products movements were considered separately and the results of the crude oil movement analysis are shown in Table II-3.

In order to obtain the crude oil tanker ton-miles implied by these growth rates, the resulting regional supplies and demands for each year from 1970 to 1985, together with distances along major inter-regional trade routes were analyzed to determine that allocation of supplies to demands which resulted in all demands being filled with the least amount of ton-miles. In so doing, trade route distances were adjusted by the time to load and discharge (assumed to be two days each), the weights of the crudes were adjusted by the regional API gravities, and it was assumed that the Persian Gulf output could be expanded to meet any otherwise unfulfilled demands. Thus, in these analyses, the Persian Gulf which is generally the most distant supply source as far as the major markets are concerned serves as the supplier of the last resort.

With respect to pipelines, two sets of assumptions were considered, one relatively optimistic from the point of view of tanker owners and one relatively pessimistic:

1. RELATIVELY OPTIMISTIC (High ton-miles)
   a) Iraqi Petroleum Company line open throughout at 13.75 million long tons/quarter and TAP line opens in 1971 at 6.25×10^6 long tons/quarter and stays open.

   b) Suez Canal closes. Eliat-Ashkelon pipeline grows to 15 million long tons/quarter, constant thereafter. Two SUMED lines open at 30 million long tons/quarter in 1973, constant thereafter.

   c) Trans-Alaskan Pipeline opens in 1975 at 26 million long tons per quarter.

2. RELATIVELY PESSIMISTIC (Low ton-miles)
   a) IPC and TAP line as above

   b) Suez Canal opened from 1972 on

   c) In addition to Trans-Alaskan Line, McKensie Valley Line opens in 1978 at 26 million long tons/quarter.

Under each of these assumptions, the following adjusted ton-miles of oil shipments per quarter are implied:

Table II-3

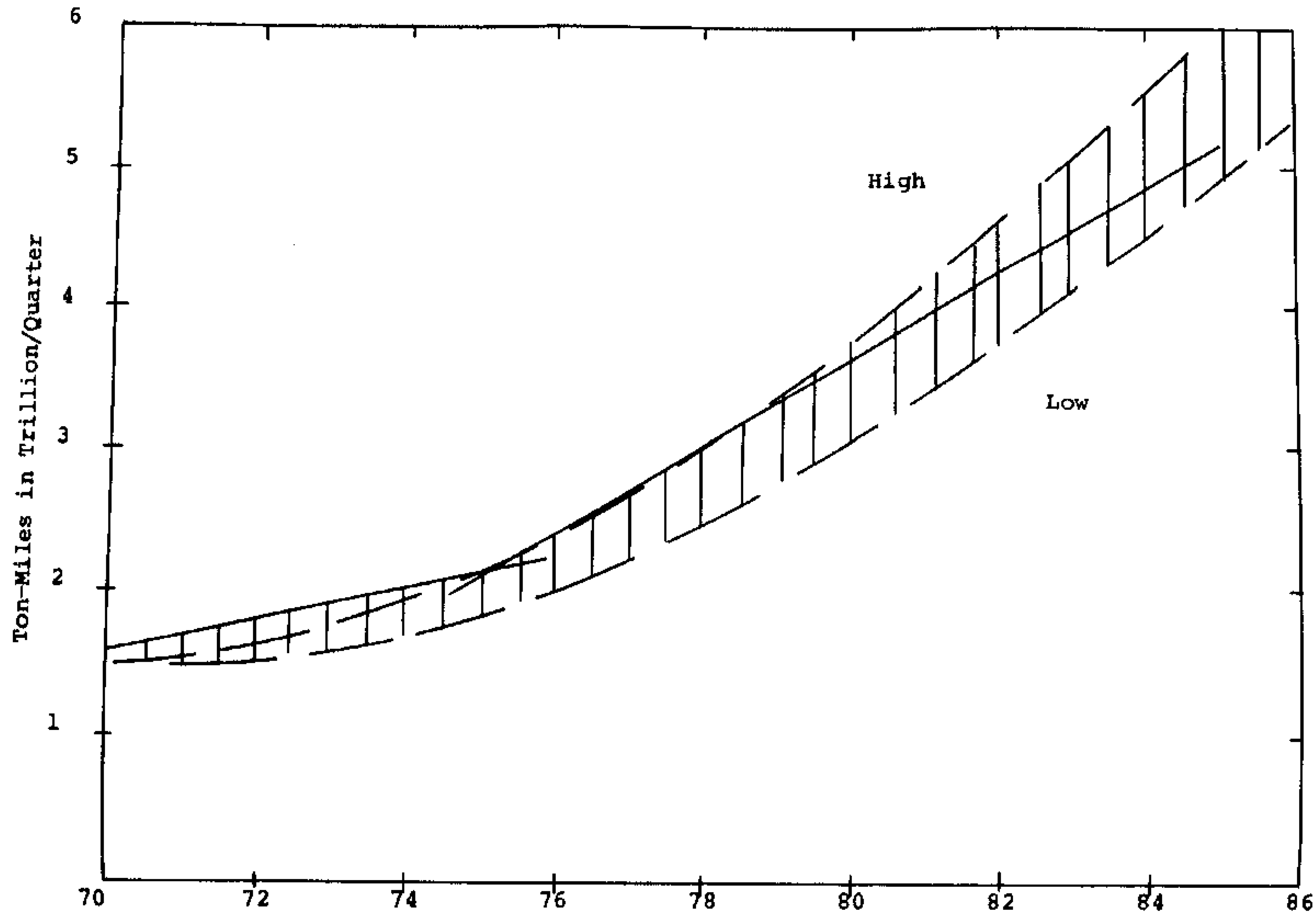
PREDICTED MOVEMENTS OF CRUDE OIL

YEAR	BILLIONS OF TON-MILES PER QUARTER HIGH EST.	LOW EST.
70	1664	1498
71	1647	1518
72	1841	1688
73	1972	1858
74	1933	1884
75	2003	1969
76	2319	2225
77	2655	2502
78	3013	2538
79	3393	2847
80	3798	3038
81	4190	3417
82	4599	3760
83	5024	4116
84	5466	4488
85	5927	4875

These relationships are depicted graphically in Figure II-1. Both sets of assumptions lead to the same basic picture. After a three or four year period of consolidation of recent near market discoveries and new pipelines, during which time the demand in loaded ton miles will grow at something less than 6%, the demand will move to a relatively stable growth rate of 10-11%. Major new near market discoveries could, of course, obviate this latter conclusion.

During the last five years, the demand in loaded ton-miles has been growing at an average rate of 18%. During this time, the average loaded crude route distance jumped from 4600 and 6700 miles. We believe this to be a transient situation fostered by a closing of the Canal coupled with the replacement of Venezuela by the Persian Gulf as the major source of European oil. The program does not feel that such increases in route lengths as we saw through this period will be maintained through the future. However, after

Figure II-1
Crude Oil Movements in Trillion of Ton-Miles Per Quarter



1975, the percentage of world oil emanating from the Persian Gulf begins a steady climb, as is indicated by Figure II-1. Thus route lengths will begin to increase again but it will be nothing like the increase observed in the 1965-1970 period. The demand for product tankers is a fraction of the crude tanker demand. It furthermore fluctuates even more widely as pipeline, barge and other modal distribution transport modes find increasing application. Total tanker ton-miles of product movements world wide were approximately 160 BILLION/year in 1970 performed by about 4.2 MILLION GRT of product tankers. This number is expected to increase at about 4% until 1976 and at about 6% thereafter.

A more detailed analysis of ton-mile requirements for crude oil movements was performed which includes the effects of:

1.) Suez Canal and Persian Gulf Mediterranean available at all times.

2.) Indonesian offshore production at 2 million barrels per day.

3.) Alaska production at 4 million barrels per day.

The resulting requirements in billion of ton-miles are shown in Figure II-2. Persian Gulf loadings are shown in Figure II-3 and the effect of increased annual production after 1976 at the rate of 1-3 barrels per day is presented.

Most projections of oil ton-miles are mere extrapolations of past practice tied to projections in population growth and GNP and do not account for changes in route length. An exception is the INTERFAFT report on Middle East pipelines which arrives at a conclusion similar to ours. Since the INTERNAFT report was prepared, the Shah of Iran has agreed to finance a second 42" crude pipeline, SUMED No. 2.

Figure II-2

Ton Mile Requirements for Crude Petroleum

1970-1985

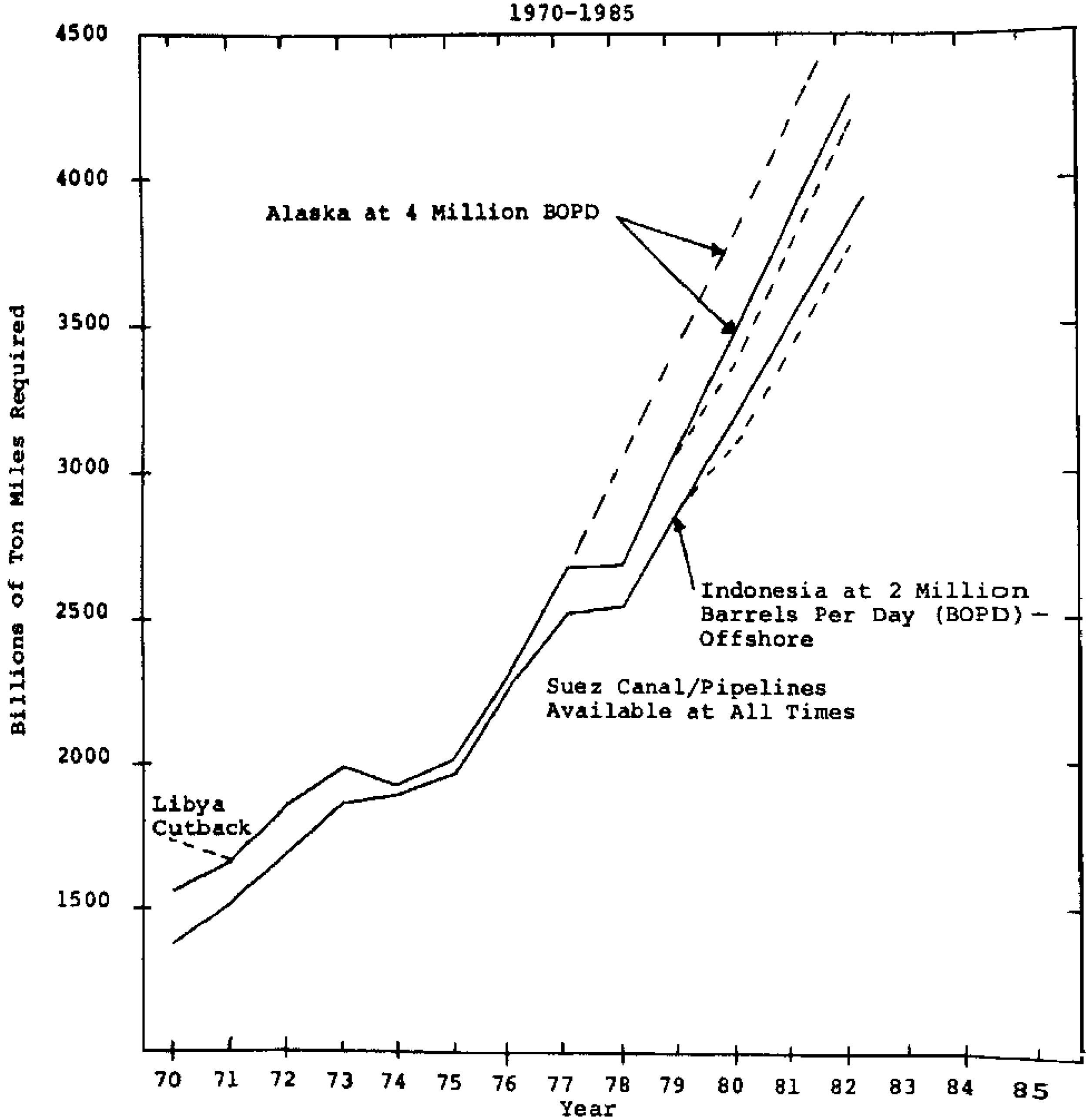
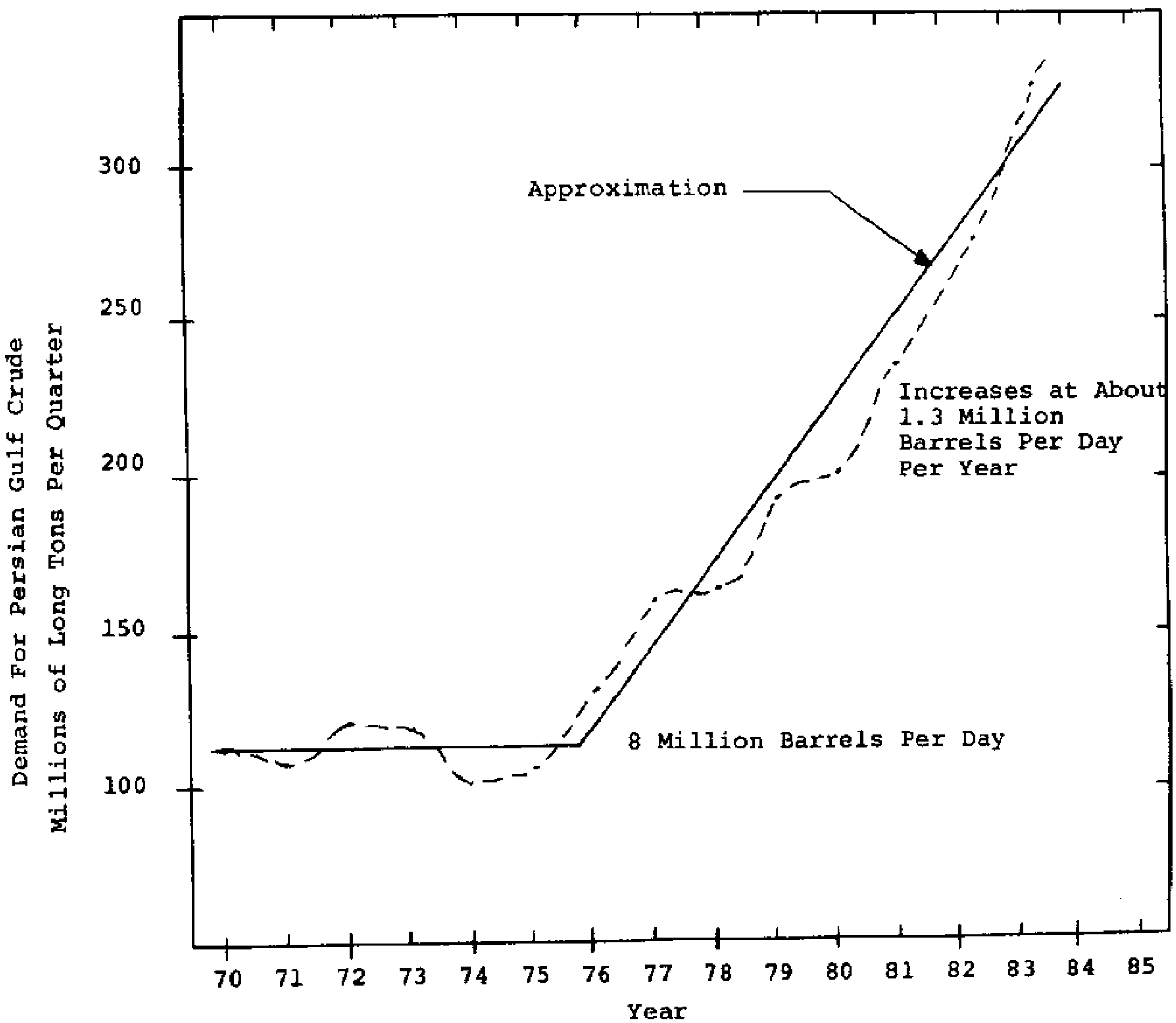


Figure II-3

Persian Gulf Loadings

1970-1985



Dry Bulk Ship Demand

Dry bulk carrier ton-miles have been increasing at a remarkably rapid rate over the last ten years. In part this was due to penetration by the bulk carrier of trades which had been carried in tweendeckers largely occupied in the tramp trade. This process has gone about as far as it can with over 80% of all bulkable cargoes being carried in pure bulk carriers now. Hence, any further increases will have to be based on market growth.

The single most important bulk trade is iron ore trade for which ton-mile growth has been of the order of 23% for the last three years. It is felt, that route length increases will level off and that a growth rate for iron ore of perhaps 15% for the next five years falling to 10% in the late 70's as route length growth ceases would be a reasonable estimate.

Coal is the second most important trade. It also has enjoyed spectacular growth in ton-miles over the last three years. However, Japan imports over 70% of all the coal moved mostly from the U.S. It is anticipated that Australia will penetrate some of the U.S. trade and that a net decrease in route length is possible. Hence, a growth rate of 10-8% in this trade is reasonable. With the grain revolution, the FAO is currently predicting a leveling off of the trade in coarse grains. No route length increases are foreseen. Hence, little growth in this trade is predicted although increasing imports to Japan from Brazil may influence this trend. Trade in aluminum currently representing less than 5% of the world's total dry bulk ton-miles will grow quite rapidly with an anticipated increase of 13% per year in tons coupled with a rapid increase in route length as Australia supplants nearer market sources. Fertilizer trades will most likely continue to grow along present lines. In summary, we do not believe recent growth rates in the bulk trades can be sustained, but rather that they were a transient response to the economies of the bulk carrier and that the now established average loaded route lengths will be increasingly stable.

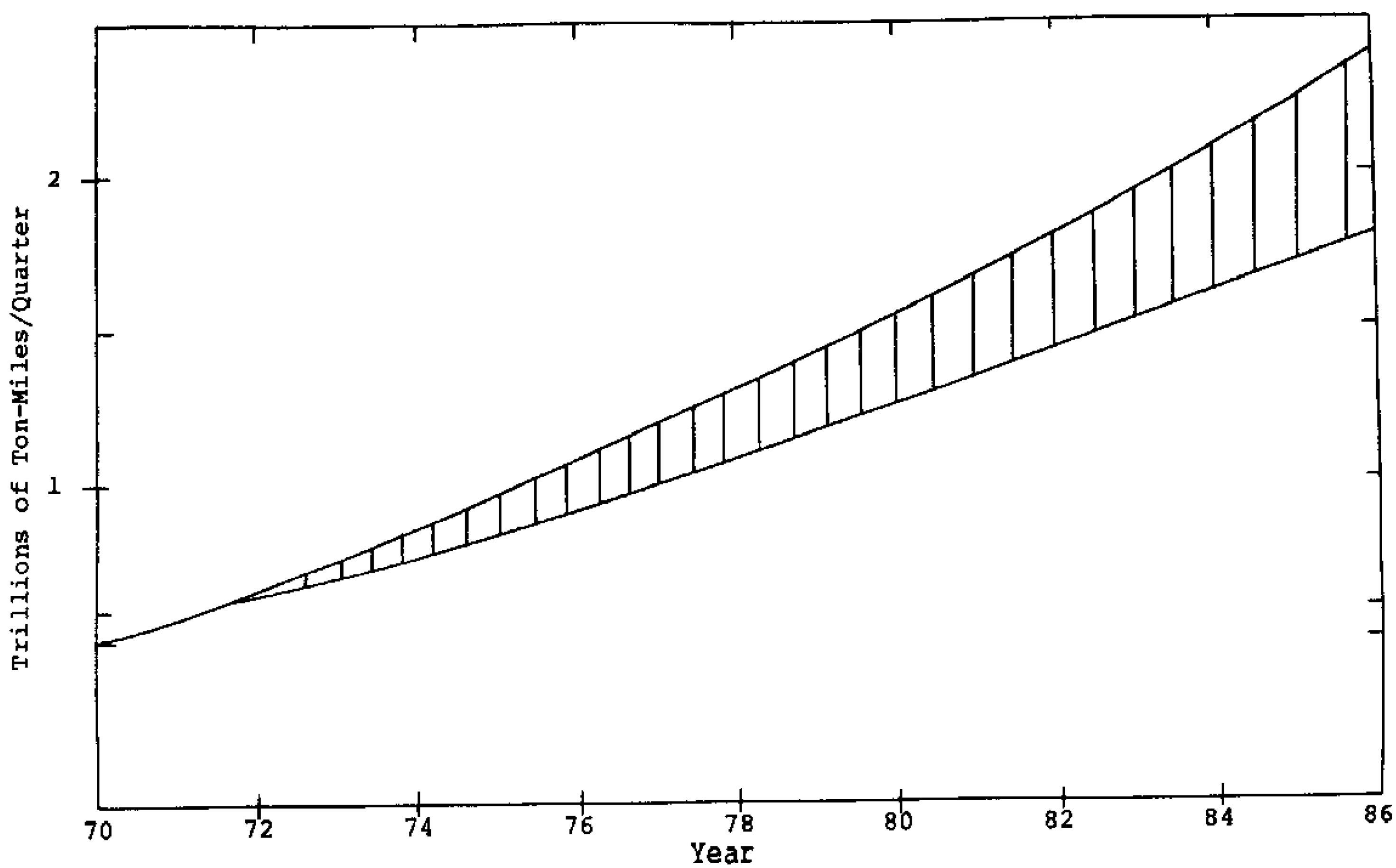
Taking this basic viewpoint, we have examined two possibilities, one which we regard as relatively optimistic and one which we think is relatively pessimistic. For the optimistic case we have assumed 15% growth in loaded ton miles for all bulk trades for the period 70-75, 10% growth for the next five years and 8% growth in the period 1980-1985. The pessimistic set of assumptions was based on 12% growth in dry bulk ton miles for the next five years, followed by five years of 8% growth and finally five years of 6% growth. We believe that these two sets of assumptions bracket the possibilities. A more detailed supply and demand analysis as undertaken for the oil trades would be required to be more specific. The fact that the dry bulk ton-miles are approximately one-third the oil ton-miles ameliorates the effects of errors in the dry bulk side. In any event, under these assumptions the following total loaded billions of per quarter ton-miles would be required:

	HIGH			LOW		
YEAR	DRY	OIL	TOTAL	DRY	OIL	TOTAL
1970	507	1664	2171	494	1498	1992
1971	583	1647	2230	553	1518	2071
1972	671	1841	2512	619	1688	2307
1973	771	1972	2743	694	1858	2552
1974	887	1933	2859	777	1884	2661
1975	976	2003	2909	834	1969	2838
1976	1070	2319	3389	906	2225	3131
1977	1180	2655	3835	979	2502	3482
1978	1298	3013	4311	1057	2538	3595
1979	1428	3393	4821	1142	2847	3989
1980	1542	3798	5340	1210	3038	4248
1981	1666	4190	5856	1283	3417	4700
1982	1799	4599	6398	1360	3760	5120
1983	1943	5024	6967	1441	4116	5557
1984	2098	5466	7564	1528	4488	6016
1985	2266	5927	8193	1619	4875	6494

These results are shown in Figure II-4. The results differ from most projections with respect to the low rate of growth in oil ton-miles through the next four years. Growth rates in demand for oil in the various regions are generally higher in the next five years than they are in subsequent periods. Rather it is due to the consolidation of new near-market finds principally in the North Sea and Alaska and the introduction or reintroduction of new Middle East Pipeline. This basic pattern holds even if the Canal does not reopen.

Figure II-4

Dry Bulk Movements

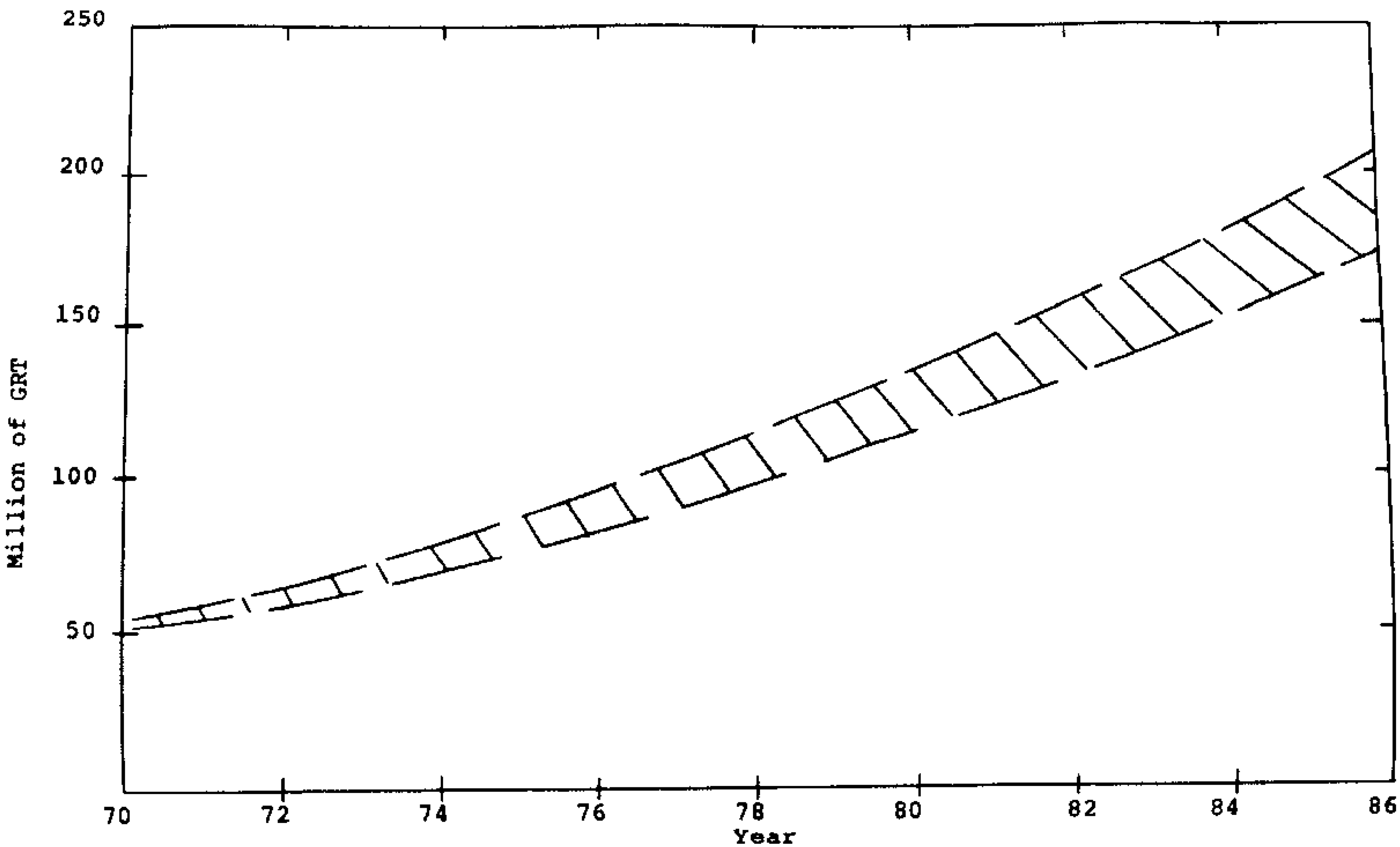


The average bulk carrier increased in size from 10,000 DWT in 1936 to 16,000 DWT in 1960 and 25,000 DWT in 1970. Assuming a continuation of this trend the total dry bulk tonnage demand is expected to increase from about 50 million GRT in 1970 to about 130 million GRT in 1980.

The results of the required dry bulk movement projections were used to compute required dry bulk shipping capacity as presented in GRT in Figure II-5.

Figure II-5

Projected Demand for Dry Bulk Shipping



General Cargo Ship Demand

New bulk dry cargo transportation demand is particularly hazardous to estimate and project because it comprises an unlimited number of heterogeneous products whose movement is subject to a large number of factors. Some recent studies such as those of B.R.T. Emery ("The Relation of Export and Economic Growth") and L.W.M. Mennes ("A World Trade Model for 1970") closely couple general cargo movements in foreign trade to the growth in GNP. While this appears to be true for trade between the major developed nations, it seems more difficult to justify in trade to or from developing nations. General cargo transportation demand includes, for our purposes:

1.) General cargo consisting of packaged, bagged, or otherwise contained manufactured and semi-processed goods. These are included under the general term of general cargo moved largely in scheduled service. Odd lot containerized and/or unitized cargo is included in this category.

2.) Containerized cargo consisting of unitized movements by container and/or barge ships which handle such cargo exclusively.

3.) Miscellaneous dry cargo is defined as raw or processed commodities handled by general cargo ships in non-scheduled service, which move in quantities too small to justify bulk movements and/or cannot be handled by bulk transfer methods. This category includes cargo generally classed under neo-bulk.

To determine the demand for general cargo movements in world trade we used as a reference the trend from 1966 to 1970 when this cargo increased from 355 to 428 million tons. The transport effectiveness measured by tons one year divided by fleet dead weight during this time period was found to be 4.4-5.1 for scheduled general cargo ships, 5.9-6.7 for containerships and 4.2-5.4 for miscellaneous non-scheduled cargo ships (non-bulk). Although air freight became a factor in general cargo movements during this period, particularly in high value cargo movements, the increased use of high speed containerships in the carriage of such trade seems to have stemmed the growth of inroads made by this competition. It will be assumed that air freight will continue to handle an increasing amount of high value general cargo freight, but that the growth of such air freight will be only slightly above the total growth of this trade, or 6.5-7.5% per year.

The total demand for general cargo movement in world ocean trade is presented in Figure II-6. It is divided into the above named three categories.

The growth rates are a composite of the percentage of the trade between developed countries multiplied by their average expected annual growth in GNP and the percentage trade with developing countries multiplied by a factor equal to twice their average expected annual growth in GNP in 1970. This factor is reduced to the average expected annual growth in GNP of developing countries in 1980. The basic assumption made was that various foreign aid and similar agreements will permit growth of general cargo trade with such nations at a higher rate than GNP. On the other hand new trading patterns and developments in international relations are expected to largely offset foreign aid effects in such trades by 1980.

The resulting expected annual growth rates (for 1970-1980) in demand are 7.4% per annum for container cargo moved in container and/or barge carrying ships, and 5.5% for both general and miscellaneous dry cargo moving in scheduled and/or unscheduled general cargo ships. It will be noted that the deviation from the estimated growth is largest for general cargo ships. The growth of miscellaneous dry cargo may be affected by the introduction of an increasing number of barge carrying ships, which offer unique advantages to neo-bulk and similar cargoes.

Difficulty was met in determining the average route length in total world general cargo trade. This is largely because of the great fluctuations in trading patterns. As a result, the demand for DWT in the three categories of total general dry cargo was established by using current and expected trend in transport effectiveness. Figure II-7 gives the results of this analysis. It was assumed that the transport effectiveness of scheduled and unscheduled general cargo ships will not increase because effects of improved turn-around time will probably be balanced by the effect of longer average route lengths. On the other hand, it is estimated that containership transport effectiveness will increase by about 20% to 6.8-7.9 by 1980. This is expected to be largely the result of higher speeds and relatively constant average route lengths.

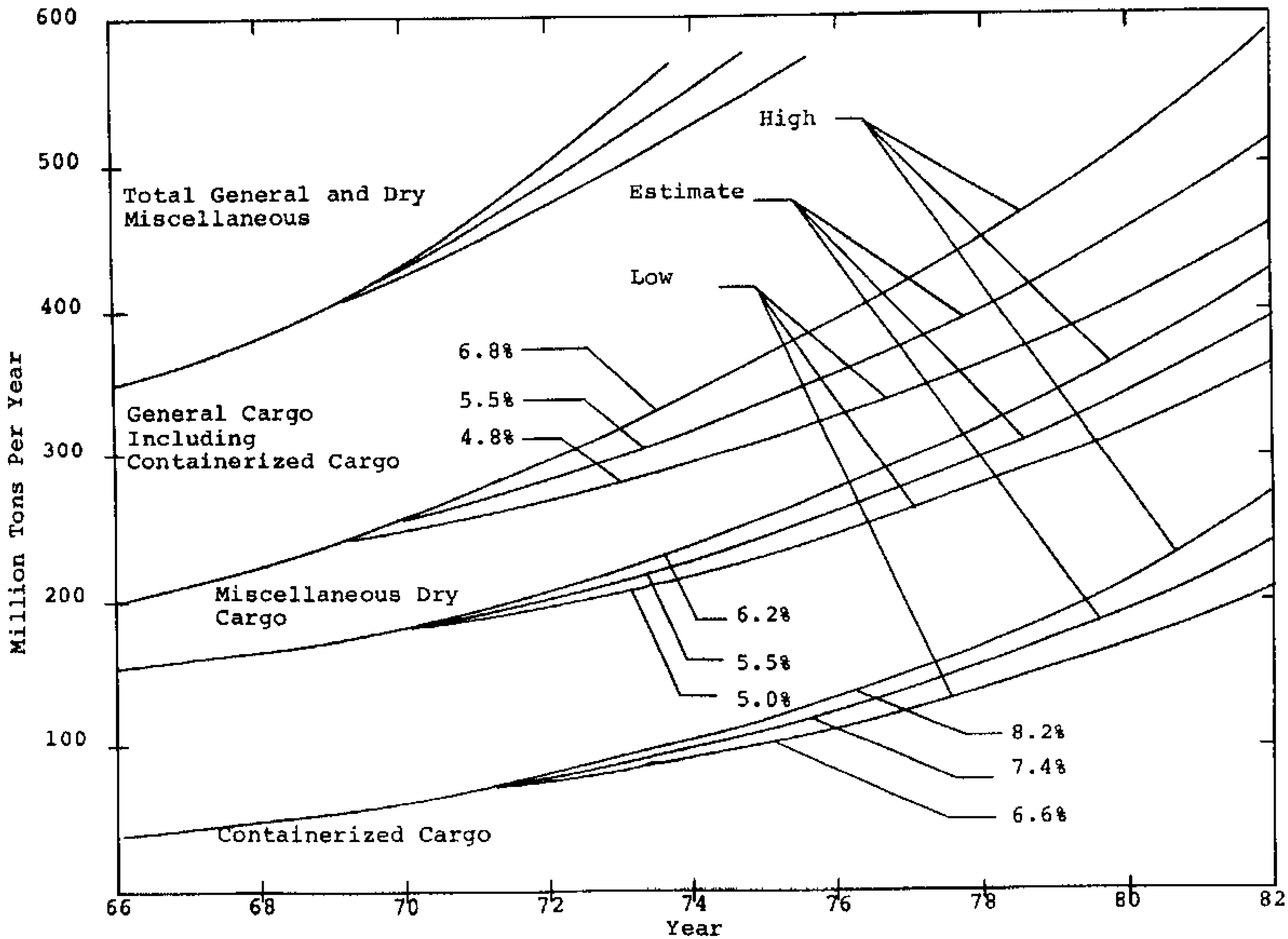
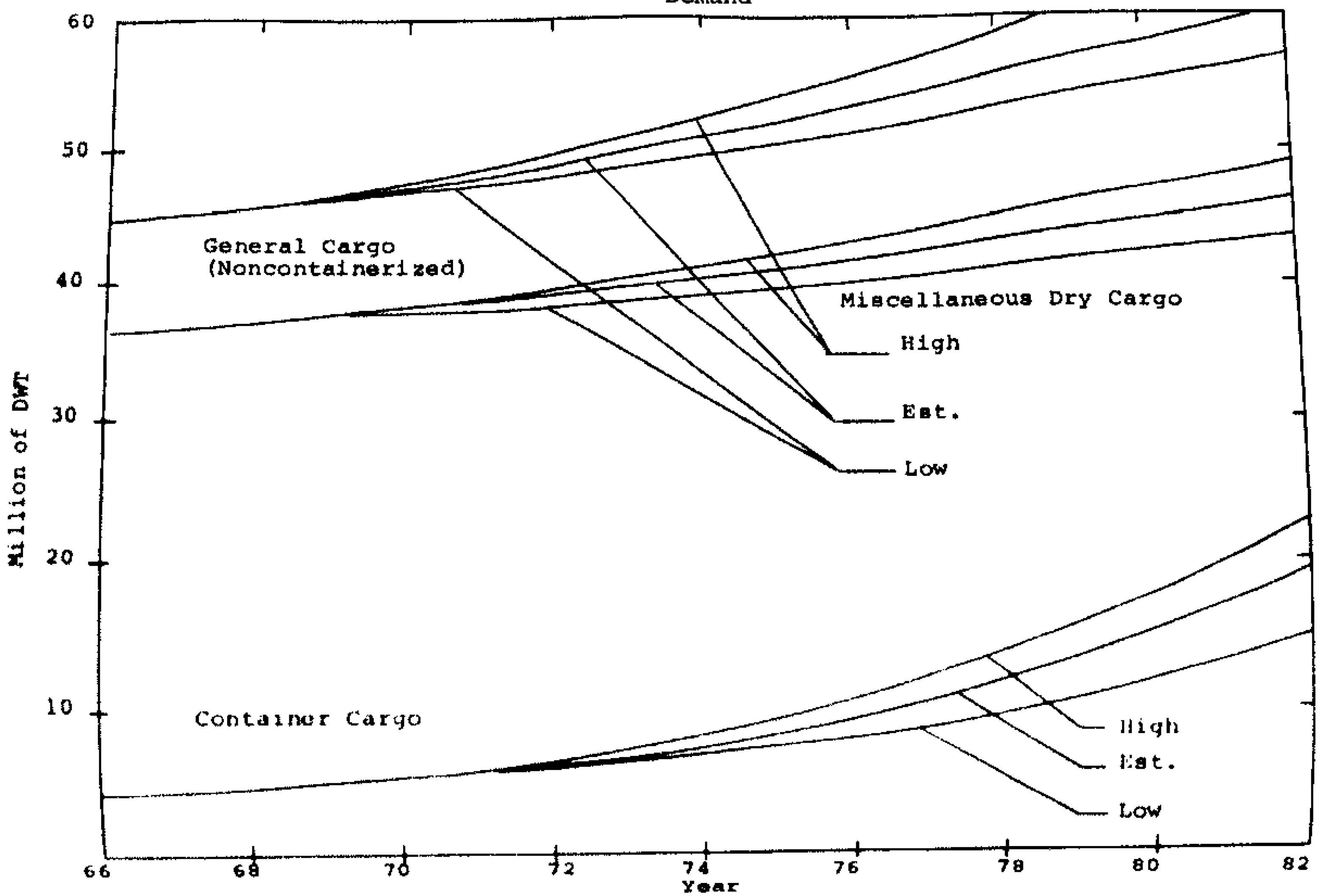


Figure II-6: General Cargo Movements

Figure II-7

General Cargo - DWT

Demand



Chapter III

SHIPPING SUPPLY

Available Shipping

The fastest growing component of world shipping is the bulk fleet. The total dry and liquid bulk fleet DWT increased in 1971 by over 13.5% while tanker DWT increased by over 12%. General cargo ship DWT, on the other hand, increased by a mere 5.0% of which containership accounted for the major part. Currently available world ocean shipping capacity is presented in Table III-1. The average tanker has now a deadweight of over 45000 DWT, combined carriers 82000 DWT, bulk carriers 29500 DWT, and general cargo ships 8500 DWT. (It should be noted that short route and coastal vessels of less than 4000 DWT are not included.)

The average size of vessel in the dry and liquid bulk fleet now exceeds 44000 DWT.

The average age of ships in the bulk fleet continues to decrease and is now less than 7 years; the average age of ships in the general cargo fleet (excluding U.S. reserve fleet vessels) remains at about 9.2 years. It should be noted, though, that the average age per DWT of bulk carriers is appreciably lower. Combined carriers and LNG tankers have the lowest average age with 3.8 and 0.8 years respectively. Among general cargo ships we find that containerships average 2.8 years of age.

The average speed of liquid and dry bulk carriers has remained at 15-16 knots, while the average speed of general cargo ships has increased to 16-17 knots. Of this, containerships now in existance average a speed of nearly 22 knots.

Shipbuilding Capacity

World shipbuilding capacity has increased rapidly since 1960, largely as a result of the construction of over 20 new larger tanker shipyards and today comprises a capacity in excess of 29 million GRT. This capacity will be increased to over 34 million GRT by 1974 when another 4-6 new shipyards become operational. Total output of the world shipbuilding industry amounts to about 24.5 million GRT and is expected to exceed 27 million GRT in 1974 (this is less than the total GRT on order, as some orders are expected to be canceled).

The output and capacity of the world shipbuilding industry are presented in Figure III-1 and by countries in Table III-2. Large tanker shipbuilding capacity is presented in Table III-3 while Table III-4 presents a list of the shipyards capable of building such large tankers.

Location, size and average recent yearly launching rate of building docks for large tankers are presented in Table III-5.

Table III-1

SHIPPING CAPACITY (Dec. 1971)*

(Vessels 4000 DWT and Over)

	No.	DWT (Million)	GRT (Million)
Tankers	3808	168.5	97.8
Combined Carriers	251	20.7	12.8
Bulk Carriers	2345	69.3	42.4
General Cargo Ships	10800	92.2	72.6
TOTAL	15204	350.7	225.6

* References:

1.) Fearnley and Egers Chartering Co., Ltd., "World Bulk Fleet," (1971-1972 monthly).

2.) U.S. Maritime Administration, "Merchant Fleets of the World," (1969-1970).

3.) Fairplay Publications.

Figure III-1

Output and Capacity of World Shipbuilding

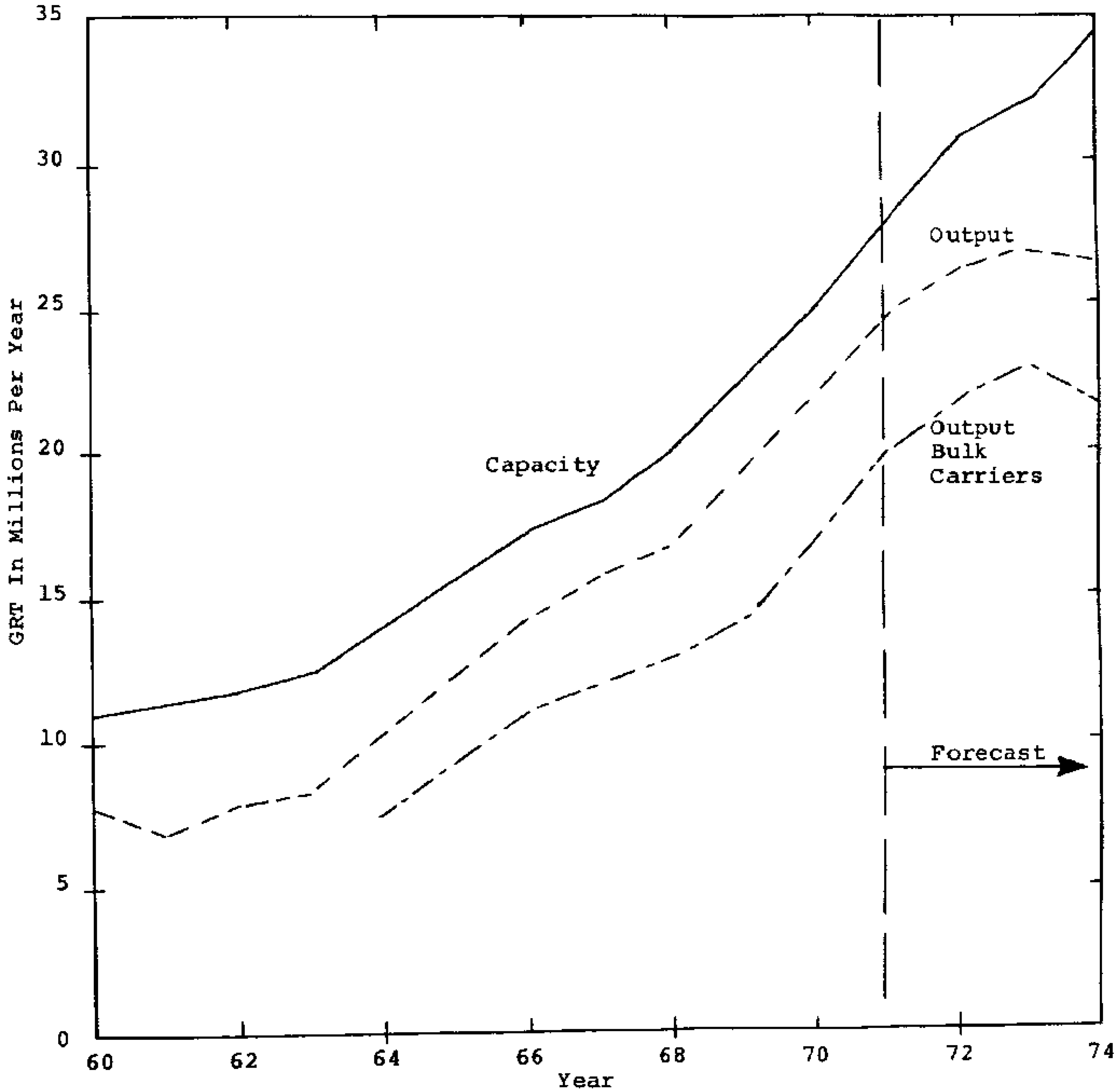


Table III-2

SHIPYARD CAPACITY AND EXISTING ORDERS*

1,000,000's GRT/Year

Country \ Year	Existing Yard Capacity 1971	Orders 1972	Expansion by 1974	Indicated Yard Capacity 1974
Japan	12.500	13.999	3.0	15.5
United Kingdom	1.700	1.056	.0	1.7
Sweden	3.000	3.041	.0	3.0
Norway	1.000	1.017	.5	1.5
Denmark	1.200	1.132	.1	1.3
Germany	1.500	.225	.5	2.0
Italy	1.000	1.264	.2	1.2
Spain	1.700	1.676	1.3	3.0
Netherlands	.800	.950	.4	1.2
Taiwan	.100	.098	.4	.5
France	1.000	1.395	.5	1.5
Yugoslavia	.750	1.078	.25	1.0
Portugal	.250	.0	.0	.25
Brazil	.100	.0	.4	.50
Others	1.000			1.20
Totals	27.600	26,93	7.55	34.35**

* As of June 1971.

** Some existing yard capacity is expected to be eliminated. Therefore, indicated yard capacity (1974) is less than existing capacity (1971) plus expansion capacity.

Tanker Size $DWT \times 10^3$	1970				1975			
	Building Docks are used to build tankers whose dead-weight equals the dock size		Building Docks over 350,000 DWT are used to build 250,000 DWT tankers		Building Docks are used to build tankers whose dead-weight equals the dock size		Building Docks over 350,000 DWT are used to build 250,000 DWT tankers	
	#Tankers	DWT	#Tankers	DWT	#Tankers	DWT	#Tankers	DWT
150-200	24	4,200,000	24	4,200,000	24	4,200,000	24	4,200,000
200-250	18.5	4,387,275	18.5	4,387,275	18.5	4,387,275	18.5	4,387,275
250-300	21	6,324,450	21	6,324,450	22	6,599,450	22	6,599,450
300-350	4.5	488,475	4.5	488,475	4.5	488,475	4.5	488,475
350-400	5	1,875,000			5	1,875,000		
400-500	11.5	5,180,000			11.5	5,180,000		
500-600	3	1,650,000			3	1,650,000		
600-700	2	1,300,000			4.5	2,925,000		
700-800								
800-900								
900-1000	2	1,900,000			4			
250			33.5	8,375,000		3,800,000	41.5	10,375,000
Totals		27,305,200		23,775,200		31,105,200		26,050,200

LARGE TANKER BUILDING CAPACITY/YEAR

Table III-3

Table III-4

SHIPYARDS CAPABLE OF BUILDING SHIPS IN EXCESS OF 150,000 DWT

(1972)

	Building Docks		Building Ways	
	Qty.	For up to (DWT)	Qty.	Maximum (DWT)
DENMARK				
Odense Staalskibsvaerft	2	200,000		
	1	*500,000		
FRANCE				
Chantiers De L'Atlantique	1	700,000		
	1	250,000		
Chantiers Navals De La Ciotat	1	350,000		
France-Gironde	1	160,000	1	170,000
GERMANY				
Aktien-Gesellschaft "Weser"	1	400,000	1	250,000
Howaldtswerke-Deutsche Werft	1	250,000		
	1	300,000		
GREECE				
Hellenic Shipyards	1	240,000		
ITALY				
Italcantieri	1	400,000		
JAPAN				
Hitachi Shipbuilding & Engineering Co.	1**	400,000	1	160,000
			1	180,000
Ishikawajima-Harima Heavy Industries	1	160,000		
	1	200,000		
	1	500,000	1	150,000

*We feel this has a capability for 800,000 or maybe even 1,000,000 DWT

**They plan a new yard for '73 or '74 with a 1,000,000 DWT dock.

Table III-4
(continued)

	Building Docks		Building Ways	
	Qty	For up to (DWT)	Qty.	Maximum (DWT)
SPAIN (continued)				
Astilleros y Talleres Del Noroeste S.A. (ASTANO)			2	350,000
SWEDEN				
Ericksbergs Mck. Verkstad Aktiebolag	1	400,000		
Gotaverken AIB	2	250,000		
Kockums Mekaniska Verkstads	1	700,000		
Uddevallavarett AIB	1	250,000		
UNITED KINGDOM				
Doxford & Sunderland Shpbldg. & Eng. Co. Ltd.	1	160,000		
Harland Wolff Ltd.	1	1,000,000		
Scott Lithgow Drydocks	1	200,000		
Swan Hunter & Tyne Shipbuilders Ltd.			1 1	300,000 170,000
UNITED STATES				
Bethlehem Steel Shbldg.	1	300,000		
Seatrain Shbldg. Corp.	2	230,000		
Newport News	1	200,000		
YUGOSLAVIA				
"Split", Brodogradiliste	1	220,000		
"Uljanik" Brodogradiliste	1	300,000		
TOTAL	48		16	

Table III-4
(continued)

	Building Docks		Building Ways	
	Qty.	For up to (DWT)	Qty.	Maximum (DWT)
JAPAN (continued)				
Kawasaki	1 1	450,000 280,000	1	150,000
Mitsubishi Heavy Industries Ltd.	1 1 1	300,000 300,000 1,200,000	1	180,000
Mitsui Shipbuilding & Engineering Co.	1 1	500,000 300,000		
Nipon Kokan Kabushiki Faisha	1	600,000	1	150,000
Sasebo Heavy Industries	1	360,000		
Sumitomo Shipbuilding & Mach. Company	1 1	300,000 700,000	1	160,000
NETHERLANDS				
Nederlandshe Doken Scheepsbouw	1	250,000	1	200,000
Verolme	1 1	500,000 1,000,000		
NORWAY				
Aker Group	1	275,000		
Rosenberg Merkaniske Versted	1	160,000		
SPAIN				
Astilleros de Cadiz*	1	1,000,000	1	250,000
Bazan De Constucciones Navales Militares S.A. Emprisa Nacionel			1	160,000

*Expected completion 1975

Dock Size DWT × 10[3]	Denmark* (1)	Denmark* (2)	Denmark* (3)	France (1)	France (2)	France (3)	Germany (1)	Germany (2)	Germany (3)	Greece (1)	Greece (2)	Greece (3)	Italy (1)	Italy (2)	Italy (3)	Japan (1)	Japan (2)	Japan (3)	Netherlands (1)	Netherlands (2)	Netherlands (3)
150-200	2	3		1	2		1	2								2	10				
200-250				1	2					1	1					1	4.5		1	2	
250-300				1	2		1	2								3	12				
300-350				1	1.5																
350-400							1	1.5	2				1	2	2						
400-500	1	1	2													3	9	12	1	1.5	2
500-600																1	3	4			
600-700																1†	2.5	4			
700-800																					
800-900																					
900-1000																1*	2	4	1	1	2

Dock Size DWT × 10[3]	Norway (1)	Norway (2)	Norway (3)	Spain (1)	Spain (2)	Spain (3)	Sweden (1)	Sweden (2)	Sweden (3)	U.K. (1)	U.K. (2)	U.K. (3)	U.S.A. (1)	U.S.A. (2)	U.S.A. (3)	Yugoslavia (1)	Yugoslavia (2)	Yugoslavia (3)	Total (1)	Total (2)	Total (3)
150-200	1	2		1	1					3	3		1	1					12		
200-250							3	5		1	1		2	2		1	1		11		
250-300	1	3											1†	1		1	2		7→8†		
300-350				2	3														3		
350-400							1	1.5	2										3		
400-500																			5		
500-600																			1		
600-700							1	2	3.5										1→2†		
700-800																					
800-900																					
900-1000										1	1	2							2→3‡^		

*It should be noted that although Odense Lindo dock is classed as 500,000 DWT capacity, it is estimated to be able to handle 800,000-1,000,000 DWT tankers.

†Will come into service in 1972.

^Will come into service in 1973.

(1) Number of docks of that size in the country.

(2) Combined yearly launch rate of docks for tankers whose deadweight equals the dock size.

(3) Combined yearly launch rate of dock sizes in excess of 350,000 DWT for 250,000 DWT tankers.

LOCATION, SIZE AND YEARLY LAUNCHING RATE OF BUILDING DOCKS FOR TANKERS ABOVE 150,000 DWT

Table III-5

Similar statistics are difficult to assemble for shipyards capable of building smaller ships. The total number of the world shipyards capable of building ocean-going vessels (4000 DWT plus) is estimated at between 300-400.

The total world shipbuilding capacity for ocean-going ships now exceeds 1000 ships per year of about 27.6 million GRT and about 43 million DWT. Use of this total capacity would imply a real growth in world shipping capacity of about 7.2% (assuming scrapping and losses of 5.2% per year of available capacity). In estimating shipyard capacity we assumed full utilization of facilities in construction of ships of the average size built in the yard during the year. If we assume that each yard builds only vessels of the largest size that it is capable of building in its various facilities, then the total world shipbuilding capacity per year is estimated to be in excess of 36.0 million GRT and 57.0 million DWT. Such an estimate is largely judgmental, since many shipyards are constrained by their maximum steel throughput rather than their building way or outfit capacity.

Existing plans will result in the addition of over 10 million GRT or 38% to world shipbuilding capacity from 1970 to 1975. Furthermore plans are underway to upgrade and modernize a number of U.S. shipyards which should increase their potential output capacity by up to 500,000 GRT per annum. The growing demand for LNG tankers may result in the construction of a number of specialized shipyards which may add further to world shipbuilding capability. It appears that the capacity added during 1965-1974 averaged over 2 million GRT per year. This is vastly greater than the average required growth in shipbuilding output to meet escalation in demand. It therefore appears that the world shipbuilding industry will be subjected to a period of consolidation lasting until about 1977 when demand is expected to increase again sufficiently so as to close the gap between capacity and output to 20% or less.

Some shipbuilding such as that of LNG tankers is expected to benefit from a growing demand which may well outstrip capacity of efficient, experienced builders. This segment of the shipbuilding market may therefore offer an increasing opportunity for idle tanker capacity and/or marginal yard capability to be applied.

Shipbuilding Projection

The world shipbuilding industry has continued its rapid output growth during the last 10-20 years. This has largely been accomplished by improvements in productivity without major increases in total employment. During 1971, delivered DWT of tankers reached 19.8 million DWT, an increase of 2 million DWT over the previous year, while bulk and combined carrier DWT deliveries in 1971 were 13.6 million DWT or 2.6 million DWT more than in 1970. Delivered tonnage of general cargo ships only increased marginally. Recent trends in deliveries and delivery projections for major ship types are presented in Figure III-3. The large annual increase in tanker and dry bulk (including combined carriers) ship deliveries are expected to commence and to extend to 1977-78 when a reasonable uptrend may again occur. The major decrease in delivered DWT is estimated to occur in the tanker category. Dry bulk and combined carrier deliveries may actually continue to increase marginally until 1978-80 when deliveries will temporarily slump until 1983. General cargo ship DWT deliveries are expected to remain level to at least 1974 when a temporary decrease may reduce deliveries until 1976.

Shipbuilding delivery is subject to many factors outside pure economic and resulting transportation demand. Political, speculatory and strategic considerations usually play a major role. As a result, we established a high (upper) and low boundary of estimated total world deliveries. These boundaries were computed by eliminating output from marginal builders. It was assumed that efficient builders would continue during a price squeeze to build at 70-80% of their 1970 capacity, while marginal builders may have to cut back by as much as 50%.

Delivered commercial tonnage by U.S. shipyards was 611,000 DWT in 1970. While the total number of U.S. commercial ship deliveries is not expected to increase by more than 3-5 ships per year over the 13 vessels delivered in 1970, the delivered DWT is estimated to grow to an average of nearly 1.0 million by 1973-74. This is largely due to the increased size per unit ship deliveries resulting from the new tanker building capacity of Bethlehem Steel Company (Sparrows Point) and Seatrain Shipbuilding Corporation (Brooklyn). Total employment in U.S. commercial shipyards, though, is expected to remain level.

Historic employment levels in U.S. shipyards are shown in Figure III-2. It will be noted that non-production workers in U.S. private shipyards constitute more than 24% of production manning. This percentage is appreciably higher in Naval shipyards.

World shipbuilding delivery projections are presented in Figure III-2A which summarizes the projected requirements for tankers, dry bulk carriers and tankers previously derived.

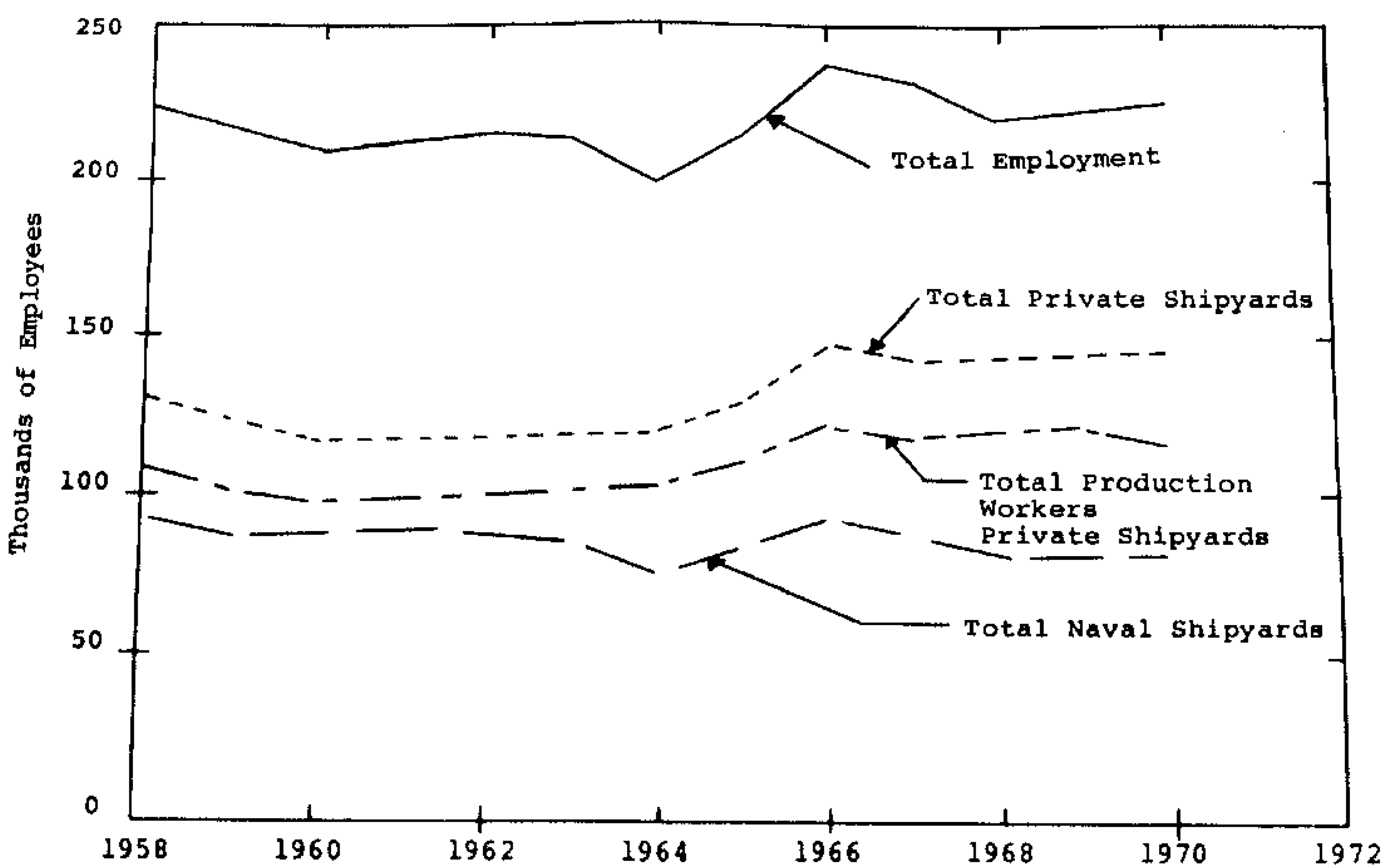
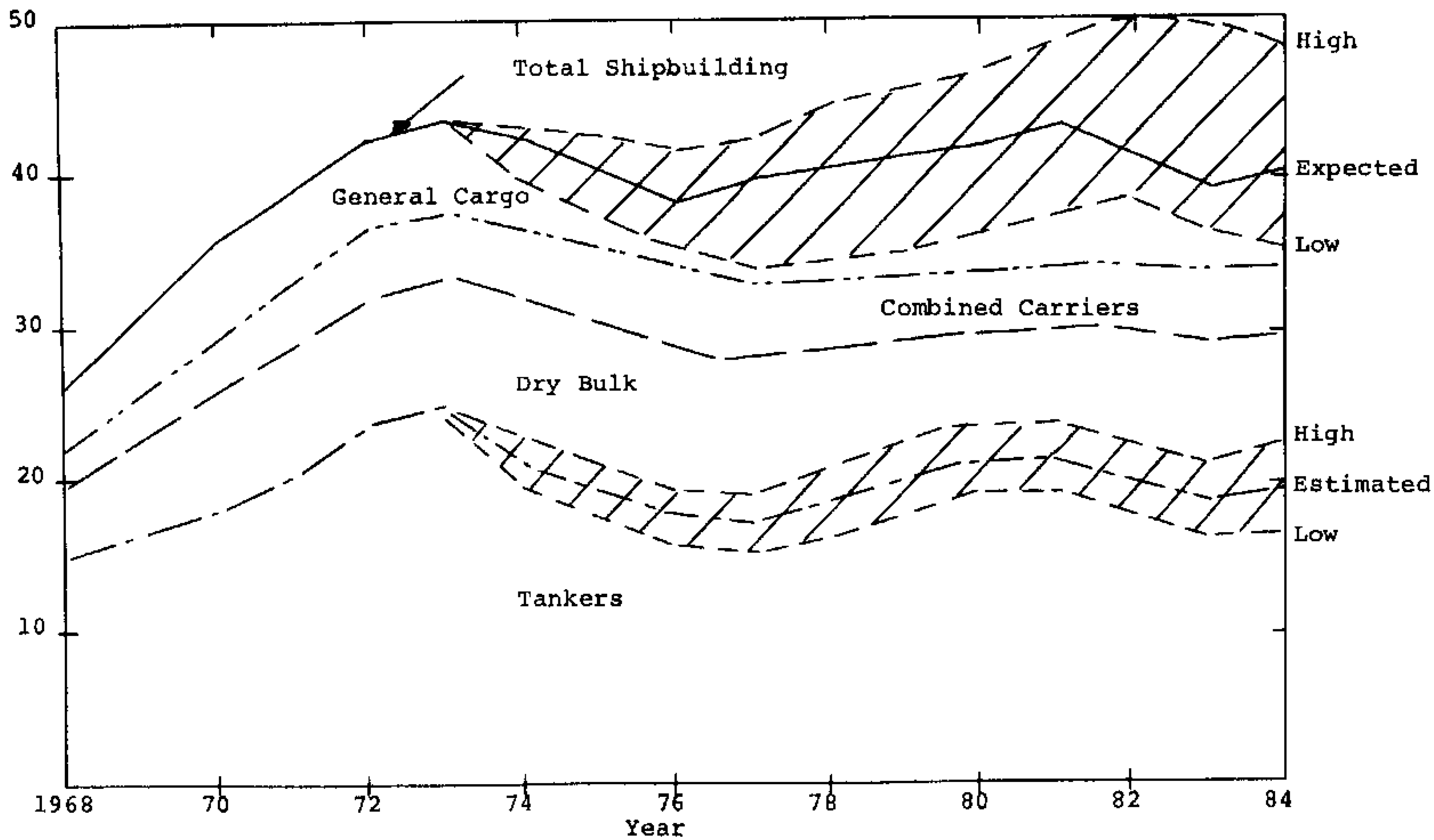


Figure III-2: U.S. Shipyard Employment

Figure III-3

Shipbuilding Delivery Projections (World)



Chapter IV

SUPPLY-DEMAND ANALYSIS

Tankers and Bulk Carriers

Combining the results of our supply and demand analysis, we next consider tankers and bulk carriers as a total group to determine sufficiency of supply to meet projected demand.

As of January, 1971, there were approximately 3235 billion loaded ton miles per quarter of large tanker-bulk carrier capacity afloat. This is based on adjusting the continuous ton-miles capacity (the amount of ton-miles a ship could make in a year if it traveled at its service speed for 365 days) by the factor .37 for tankers and .33 for bulk carriers. These factors are the ratio of loaded ton-miles to continuous ton-miles which we have observed in fully utilized tankers and bulk carriers over the last five years.

Observing the present order book, this capacity grows as shown below:

YEAR	1971	1972	1973	1974
CAPACITY	3235	3648	4090	4506

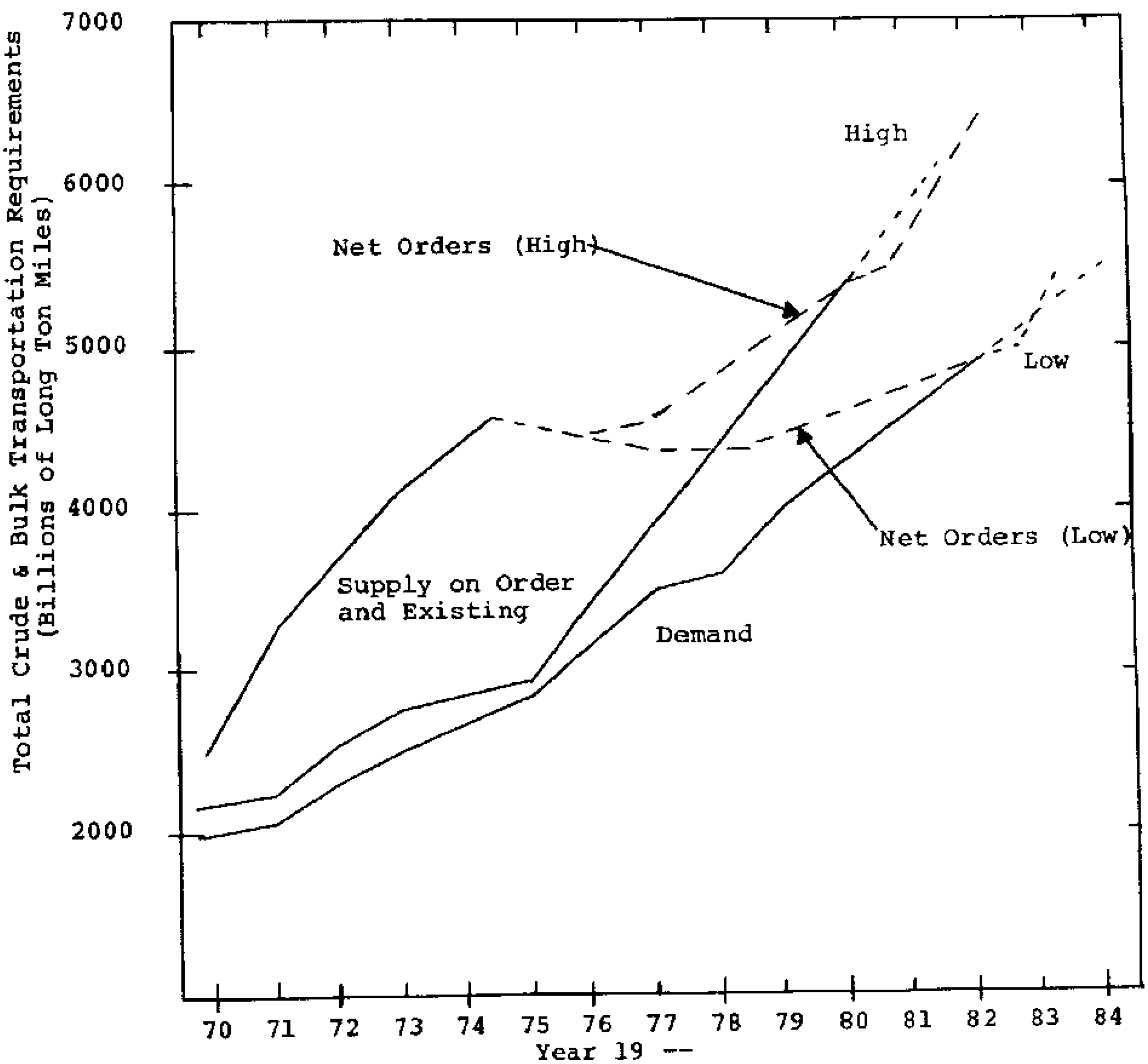
Adjusting these figures for scrappings and losses under the assumption that a ship is scrapped on its 25th birthday and 1% per year of the fleet is lost leads to the following estimates of the supply available:

YEAR	1971	1972	1973	1974
SUPPLY	3177	3587	4023	4435
DEMAND (HIGH)	2230	2512	2743	2859
DEMAND (LOW)	2071	2307	2552	2661

Quite clearly even under the high estimates, supply far surpasses demand. Hence, we are predicting extremely low rates in the ship charter markets for the next three or four years. During periods of extremely low rates, ship owners, both independent and proprietary, have a history of extremely low ordering rates. Assuming such an order rate and projecting supply and demand through the future, we find that for the high estimate, demand catches up with supply in 1977 and for the low in 1980, whereupon the rates will climb rapidly to representative levels and ordering rates will quickly respond. Under the assumption that if the market is undertonnaged, owners attempt to order so that the growth in capacity parallels the observed growth in ton-mile demand. The results of this supply-demand analysis for tanker-bulk carriers is shown in Figure IV-1.

Figure IV-1

Total Crude and Bulk Transportation Requirements



The basic pattern we are suggesting is for extremely low large ship orders from 1972-1975 followed by rapidly increasing orders. Once again, this differs from most prognostications which are based on steady state reasoning (ship orders are tied directly to the growth in trade or population or GNP). In actual fact, bulk shipping is a boom and bust business and this implies that shipbuilding will be faced with alternating periods of high orders and high prices with low orders and low prices. To assume otherwise is to assume a completely reversed buying pattern of the world's shipowners. It is obvious that we are entering a period of low orders and, given the present ships on order this period, it will last at least three or four years.

Past market behavior indicates that the amount of tonnage ordered is relatively independent of present shipyard price - demand is inelastic. Under this assumption, one can combine these projections on amount ordered with the shipbuilding industry's marginal cost curve to obtain an estimate of the ship prices which will prevail through time.

In summary we therefore conclude:

a) A good deal less than average growth in oil ton-miles through the next four years coupled with a very large orderbook built up over the last boom resulting in at least three and as much as five extremely lean years for shipowners.

b) As a result, new orders will be extremely light over the next four or five years. After the present surge of orders is launched, the fleet will grow quite slowly and eventually demand will catch up with supply. Currently, we are projecting that this will happen between 1977 and 1980 at which time charter rates will become remunerative, quite possibly extremely remunerative. This will result in orders for large oil and bulk carriers which will demand annual fleet additions of from 30-40 million DWT.

c) Yet even this large demand during the late 1970's will in all likelihood not sustain itself beyond 1982.

LNG Tankers

The demand for LNG tankers is quite recent. At this time, existing tonnage has been produced largely by three shipbuilding countries - France, Norway, and Sweden. The total number of ships in existence is still less than ten (including methane tankers, etc.) and the total existing capacity for this fleet is under 500,000 cubic meters. Concern with effects of air pollution, U.S. energy shortage, and the mushrooming increase in liquid petroleum costs indicate a rapid growth in demand for LNG. Considering western Europe, U.S., and Japanese demand, total LNG tanker requirements are projected at over 1.0 million cubic meters by 1974, 4.0 million cubic meters by 1978 and 10.0 million cubic meters by 1982.

Existing experienced LNG tanker shipbuilding capacity is not able to meet this growing demand. As a result, U.S., Spanish, and Japanese shipyards among others have shown an increased interest in this shipbuilding potential. Some U.S. yards are considering conversion to LNG building capability, while plans are underway in Spain for the construction of a new specialized LNG tanker shipyard with a capability of two 165,000 cubic meters per year.

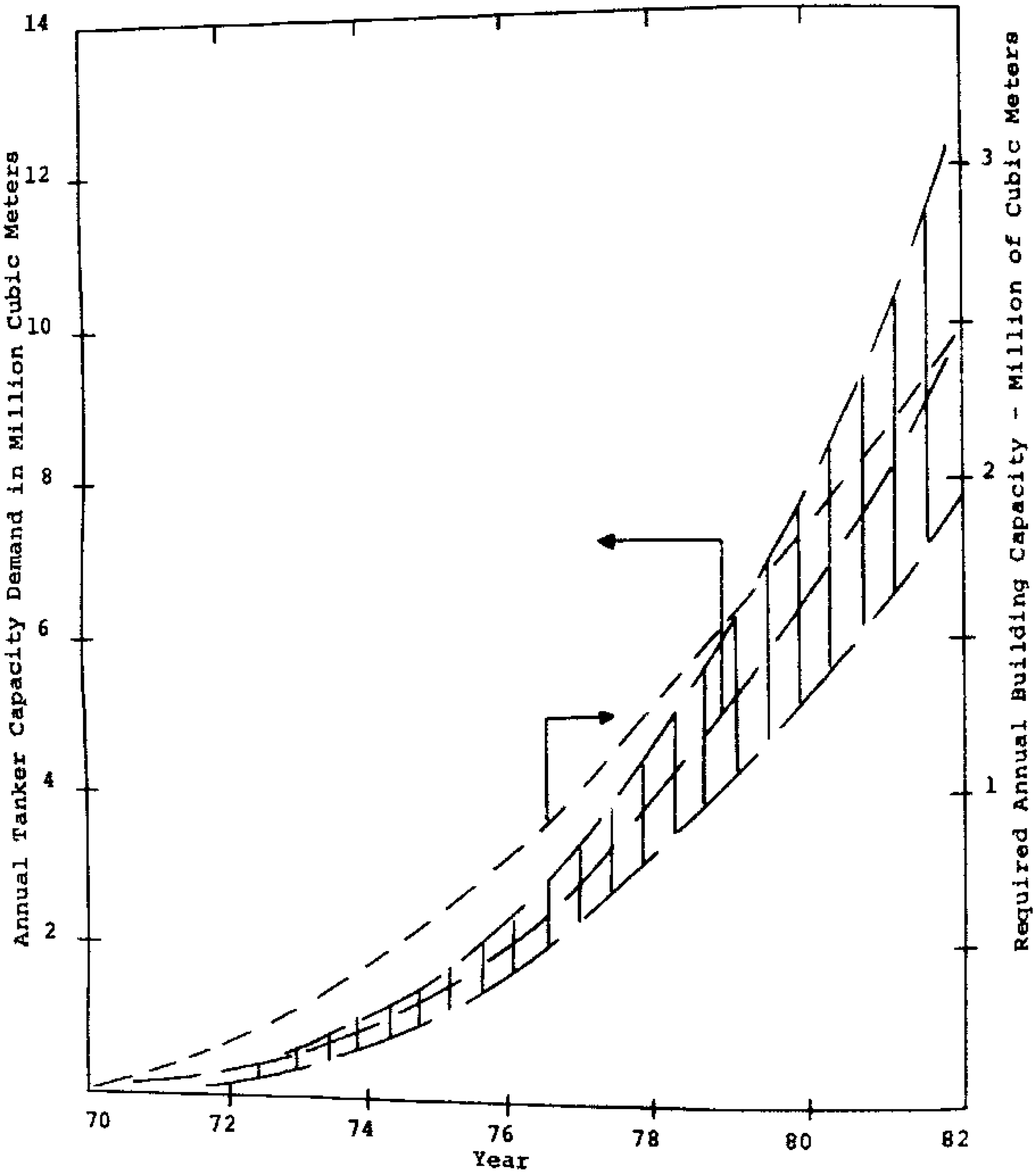
Projected demand for LNG tankers was established by using published FPC gas import requirements to the U.S. East coast and European import requirements - both largely supplied from Algeria.

Japanese demand, currently met mainly by Alaska and in part by Brunei, may in the future be supplied exclusively from Pacific U.S.S.R. on relatively short sea routes.

Figure IV-2 presents a rough estimate of projections of LNG tanker and tanker building demand. This estimate is based on an average tanker size of 125,000 cubic meters.

Figure IV-2

LNG Tanker Demand Projection



General Cargo

The relation of demand and supply of general cargo ships is very difficult to determine. This is largely due to:

1) Large diversity of general cargo ship types, sizes, capacity and special capabilities;

2) The ability of practically every shipyard building ocean-going vessels to build general cargo ships;

3) Large proportion of tramp ships in the general cargo trade;

4) Rapid changes in general cargo transport demand as well as changing routes and trading patterns;

5) Competition by bulk and combined carriers for neo-bulk and other bulkable general cargo traditionally carried by general cargo ships or in triangular trade; and

6) Competition by air freight for high value and perishable cargo.

At this time, dry cargo freight rates are extremely low on nearly every route for both scheduled and non-scheduled vessels. Container, RO-RO, and barge carrying ships (which made major in-roads into the conventional general cargo trade on the North Atlantic and Pacific-Japan routes) are now under pressure as oversupply of capacity forces rates to ever lower levels.

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PART 2

OCEAN TRANSPORTATION TECHNOLOGY

by

E. G. Frankel

Introduction

This section presents the status and predicted trends in ship technology. An attempt has been made to develop a rationale for past developments in ship technology, and use it to provide projections into the future, based on predicted or forecast technical developments considering the driving forces of engineering feasibility and economic utility. Many advances in ship technology have been introduced in the recent past. Some of these relate to ship size and speed, while others present innovations in cargo handling, ship form, ship type, propulsion, energy conversion, or a combination of such factors. Many of these developments have a long history which culminated in recent engineering and/or breakthroughs and their consequent adoption, while others were developed to fill a new requirement or resulted from the discovery of new technological principles or applications.

A large number of criteria have been developed in the past to measure ship or subsystem effectiveness, both from the point of view of synthesizing design requirements or analyzing response for potential improvements. No unique criterion is applicable to all types of ships and/or subsystems. Lift/drag ratios, transport momentum, CRF, non-dimensional productivity, required freight rate, discounted cash flow, and others have been used to evaluate the relative merits of various ship types and characteristics for a given transport effort or as transportation media in general. As a result of discrepancies in approach, environment, and many qualitative factors, no measure of performance can really be used as an absolute measure. On the other hand, a proper use of criteria coupled to economic utility, as well as other parameters, serves as an effective tool for the analysis of the advantages and potential for the introduction of various aspects of ship technology. Such criteria are found effective only if used in the framework of the basic laws of economics, such as marginal utility, expected demand, and trade or cargo distributions and requirements.

Our technology forecast is based on an analysis of technological and demand developments and the effect of each on the other. Many marginal commodity flows and resulting trades may become attractive and active with the advent of more productive and/or better integrated ocean transportation, and in turn affect demand and resulting technological developments.

Most future ship technology developments will not be the result of considerations for potential improvement of ship productivity, but transportation system productivity or effectiveness. This approach is rapidly proving to be the driving force for adaptation of new ocean transportation technology or expenditure for such new technology. Similarly, cargo handling, support services, and terminal facilities impose a growing influence on the developments of new ship technology.

A drastic change in development of new deep draft tanker terminals, for example, as shown in Table VI-3, have eliminated draft restrictions on over 80% (by tonnage) of crude runs of the world. Similar developments are currently planned for major dry bulk and specialized bulk (such as LNG, sulphur, etc.) trade routes. These deeper draft terminals are, in addition, usually provided with vastly improved ship access and navigational aids. As a result, determined efforts are under way to develop and implement bulk ocean transportation systems in which economic size of the components is not limited by technological or terminal restrictions.

Similarly, an increasing number of dry and liquid commodities are handled in bulk. To permit such bulk handling efficiently, physical form changes are often adopted. As a result, a large number of dry bulk commodities are today moved in the form of slurries. Such movement, while decreasing the deadweight of productive transportation, vastly increases the efficiency of transfer and handling of the commodity. Such slurries are usually highly saturated and in some cases even permit dehydration after each transfer operation. This development permits an integrated transportation approach for ocean and pipeline operations which result in the lowest total cost of bulk commodity transfer.

Drastic developments in ocean transportation technology, primarily during the last decade, have affected not only shipping operations, but also terminals, feeder interfaces, shipping management, shipping financing, and a large number of subsidiary industries. The large increase in the unit size of ships has introduced major changes in structural configuration and hull design approach. The large unit powers required open the door for new prime movers and major developments in thruster design. New physical forms of commodities and in commodity handling affected the configuration of ships and resulted in the development of new ship types and cargo handling equipment. New hull forms and methods for lift of waterborne vehicles have been developed which permit major changes in the assumed speed and operations of ships.

In parallel with these technological developments of the vehicle itself, recognition of the intimate dependence of ocean transportation and terminal interfaces linking transporotation to inland or coastal modes resulted in modifications of operational procedures as well as vehicle and terminal design to better serve the interest of the overall system of commodity transportation and not just the parochial interest of singular modes or the terminal by itself.

As a result, major changes in adapting technology and operations to specific requirements have occurred. These, in turn, often demand a significantly different financial and managerial approach. We therefore note a definite trend from specialized ocean transportation to multi-activity entities which comprise multi-modal as well as terminal operations in addition to other activities. The unit size of the modern transportation operator is a multiple of that of his predecessor only a decade ago. Therefore many of our conventional assumptions regarding regulations or the feasibility of adopting and developing new technology have changed. Much of the new technology is a direct result of research and development by operators.

The increasing concern with social, environmental and other effects introduces another dimension to the future development of ocean transportation technology. These developments will encompass automation to the degree of largely unmanned ships, ship loading and unloading technology, automated berthing or mooring, and efficient and reliable pollution prevention and pollutant separation technology for both air and water, as well as a whole range of technology affecting social considerations from shipborne to land based labor and related population.

As with all rapidly developing technology, we progress in some areas more rapidly than in others. Consequently we are either unable to utilize existing knowledge or use it in a less than efficient manner. We today recognize a large number of major technological voids which prevent the effective use of existing knowledge. These vary from underwater hull coatings to prevent fouling and deterioration, to advances in propulsion and thrusters of sufficient size with acceptable specific weight and fuel consumption. Other areas comprise voids of advances in social science such as human behavior under various conditions and the effect of increased automation. For example, the massive elimination of human functions, including manual tasks, in the operation of increasingly large ships has transformed the majority of the ship's crew into observers of control devices which are usually capable of performing all operations including predictable excursions. The monotony of the resulting task requires a complete reëvaluation of the traditional functions of shipborne crews. Similar problems exist increasingly in port operations and other ocean transportation related activities.

Shipbuilding technology has similarly changed drastically, and today is well ahead of ship technology requirements. To take meaningful advantage of these developments, the analysis of ship operational requirements, ship design and ship production must be integrated. Only in this manner can we take full advantage of existing and developing ship design, ship production and ship operation technology.

Our effort is primarily aimed at developing an up-to-date status review of ocean transportation technology with meaningful and realistic projections of near and medium term developments. By structuring our analysis to include the dependence of technology in the various major components of ocean transportation, we expect to be able to predict the major voids that exist and the resulting areas in which technological research and development should be channeled for maximum benefit. At the same time we are developing methods of analysis which can be used to test ocean transportation systems for sensitivity to various technological investments or changes in technology use.

Chapter I

TECHNOLOGICAL PLANNING

Technological planning is usually interpreted as the development of an effective program which uses technological forecasts for future decision. Although the life of ocean transportation vehicles and equipment has remained virtually constant, the development cycle or time between generations of new technology has shortened appreciably. In the past when the time between technological generations was equal to or larger than the normal life of ships and equipment, technological decisions could be based exclusively on present technology and past experience. Today the generation cycle time has shortened to but a fraction of the normal lifetime of ships and equipment. As a result, it is now imperative to consider future technology in present decisionmaking. Such future technology usually must not only comprise the next generation of ships and equipment, but also technological forecasts of developments at modal interfaces. We therefore, in technological planning of ocean transportation, are required to consider the total integrated system of feeders, interface terminals and ships.

Economic and trade forecasts are based on well founded theories. In fact, satisfactory forecasts are among the main tests of economic theory. Technological forecasting, on the other hand, relies less on extrapolations from the past to project future predictions than on current status and work in progress. It assumes that any development, even in completely unrelated fields, may have an effect on future technology. In recent years considerations to develop technological forecasts increasingly include environmental, social, political, military, legal, and economic factors. Such technological forecasts are often performed by statistical evaluations of responses from a meaningful sample of experts. These responses are generally in the form of answers to detailed and well developed questionnaires. One such technique which is finding increasing applications in technology forecasting is the 'Delphi' method.

Technological forecasting of ship technology was performed, for example, by the SAJ in Japan in 1960 and 1965 by conventional methods. Status in 1970 indicates fair agreement with forecast predictions. Recently a more formal forecast study of transport technology was performed by the Japan Transport Economics Research Center using the 'Delphi' method (71 items, 212 experts, repeated twice). The results of this forecast relating to shipping and shipbuilding technology were as noted in Table I-1.Such results provide effective inputs to technology planning programs, and offer opportunities for meaningful allocation of resources to and realistic timing of technology research.

Table I-1

Results of Japanese 'Delphi'
Shipping and Shipbuilding Technology Forecast

A. Items Predicted by Half the Number of the Forecasters as Realizable in Japan in the 1970's

* Completion of the first unit of an automatic anti-collision and anti-grounding device by means of wireless waves (1976).
* Completion of the first submergible rescue ship(1979).
* Completion of technology to prevent disasters due to a large quantity of flooded oil (1979).
* Completion of the first lifesaving bridge of automatically detachable type (1979).
* Completion of the first ocean-going trimaran ship (1979).

B. Items Predicted by Half the Number of Forecasters as Realizable in Japan in the 1980's

* Completion of the first oil tankers of one million tons deadweight (1980).
* Completion of the first vessel automatically maneuvered under the navigation control in harbors and bays (1980).
* Completion of unmanned deep ocean research submarine vehicle (depth of 10,000 m) (1980).
* Completion of the first oceangoing air-cushioned type passenger, 1000 passengers, more than 40 knots (1981).
* Completion of manned deep ocean research submarine vehicle (depth of 10,000 m) (1983).
* Completion of the first merchant ship with prime mover of fuel cell type (1983).
* Completion of the first ship with batteries for propulsion (1985).
* Completion of the first submarine merchant ship (1985).
* Completion of the first ship built with automatic cold steel plate joining technology (1985).
* Completion of the first ship built with man-hours of less than one-third of the one in 1969 (1985).
* Completion of the first oceangoing unmanned merchant ship (1987).
* Completion of submarine fishing boat (1987).

C. Items Predicted by Half the Number of the Forecasters as Unrealizable in Japan by the 1980's

* Prevalence of merchant ship with prime mover of fuel cell type.
* Prevalence of ship with batteries for propulsion.
* Prevalence of submarine merchant ship.
* Prevalence of oceangoing unmanned merchant ship.
* Prevailing of ship built with automatic steel plate cold joining technology.

The "Delphi" technique elicits opinions from a number of experts with the aim of generating effective group response. This is usually performed by a carefully planned, anonymous, structured program of sequential and repetitive interrogation by questionnaire. In this manner convergence of opinion is encouraged by feedback of anonymous group opinion. This and similar approaches are of particular value in technology forecasting where a general knowledge of current status, trends in research and developments, and voids in science and technology must be used to predict the future. As technological developments occur more frequently and rapidly, and as the impact of such technological developments affect an ever larger segment of the population to an increasing degree, technological forecasting must be elevated from an academic exercise to an essential planning tool.

Trends in technology are influenced by many factors as shown in Figure I-1. Among these are:

1) Scientific Advances
2) Technological Assessment
3) Limit Analysis Results
4) Analysis of Technological Voids
5) Technological Incentives
6) Demand Forecast and Assessment

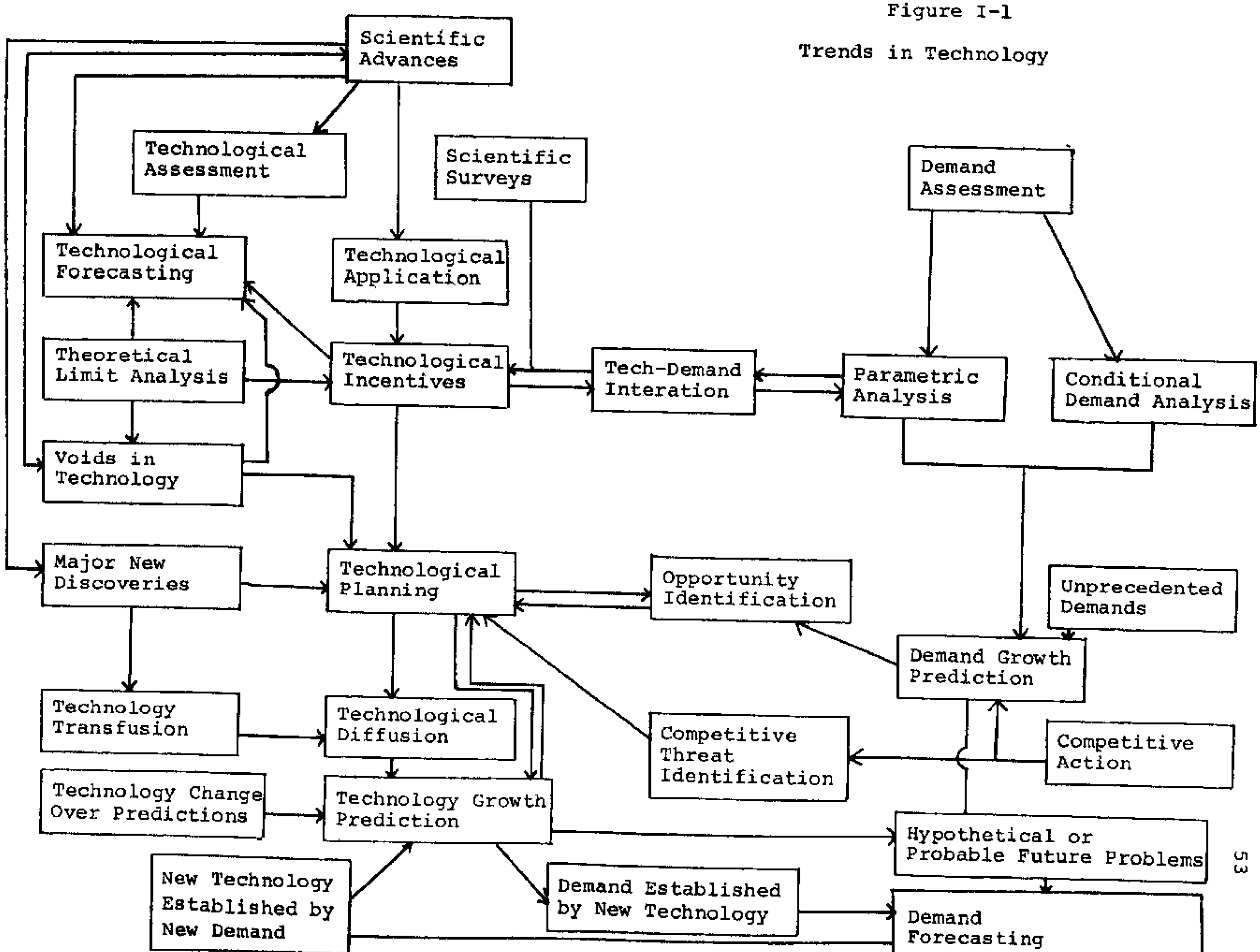
Technological planning is usually concerned with a more limited horizon, and performed for a defined group or society. It uses as inputs more specific demand analysis and forecast opportunity identification, projected payoff determination, competitive threat identification, resource limitation, know-how surveys, and evaluations of technological transfusion and diffusion capability. Overriding considerations are economic, social, political and strategic need (or goals) ordered by some priority system.

Technological planning in Ocean Transportation is largely affected by the highly fluctuating demand for shipping services and the basic international character of the industry. Because of it, ocean transportation is generally very mobile and has an ability to transfer units, capacity, technology, and resources from one control or jurisdiction to another. This phenomena influences competitive and complementary technological development. Ocean transportation is among the most competitive industries, while at the same time tending towards monopolistic operations.

As a result technologic planning of ocean transportation has in the past not been performed on a continuous and systematic basis. We therefore today, have large inbalances in capabilities, capacities and quality of service. Technological developments have until recently been slow and consisted mainly of incremental improvements of past technology. The situation

Figure I-1

Trends in Technology



has changed drastically in the last few years though, and sporadic developments have recently taken place in many segments of ocean transportation. These in turn have induced new efforts in developing related or competing technology. The needs and challenges of ocean transportation increase all the time. Demands for capacity, novel carriage of cargoes, integrated services and others provide new incentives for technological advances. Yet, the piecewise technological developments of the recent past, however noteworthy, suffer greatly from the lack of effective technological planning. We therefore have ships unable to call or effectively use desirable ports or ports with transfer capacities which no ship existing or contemplated can use.

The most important requirements are for technological planning of the intermodal interface between ships or ship and land vehicles. The trends in maritime technology have also left a number of ship particular technological voids, such as low specific weight and consumption propulsion plants designed to permit effective use of high performance hull forms such as hydrofoil, ground effect machine, semcats, submarine cargo vessels, Trimarans and similar.

Advances in ship hydrodynamics in general have not been paralleled by similar progress in propulsion and auxiliary ship systems. Effective technological planning of ocean transportation must become a formal and systematic discipline, rigorously applied to all ocean transportation investment and operational planning. Trade-off analysis and determination of investment and operational alternatives must include evaluation of technological alternatives, existing or planned. There are many developments which have been effectively applied in other technologies which may benefit ocean transportation.

We must widen our horizon and accept the fact that effective pier to pier ocean transport does not necessarily constitute an effective link in the overall transportation effort from origin to destination. Only if we include in our planning and resulting developments consideration of all factors and discourage parochial suboptimization benefiting but a segment of the system will we be able to determine technological development needs and opportunities in their true perspective and truly advance ocean transportation as a most important segment of transportation.

To determine the voids or unmet needs for technology and the demands which may force infusion of new technology it is usually necessary to consider the interaction of ocean transportation with:

1) Interfaces (ports, termini, etc.)
2) Feeder systems
3) Complementary or competing transportation systems
4) Physical, Social, and Political Environment

5) Economic Realities such as resource limitations, cost factors, etc.

This is necessary to improve our understanding of the process of technological advancement by establishing various "cause and effect" relationships which in turn permit a better understanding of the mechanisms of technological advance and transfer.

The technological forecasting and planning process also requires an evaluation of the effect of system parameter changes, functional and operational changes and the availability of subsystems or components such as material handling, packaging, mooring and other. Similarly information on recent developments (and use) in metallurgy, materials processing, (welding, adhesion, insulation) cargo processing and packaging, control, automation, information processing, navigation and communication are required to establish the range of analysis.

Both the benefits and costs of alternative technological forecasting and planning as well as resulting resource allocation can be estimated by identifying the functions that must be performed by the ocean transportation systems of the future.

The required functions are:

1) Identification and Valuation of Objectives of Future Ocean Transportation Systems
2) Contributions of Alternative Technological and Operational Alternatives to those Objectives
3) Effect of Resource Allocation on rate of progress
4) Method and Approach to resource allocation
5) Resource Allocation

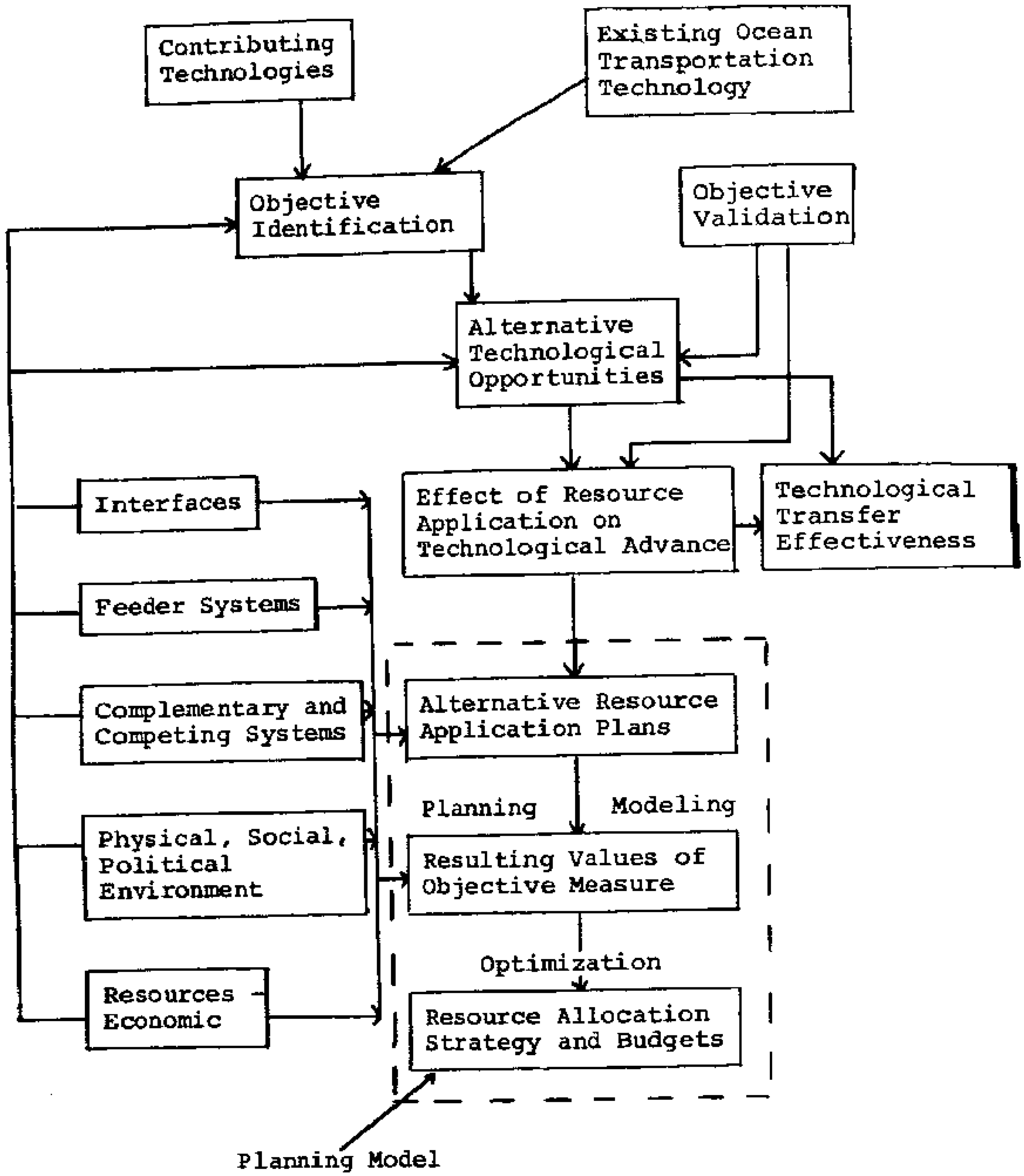
As opportunities for technological progress occur more frequently, it is increasingly important to integrate technological forecasting and planning. As noted before forecasting methodology must include a detailed understanding of the process of technological advancement and technology transfer. Similarly careful validation must be made both of the objective and information inputs. It is usually advantageous to incorporate probabilistic distribution or conditional probability density functions into the technology forecasting model.

The objectives furthermore should include economic, social and political utility functions. Another important consideration is the effect of feedback. New technological developments usually open new opportunities which in turn force resource allocation for additional technological advances and/or technology transfer.

A typical approach to technological planning is shown in Figure I-2 based on a formal planning model.

Figure I-2

Ocean Transportation Technology Forecasting and Planning Model



The inputs into such a technological planning model may, in addition to system particular requirements, consist of such information as:

1) Availability (Nonavailability) of Technology
2) Cost (Economics) of Use of Current Technology
3) Interface Effectiveness
4) Intermodal Integration
5) Changes in Capital Intensity, Investment Distribution, and Use of Resources, Manpower, (Skill)
6) Technology Transfusion and Diffusion
7) Capability of Technology Absorption
8) Public Image, Interest and Incentive
9) Safety, Reliability, Cost Factors
10) Environmental Factors
11) Competitive Factors

Various analytical techniques are available for technological forecasting. These include:

1) Mapping methods
2) Network analysis such as:
    - Relevance tree diagrams
    - Decision or conditional networks
    - Decision trees
    - Graphic network models
3) Systems analysis models
4) Demand assessment models
5) Limit analysis methods
6) Changeover point prediction techniques
7) Matrix methods
8) Polling of Experts and statistical opinion analysis
9) Statistical data analysis methods

The objective identification is usually based on an overall systems measure of performance which must then be analyzed with respect to the resulting performance characteristics of the ocean transportation system as shown in simplified form in Figure I-3.

Objective validation and establishment of Alternative technological opportunities as well as subsequent technological planning is affected by:

1) Demand assessment analysis results, and cargo flow corrected, where applicable, for the effect of future technological development and resulting economic and operational factors on the demand or cargo flow.

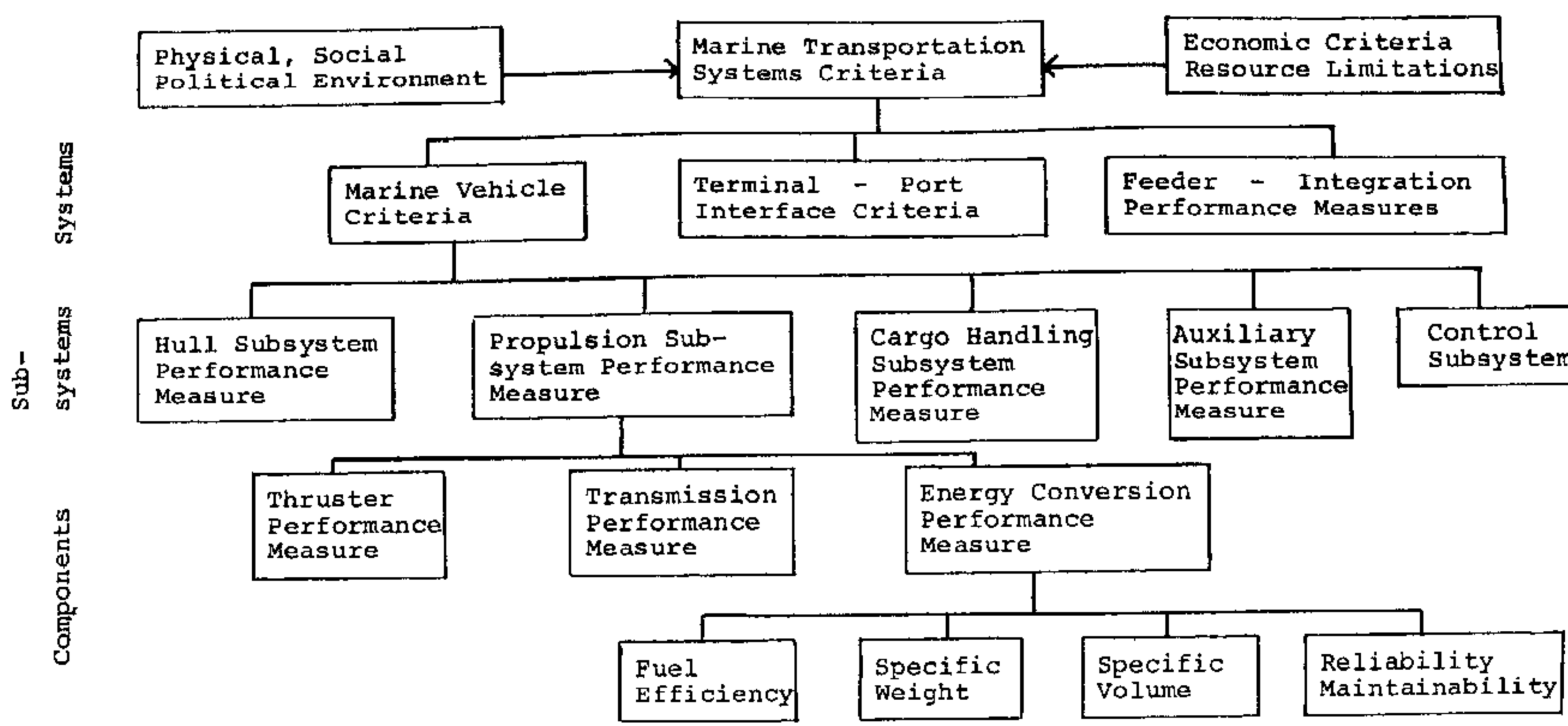
2) Influence of external policy decisions.

3) Effect of political and military contingencies.

4) Interaction with other technical areas and intensity of effort in these areas.

Figure I-3

Typical Simplified Performance Characteristics Tree



5) Effect of private and public investment and involvement.

6) Effect of international relations and collaboration on technological development including such factors as new trade routes, channels

7) Effect of international and national laws, agreements, conventions such as those pertaining to safety, pollution, (oily ballast, sewage, etc.), radiation, etc.

8) Significance and effect of interaction among selected prime parameters affecting performance of ocean shipping vehicles on systems.

A large number of methods are available for the construction, analysis, and optimization of the "planning model." The model may consist of a formal mathematical programming model whose structure dictates analysis and optimization techniques. Linear and dynamic programming models are typical examples. In most instances though the model is far too complex to permit application of one unique solution technique. This is furthermore affected by the use of probabilistic and/or conditional statements or relationships.

Effective hierarchical structuring and use of subjective matrices, which translate objectives and their relative values into relative outcomes of alternative programs,are useful devices which force explicit statements about the objectives and the programs. The inputs to the planning model or alternative programs are usually in the form of quantifiable engineering and operating performance parameters, which are used to derive resulting values of resource requirements, resource schedule, and level of objective measure. The most important decision in technological forecasting and planning concerns determination of the uncertainties involved in cost, time, development, transfer, application, acceptance, and operational success of new technology. It is for this reason that technological forecasting and planning cannot be performed effectively as a once through study. It requires continuous feedback and updating which provide the inputs for improved estimates of uncertainties. With all the shortcomings inherent in any attempt of planning for the future based on forecasts derived from insufficient data and knowledge, it is increasingly important to use formal technological planning approaches in ocean transportation not to eliminate inaccurate planning but to reduce the probability of downright mistakes.

Chapter II

SHIP FORMS

General Characteristics

During recent years ocean transportation has been subjected to an ever increasing amount of specialization. This in turn has resulted in many new ship types. Ship types can be divided into:

1) Function
2) Form of Lift

The functions of ships have multiplied as the physical, packaging and handling form of commodities continue to change. In addition,many commodities never carried by ships before are now so transported. Until recently cargo carrying ocean vessels could be simply divided into:

1) Dry General Cargo Vessels
2) Dry Bulk Cargo
3) Liquid Bulk Cargo Vessels

Today vessels while still grouped in about the same manner must be subdivided into many more categories to describe ship characteristics.

A summary of major ship functions is presented in Table II-1. These functional characteristics usually dictate the volumetric and deadweight requirements associated with the payload which then affect geometric proportions. They furthermore impose considerations of deck penetrations, load distribution, ship subdivision, cargo compartment configuration and size, shipboard cargo equipment needs, auxiliary power requirements, and many more.

In parallel with these changes in functional use of ships there occurred many developments in the method of providing the required lift to support the ships' displacement. Historically single hull displacement vessels have been in use for both surface and submarine operations.

In recent years surface displacement vessels with 2 or more hulls have been built. Similarly,semisubmerged vessels, which use a submerged displacement body (or bodies) to provide the bulk of the required buoyancy volume have become of great interest because of their presumed improved resistance and motion characteristics. Increasingly,submarine vessels use artificial lift (nonbuoyancy lift provided by lifting surfaces) in their operations.

In parallel we note the development of the group of so called high performance ships consisting of hydrofoil ships, ground effect vessels, and planing hulls all of which rely

Table II-1

Summary of Ship Functions

Dry General Cargo -	Refrigerated Carrier Cargo Liner Dry Cargo Tramp Multipurpose General Cargo Roll-On/Roll-Off Cellular Containership Trailer - Containership Trailership Fruit (Ventilated-Refrigerated) Carrier Universal Cargo Ship Automobile (Car) Ships Barge Carrier Cellular Barge Carrier Horizontal Shelf Pallet Ship
Specialized Dry Cargo -	Lumber Carrier Car Ferry Paper Carrier
Dry Bulk Carrier -	Gypsum Carrier Cement Carrier Coal Carrier OBO Carrier Grain Carrier Ore Carrier Sugar Carrier
Liquid Bulk Carrier -	Crude Oil Tanker Products Tanker Slurry Tanker OBO Tanker Wine Tanker Milk Tanker Chemical Tanker LPG Tanker LNG Tanker

on some or all of the required operational lift on non-buoyancy factors such as lifting surfaces and air cushions. These trends are summarized in Figure II-1. Under consideration are also segmented (or sequential) ships in which cargo compartments or cargo and the machinery compartments can be divided into separate self-floatable bodies which can be coupled and decoupled as operations require. A number of flexible, semirigid, and rigid coupling systems have been developed. Several of these have been installed in oceangoing tug barge systems. Some years ago pinjointed mammoth tankers were proposed not to increase operational flexibility but to reduce required structural weight, but the idea was never implemented.

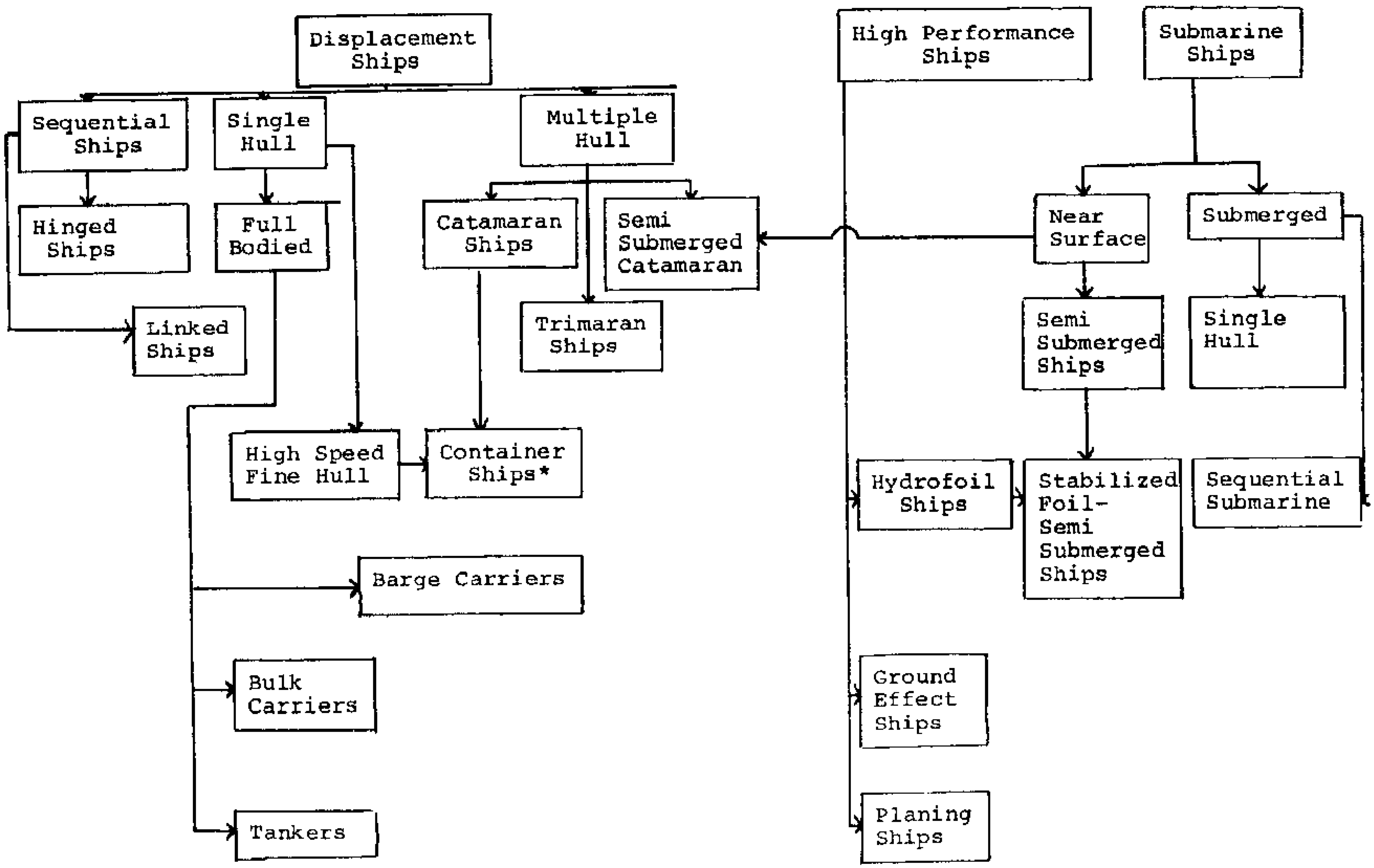
The various ship groups shown in Figure II-1 can be further classified as in Figure II-2 for containerships.

We may similarly observe semisubmerged ships with single, twin or triple displacement bodies which, in turn, may be cylindrical, eliptical or parabolic; all may serve a large number of ship functions. Such ships are generally considered when stable platforms are acquired. They may in the future serve as containerships or barge carriers. They may similarly be designed as warehouse type ships capable of loading or discharging complete and preloaded warehouse boxes by straddling warehouse finger piers for transfer. Catamaran ships of various sorts are largely used for oceanographic work although their application in high speed, low density cargo trade also provides attractive advantages.

Catamaran tugs and/or barges are currently being considered, largely because they offer certain possibilities for more efficient and reliable ocean tug/barge coupling. While surface effect ships (SES) are now only used for short endurance passenger and car transportation, it appears that near term developments may permit the use of such vehicles for high value cargo transport in short trans-ocean routes as well.

Hydrofoil ships, on the other hand, are only in use for passenger transportation.

Submarine cargo carriers have been extensively investigated, and designs for liquid bulk commodity transport have been developed. At this time the economic viability of such ship types is in serious doubt except in cases where particular operational conditions eliminate more conventional displacement type vessels, such as in Arctic locations.

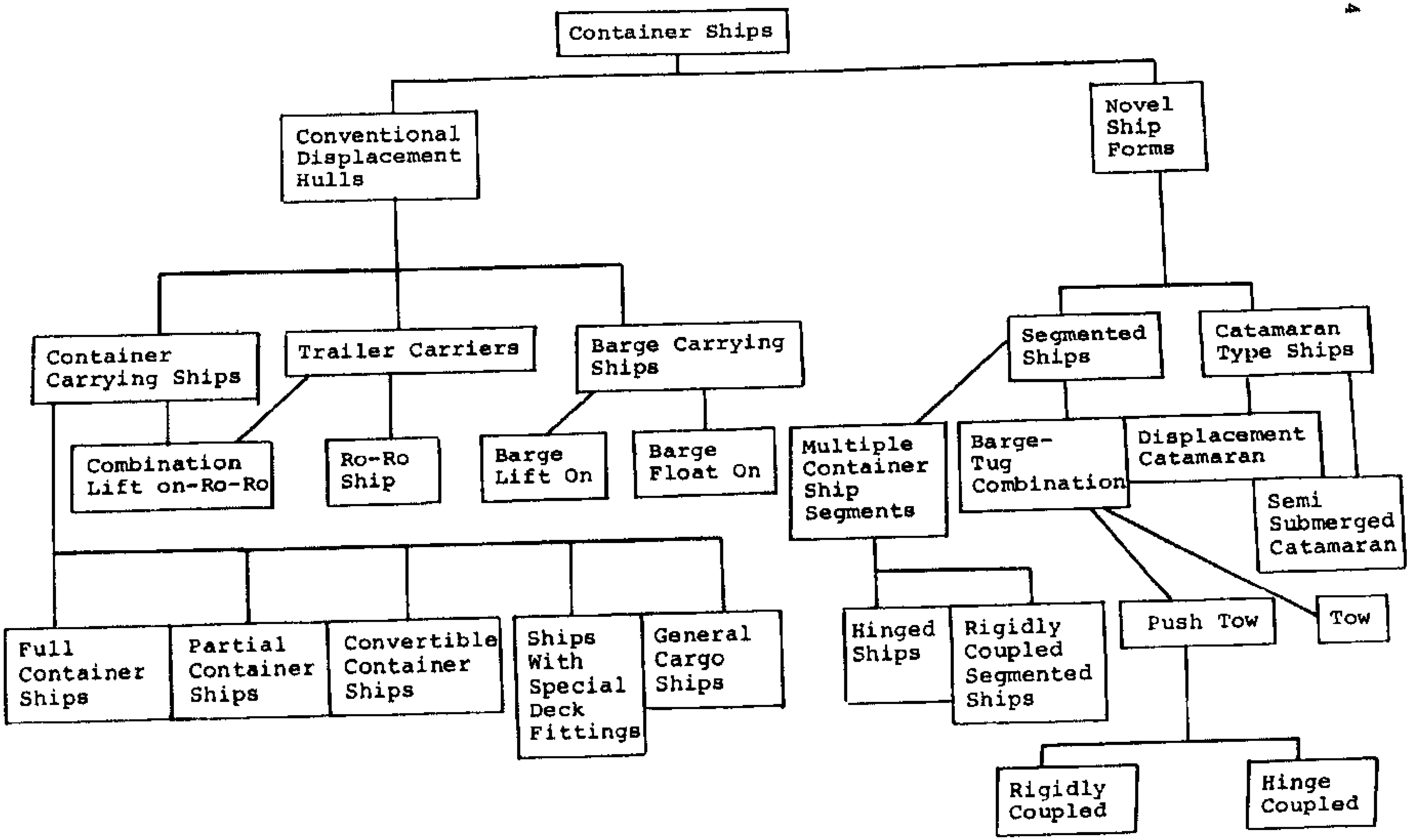


*See Detailed Chart.

Figure II-1

Trends in Ship Technology

Figure II-2: Classification of Container Ships



Physical Characteristics

The physical characteristics of the major types of ships consist of dimensions, dimensional and form coefficients, transverse and longitudinal subdivision, horizontal arrangement (decks), stability, openings and penetrations, appendages, propulsion, steering, and auxiliary systems. In this section we present Figures II-3 to II-7 showing the relationships for major physical dimensions for typical tanker dry bulk carriers, general cargo and containerships.

Displacement vs. speed and SHP for cargo liners, containerships, dry bulk carriers and tankers are shown in Figures II-8 and II-9 respectively. Hull form characteristics are discussed in Chapter III, while cargo handling and stowage are reviewed in Chapter VI.

Novel Ship Types

Many new and unusual ship types and forms have developed in the recent past. Some have captured a definite share of the market or established a new demand; others have been less successful or are still under development. The major types of novel ships are summarized in Table II-2.

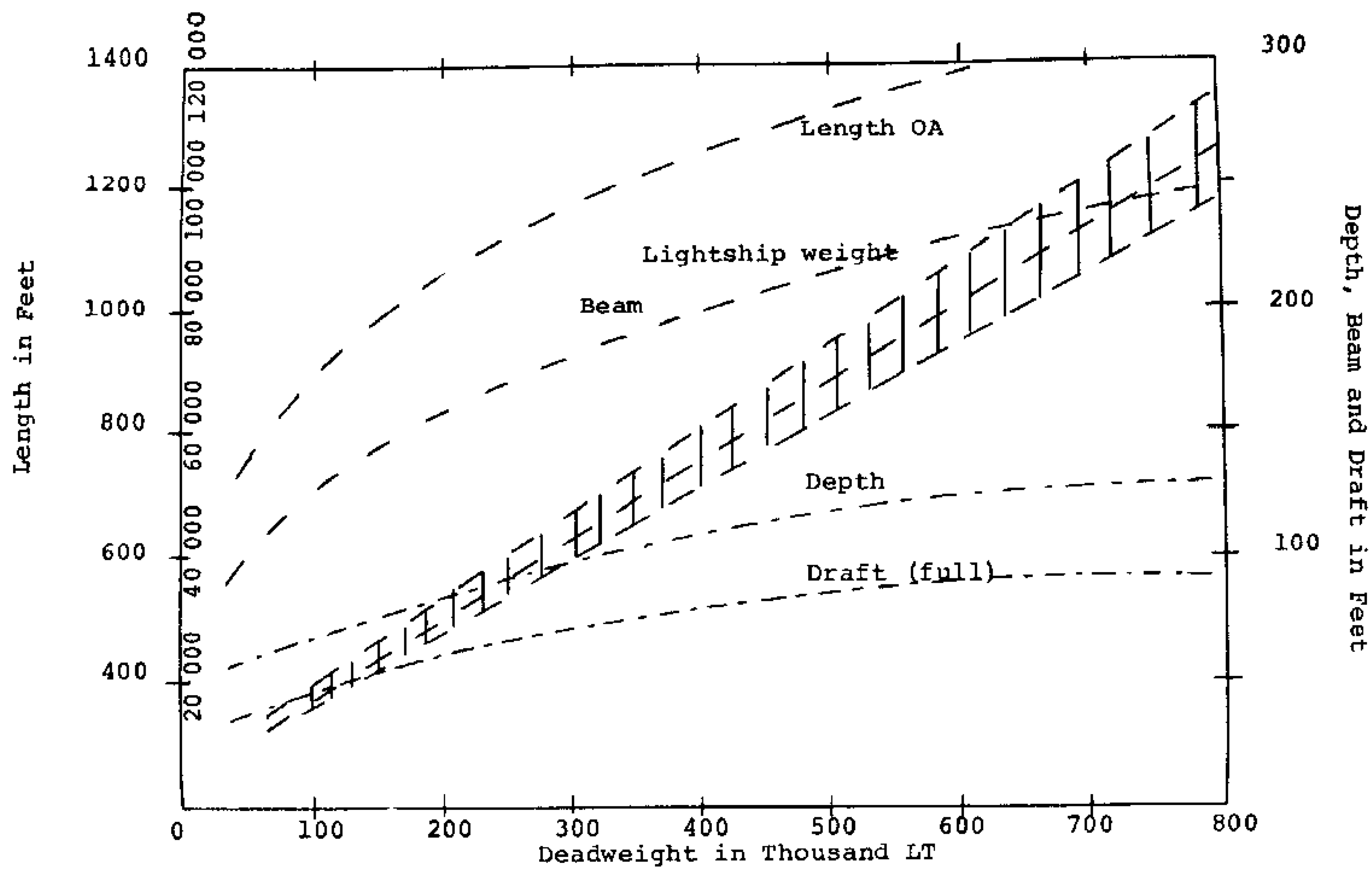
Projected Trends in Ship Types

During recent years primary emphasis has been placed on the advantage of the economy of size in ocean transportation. While speed considerations were introduced in the development of new containerships and other unitized carriers, the major advance was in the unit capacity of bulk carriers and containerships. Since 1940, for example, the size of tankers and dry bulk carriers has more than doubled every 10 years. The major reason for this was the diminishing investment and operating cost per unit capacity of bulk carriers with increasing size. It should be noted, though, that the law of diminishing returns introduces the fact that for very large ships the advantages of increased size decrease appreciable and for tankers the investment cost per deadweight ton capacity was a minimum for 230,000 DWT in 1970. This minimum investment cost point continues to increase as many new and larger shipyards go into operation and as larger ships are built in increasing quantities. As a result, it is expected that by 1975 the minimum investment cost point per unit DWT will be approximately 300,000 DWT for tankers and 200,000 DWT for dry bulk carriers.

Yet total direct and indirect operating costs of dry and liquid bulk carriers will continue to decrease with size independent of the inflection point of the investment cost curve.

Figure II-3

Tanker Dimensions



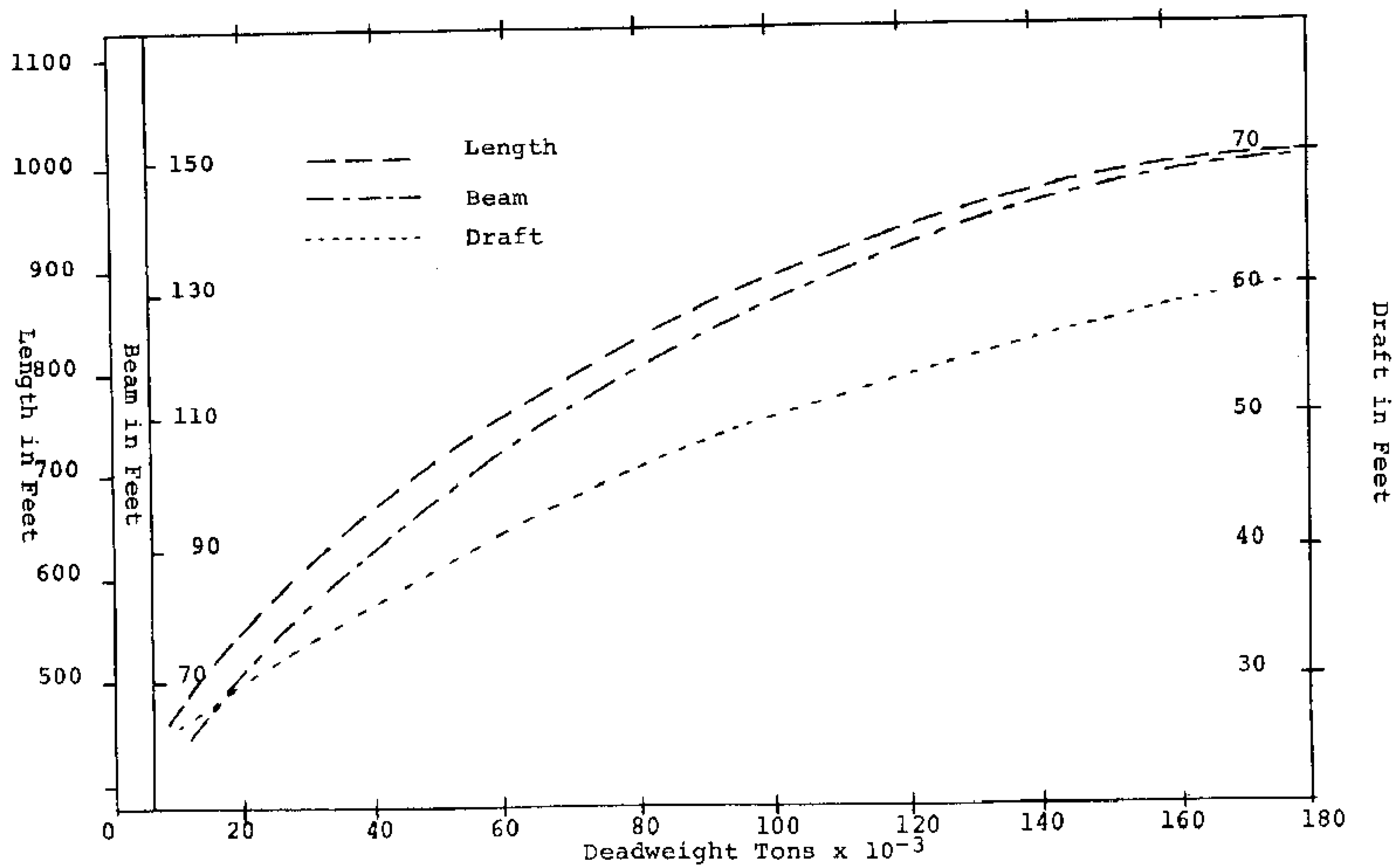
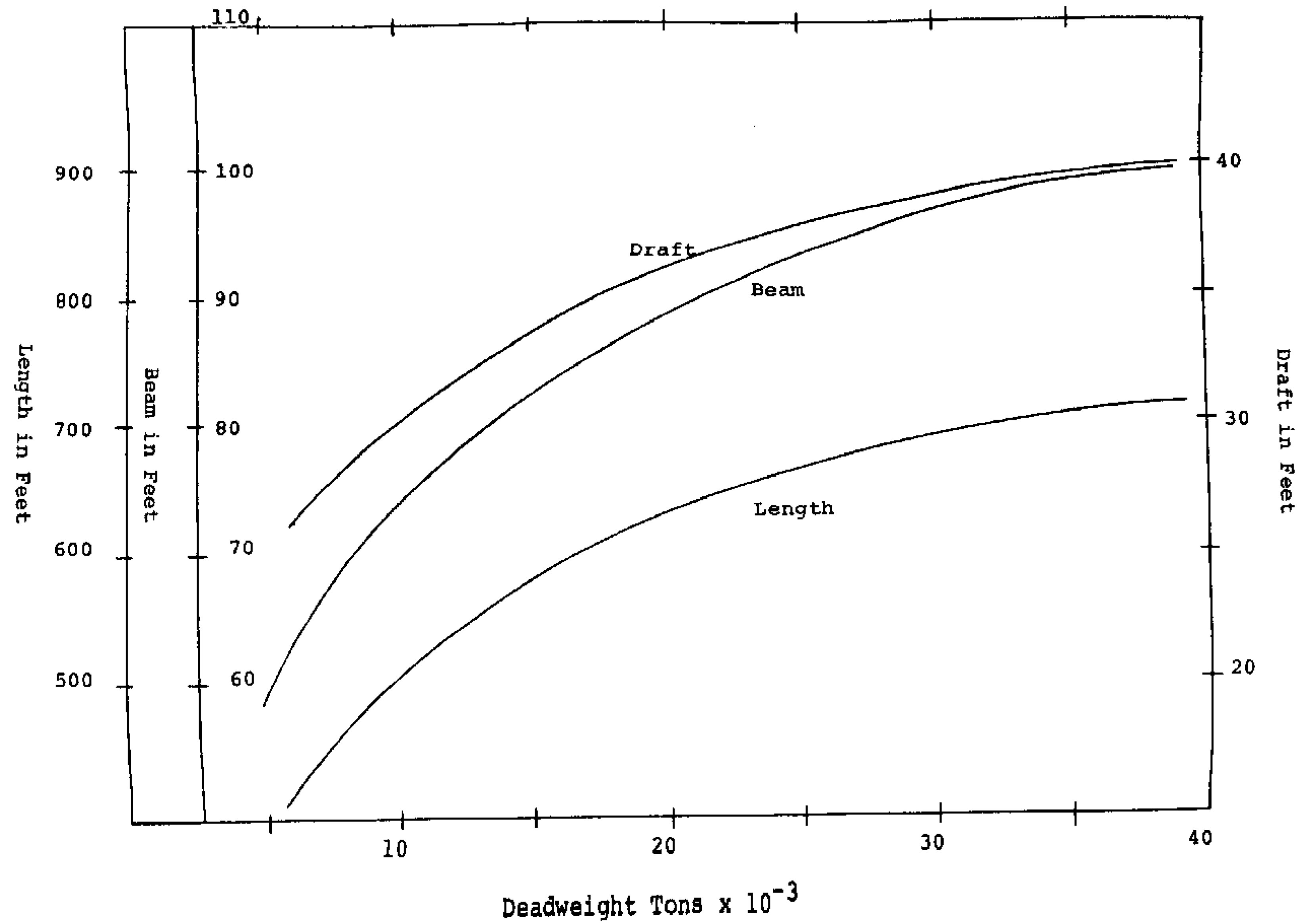


Figure II-4

Bulk and Ore Carrier Dimensions

Figure II-5

General Cargo Ship Dimensions



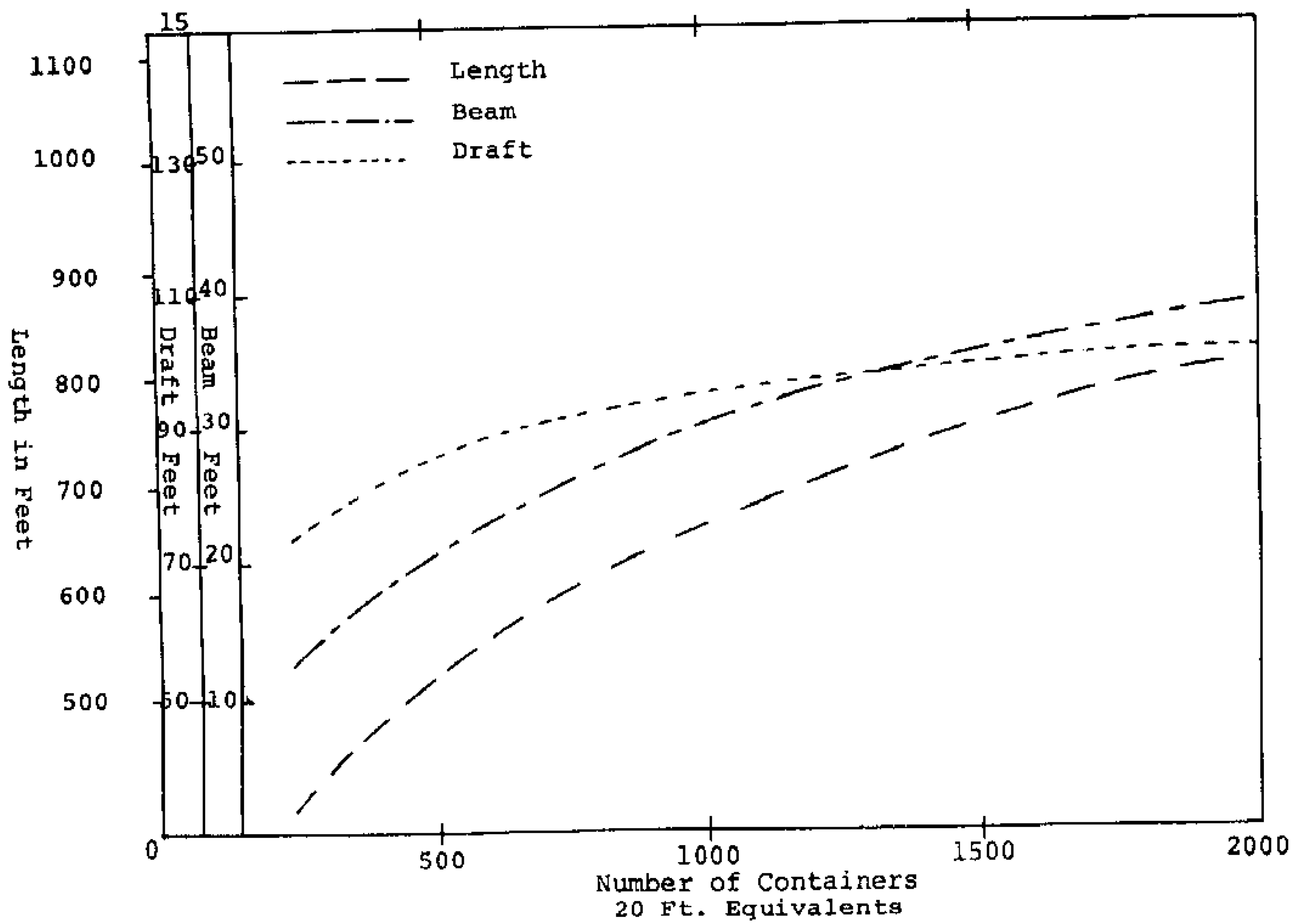


Figure II-6

Containership Dimensions

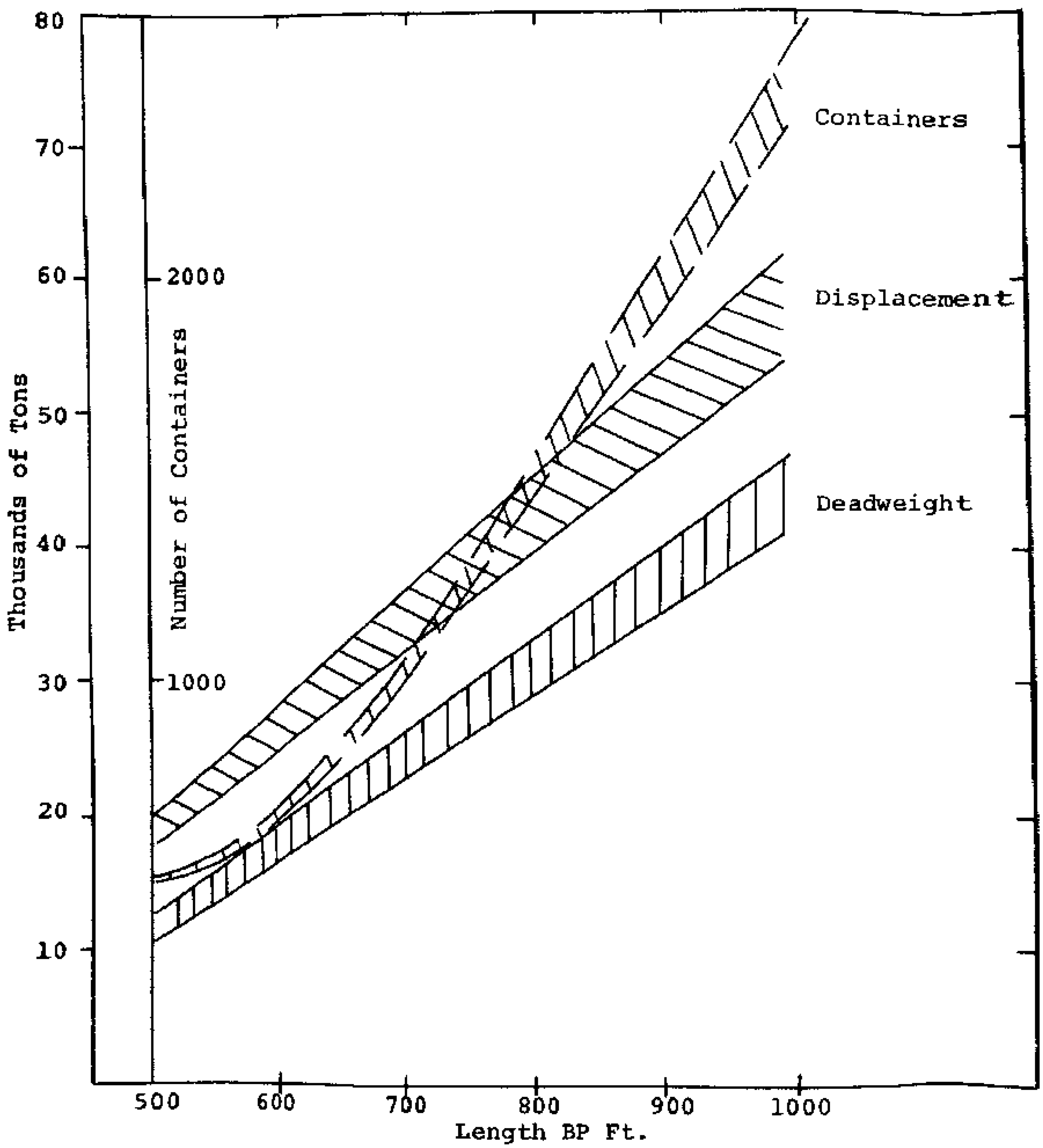


Figure II-7
Containership Characteristics

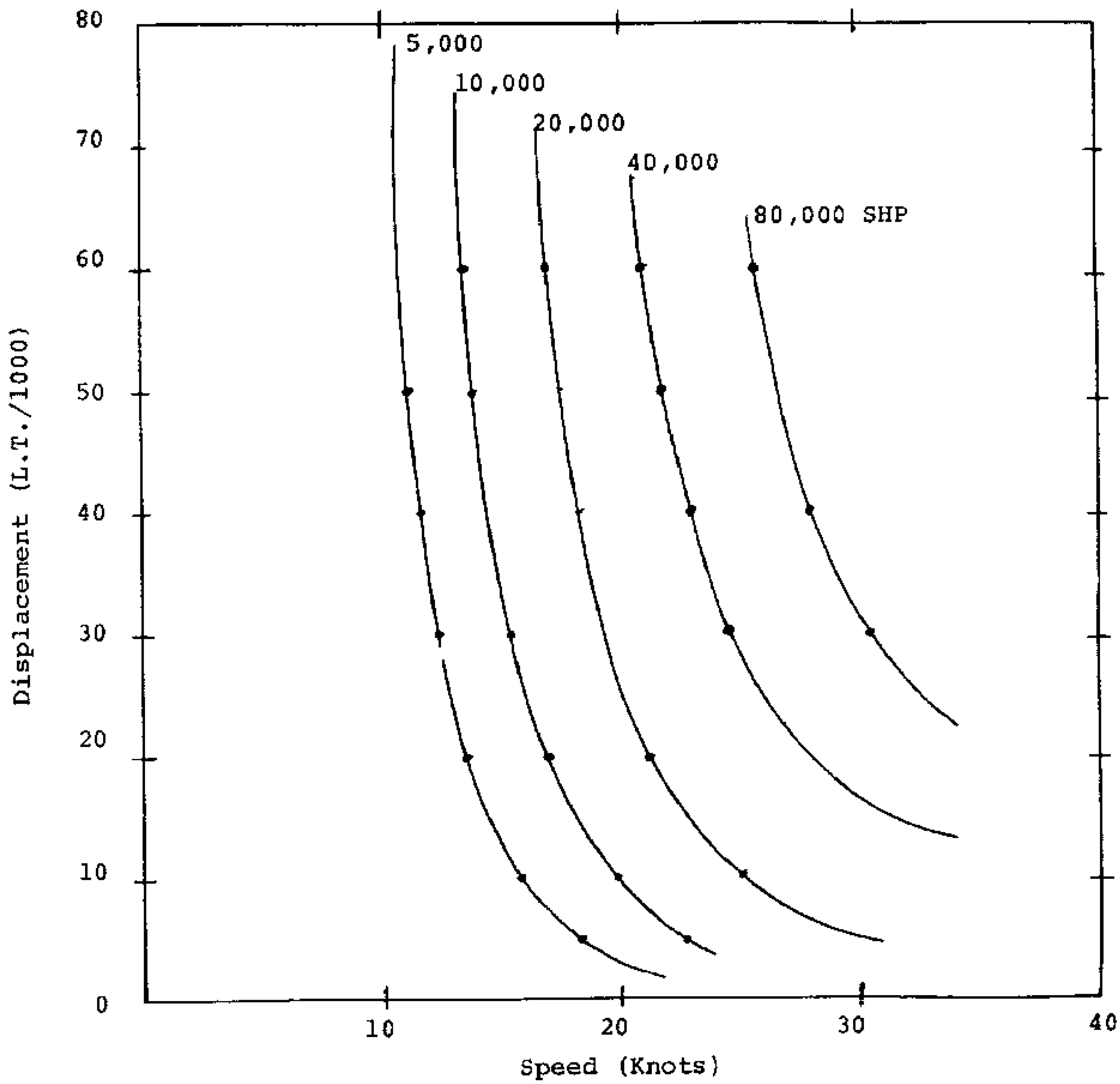


Figure II-8

Displacement vs. Speed and Shaft Horsepower for Cargo Liners and Containerships

Figure II-9

Displacement vs. Speed and Shaft Horsepower for Bulk Containers and Tankers

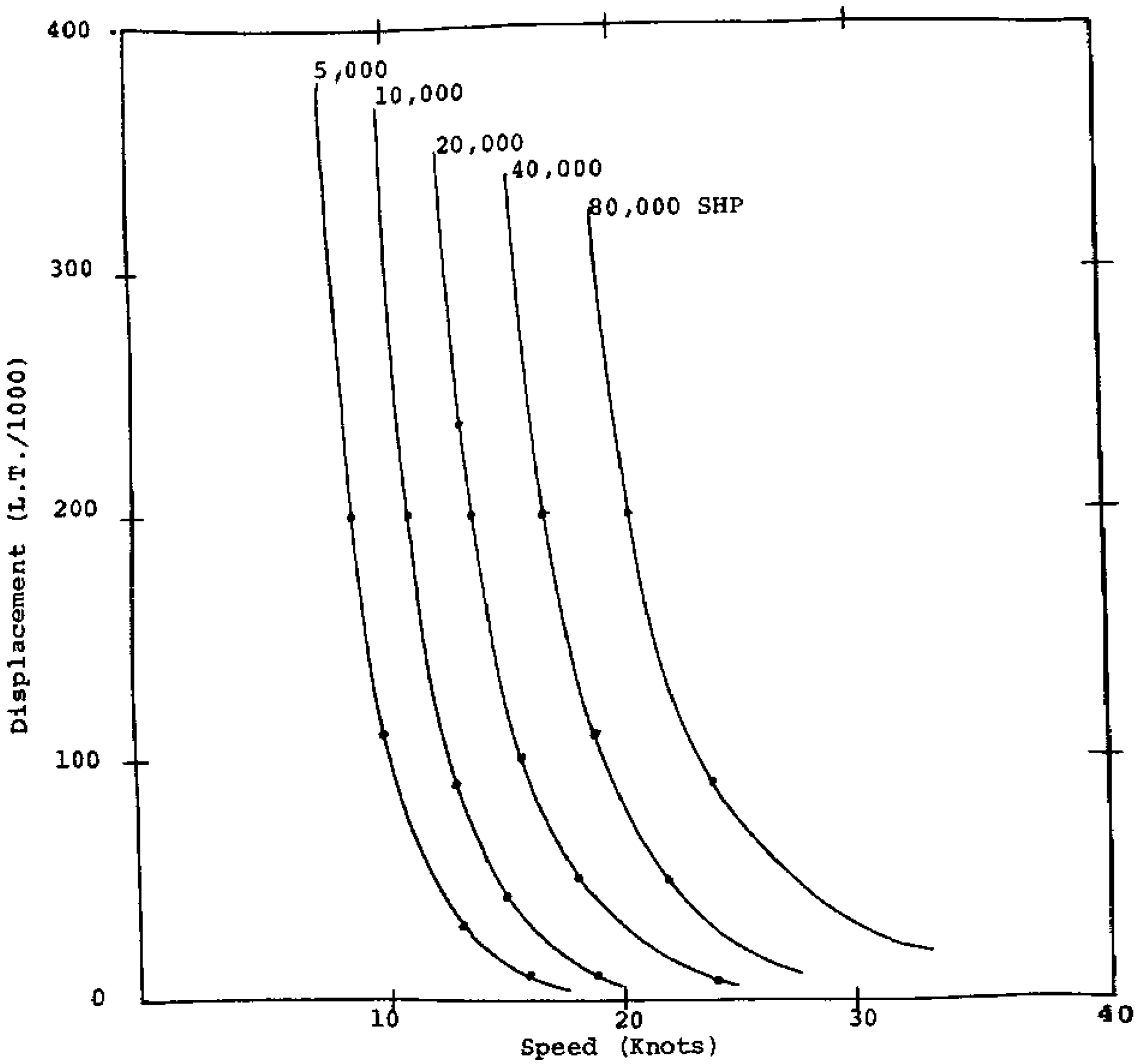


Table II-2

Summary of Ship Functions

Dry General Cargo	-	Refrigerated Carrier Cargo Liner Dry Cargo Tramp Multipurpose General Cargo Roll-On/Roll-Off Cellular Containership Trailer - Containership Trailership Fruit (Ventilated - Refrigerated) Carrier Universal Cargo Ship Automobile (Car) Ship Barge Carrier Cellular Barge Carrier Horizontal Shelf Pallet Ship
Specialized Dry Cargo	-	Lumber Carrier Car Ferry Paper Carrier
Dry Bulk Carrier	-	Gypsum Carrier Cement Carrier Coal Carrier OBO Carrier Grain Carrier Ore Carrier Sugar Carrier
Liquid Bulk Carrier	-	Crude Oil Tanker Products Tanker Slurry Tanker OBO Tanker Wine Tanker Milk Tanker Chemical Tanker LPG Tanker LNG Tanker

One consideration which influences owners to an ever increasing extent is the total cost of transport including loading and unloading. The latter cost elements incorporate operating and financial costs of feeders and transfer terminals. A large number of feeder and transfer systems in operation now have had varied successes. As a result, the total cost of transporting bulk cargoes differ appreciably even for identical ships.

It now appears that although tanker sizes continue to increase, the rate of growth in capacity will diminish appreciably by 1980 and is expected to level off at or below the half million DWT mark. The average size of crude oil tanker in operation on long haul movements is expected to be 250,000 DWT by 1980. The reasons for the diminishing rate of growth in tanker size are 1) marginal improvement in total cost, if any, 2) increased cost of crude petroleum in process or transport, and 3) lack of capacity and cost of storage at various receiving refineries.

As crude oil prices continue to increase, the time cost of transport and storage of crude oil become more significant. This, in turn, affects the desirable unit size of delivery and limits the size of optimum tanker for a specific route.

Many of the same arguments as quoted above are applicable to dry bulk carrier operation. Here, though, the feeder, transfer and storage costs consume an even larger percentage of total origin-to-destination transportation cost. As a result, it is also expected that dry bulk carriers will level off their growth rate by about 1984, at which time the average dry bulk carrier in operation on long distance routes is expected to have a size of 200,000 DWT, while dry bulk carriers of up to 400,000 DWT will be constructed in series.

Containerships and other unitized cargo carriers have proliferated in form, size and type in recent years. The large competition among them on the most remunerative trade routes such as the North Atlantic and the North Pacific have resulted in the development of over-capacity. This, in turn, introduces many new competitive aspects which are expected to produce a number of new concepts in unitized cargo carriage. It is recognized that unitized cargo carriage is most effective if developed and used as a captive system operating between defined and specialized ports. While the barge carriers and roll-on roll-off ships were initially designed to provide more flexibility and permit the use of unitization in lesser developed ports and on more flexible trade routes, recent experiences have dictated the use of most of these ships on defined and specialized trade routes.

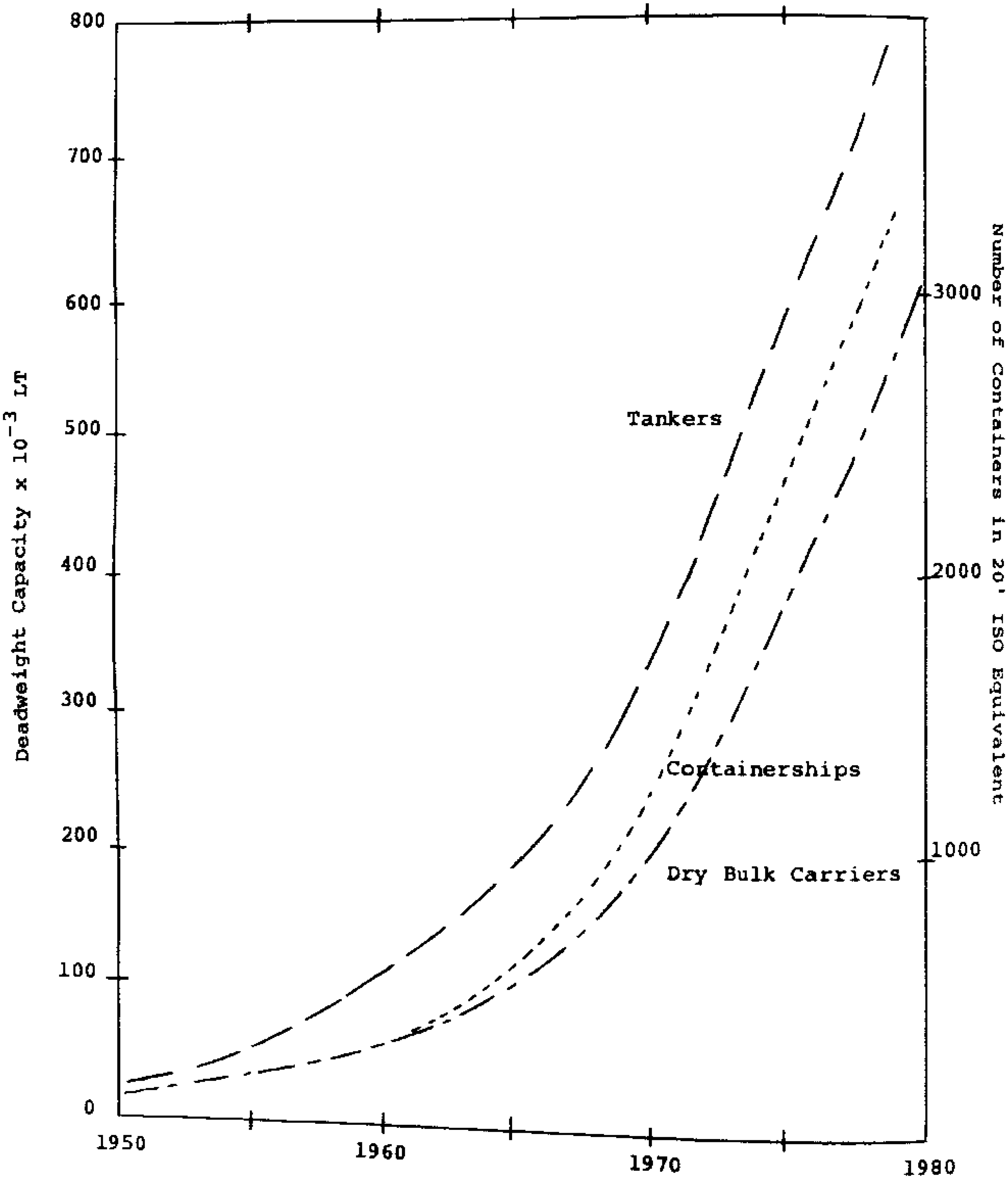
The general expected trend in maximum vessel size for tankers, dry bulk carriers and containerships is presented in Figure II-10. There are some indications that although the maximum size of vessels will continue to grow practically linearly, the growth of the average ship delivered or in operation will slow down by 1975 when the tonnage demands for the major high intensity bulk trade routes are met by the delivery of mammoth carriers.

Among high performance ships, the rigid sidewall SES appears to offer the most significant near term potential. SES of 2000 ton displacement with trans-ocean capability are expected to be operational in 1975-77. SES of 10,000 ton displacement are planned for 1980.

Catamaran and semisubmerged catamaran ships are of increasing interest. Though such vessels are currently only used for stable platform and research work, with some exception, trans-ocean catamaran cargo and passenger carriers of about 10,000 DWT are expected by the end of this decade. Their high volume and deck area-to-displacement ratio as well as their comparatively lower resistance at high speeds (30-35 knots plus), makes them attractive vehicles for unitized cargo and other trades.

Figure II-10

Trend in Vessel Size



Chapter III

HULL FORMS

Hull Forms

The shipping industry has become increasingly willing to forsake the traditional tenets of ship design and to venture toward novel and unusual ships. The construction of nuclear powered commercial ships, the rapid and extreme increase in ship size, and the utilization of air cushion vehicles (ACVs) in commercial routes are all examples of this willingness. It is in this atmosphere that the development of unusual and heretofore untested hull forms has become possible. These hull forms have been developed to better satisfy commercial shipping needs for size, speed, and seakeeping. This chapter is a comparative evaluation of new and convention hull forms in terms of their applicability to commercial shipping.

The evaluation of any hull form must be in terms of the mission to be performed. For this study the mission of commercial shipping is too broad for any final evaluation of the best hull form. This chapter does consider those general characteristics of all hull forms which influence performance and cost independently of cargo and route. These characteristics are the speed-power relationship, the hull weight and therefore cost, the payload capability, and the seakeeping ability.

Certain hull forms such as tankers and hydrofoils have a specific mission orientation. While this is not a factor in the comparison, it does enter into the chosen design and performance characteristics of the various hull forms considered. For example, small and extremely fast tankers are not considered, nor are slow, blunt, and large hydrofoils considered.

There is considerable research in progress on new hull forms. Changing demands in the industry have made conventional hulls less desirable from economic considerations. The clearest changing demand is for size. New tankers will be of 500,000 D.W.T., and this trend has carried into almost all ship types. Along with increased size the shipping industry is also looking for greater speeds and improved seakeeping. Conventional ship design does not allow economic increases in ship size and speed.

This failure of conventional ship designs arises from the operation of the ship at the air-water interface. At high speeds ship resistance is primarily wave making. Unless the ship form is such that it makes few waves or it operates away from the interface it appears unfeasible to operate the ship at high speeds. Ship seakeeping characteristics become critical at high speeds. This problem also arises from ship operation at the air water interface and can be relieved by removing the ship from the interface. These two problems have led to the trend in new ship design which is towards operation away from the air-water interface.

To avoid the air-water interface one can either go above it with ACVs or below it with submarines. It may also be sufficient and desirable to remove the bulk of the hull from the interface and allow only a small portion of the hull to pierce the interface. Examples of these craft are hydrofoils and semi-submersibles. Multihulled ships which reduce wave making resistance and offer good stability have also been developed. It is possible to improve the performance of conventional displacement hulls (e.g. with bulbous bow), but it is felt that the basic fault remains and will become critical as size and speed requirements increase further. On the basis of the foregoing the following hull forms were considered as most feasible for ocean transportation: captive air bubble (CAB) vehicles, hydrofoils, catamarans, tanker, dry cargo ships, semi-submersibles, and submarines. (See Appendix A)

CAB vehicles are a type of ACV. The principle behind ACVs is the introduction of an air bearing between the vehicle and the water surface. This air bearing serves to reduce the resistance of the vehicle in the water by supporting the vehicle above the water surface. CAB vehicles are not lifted completely above the water but have fine shallow-draft hulls on each side. These rigid side walls make an effective seal for the air bearing or cushion. The fore and aft seals are provided by flexible skirts which contain the air and have minimum contact with and resistance in the water. The air cushion pressure is maintained by a power plant which may or may not be integrated with the propulsive plant. Propulsion is provided by water jet, super cavitating propeller, or air propeller. All ACVs offer low power requirements for speeds of 100 knots or more. CAB vehicles have somewhat larger power requirements than other ACVs because of the resistance of the side walls. It is felt, however that the stability and course keeping stability afforded by the rigid side walls makes these craft more desirable for ocean service.

Hydrofoils are familiar craft, yet they have only recently been used for commercial shipping. For this study fully submerged foils are assumed. The complex control system for foil altitude is more than offset by the enhanced seakeeping characteristics of this foil system.

Catamarans are typical of multihulled ships in that they are designed for improved wave making resistance. The higher speeds offered by this hull form are somewhat negated by their increased hull structural weight.

Semi-submersibles are volume limited displacement ships having the major portion of the hull located well below the surface. For this study a two-hulled arrangement is assumed with the surface piercing struts being connected above the water by a cross platform similar to a catamaran. The multi-hull arrangement offers greater stability and enhances ocean operation. The resistance of these craft at high speed is considerably better than for conventional surface ships.

A length to diameter ratio of approximately 7 is most favorable hydrodynamically for submarines. For payloads of 20,000 and more tons this ratio results in excessive diameters. For this reason a rectangular cross section is assumed to bring the surfaced draft within the range of conventional surface ships and existing terminals. The performance of submarines at high speeds is better than for conventional ships and seakeeping is clearly of little significance.

The tankers and dry cargo ships considered are based on current and project design characteristics. The dry cargo ships are an amalgam of medium and high speed cargo and containerships.

The power requirements for all hull forms depend on speed and size. Power for a given hull is a function of Froude Number ($\frac{V}{(gL)^{1/2}}$). In this study the displacement or weight (Δ) is assumed to be a linear function of the length (L) cubed and the Froude Number has been expressed as $V/\Delta^{1/6}$. Figure III-1 gives the shaft horsepower requirements per ton of displacement versus Froude Number. Except for the non-displacement hull forms the power requirements are similar for all hulls. The hull forms designed for improved high speed operation require more power at lower sizes and speeds because of their larger wetted surfaces.

Hull weight (W_H) (Figure III-2) is another important cost factor and has an effect on payload capability. Hull cost is directly dependent on weight and it must be remembered that Figure III-2 reflects the use of different materials for different hulls. The displacement hulls are of mild steel construction while the CAB vehicles and hydrofoils are constructed of light weight aluminum alloys and other structural materials. The submarine hull weights assume that the hull need not withstand longitudinal wave bending stresses and that most tanks will be free flooding and therefore need not be part of the pressure hull. The regulatory agencies may not allow such practices, however these assumptions give a minimum value for hull steel weight.

The payload (W_P) shown in Figure III-3 includes all fuel, cargo, and consumables. Hydrofoils show a definite size limitation. Figure III-3 also shows that hydrofoils alone display increasing payload with increasing speed. This is because the reduction in foil area and weight as speed increases is greater than the increase in power plant weight with speed.

Seakeeping characteristics are a significant consideration for commercial ocean transportation. Sea waves may cause severe ship motions, cargo and ship damage, and may endanger the safety of the ship. Seas may force course changes or a reduction in speed which can be critical for ships with perishable cargoes or schedules to meet. Seakeeping characteristics discussed in this section are not quantitative but rather a general description of the characteristics of the various hull forms.

CAB vehicles are characterized by small waterplane areas and negligible buoyancy. This plus the damping effect of the air cushion tend to reduce the response to seas of these hulls in comparison with conventional displacement hulls. CAB vehicles are not immune to seas and care must be taken that the air bubble does not escape which would happen if a portion of the side wall were lifted above the water surface. This plus the high speed and therefore high frequency of wave encounters will necessitate a reduction in speed in sea states above 5.

The fully submerged foil system considered here allows hydrofoils to operate in almost any sea state. Sophisticated control and sensing systems adjust the foil attitudes to compensate for approaching waves and protect the hull from severe impacts. The control system can also be designed to prevent excessive accelerations and ship motions.

Catamarans offer slightly improved seakeeping over single hull displacement ships. Normal operation in sea states less than 5 appear feasible. Some problems may be encountered from excessive rolling accelerations.

Semi-submersibles, because of their small waterplane area and deep submergence of the main portion of the hull, offer very good seakeeping characteristics. They operate independently of sea state except in following seas. When the frequency of wave encounters is very low severe pitching and heaving motions may result.

Submarines operate independently from sea state when a submergence of four hull diameters is maintained.

While a mission or trade route must be defined before any specific conclusions can be made a few general statements can be made. The hull forms suited primarily for the transportation of liquid bulk are the conventional tanker, the semi-submersible and the submarine. Assuming no large change in the speed requirements for the transportation of this cargo the conventional tanker form appears most desirable. A significant change in speed requirements will be required before multi-hulled ships overtake single hull displacement ships for the carriage of dry cargo. CAB vehicles and hydrofoil are most suited for short haul high speed transport of high rate cargo. All in all, conventional hull forms compare well with current developments in new hull forms.

Figure III-1

SHP/Ton Displacement vs. Froude No.

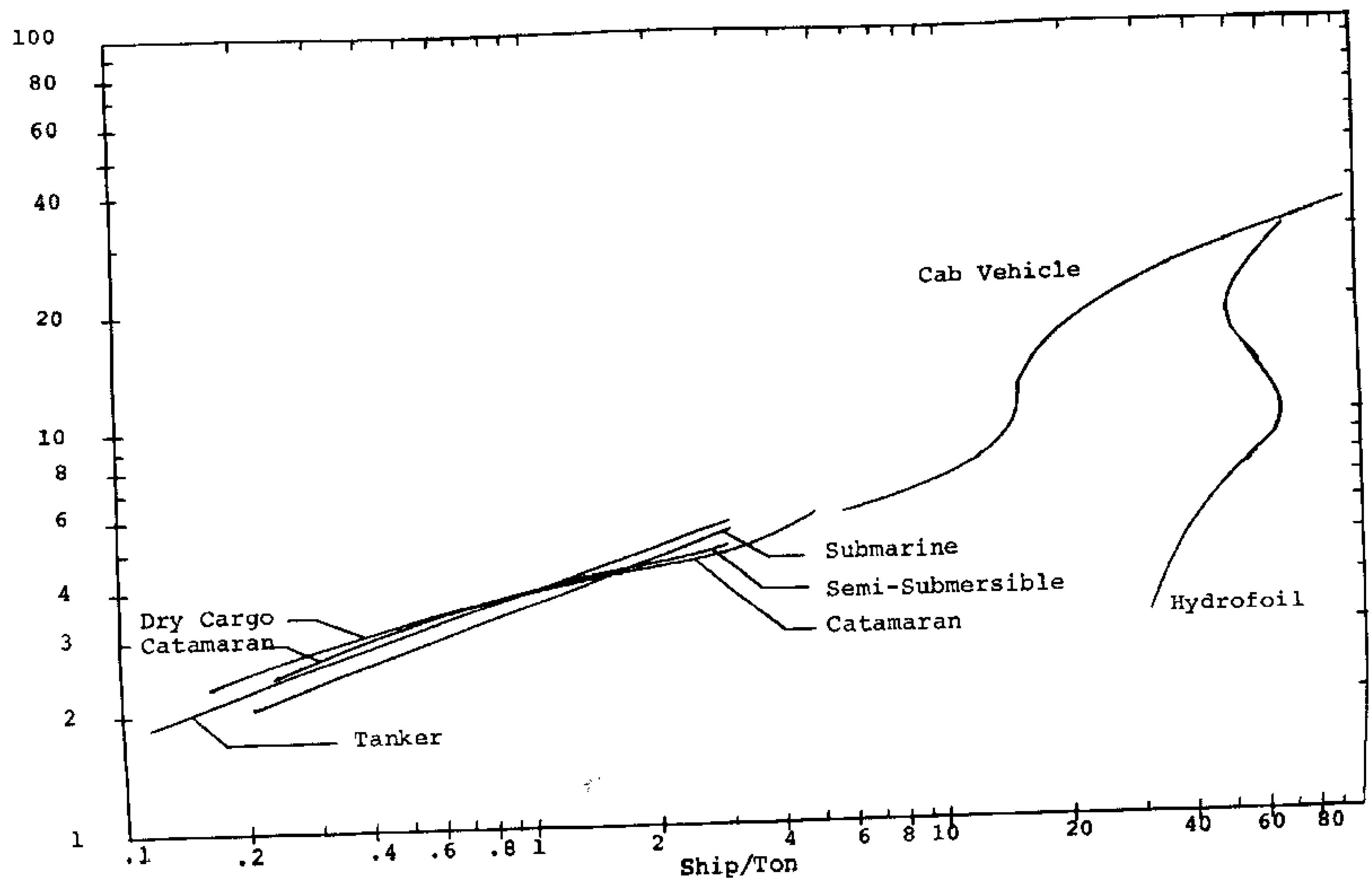


Figure III-2
Specific Hull Weight

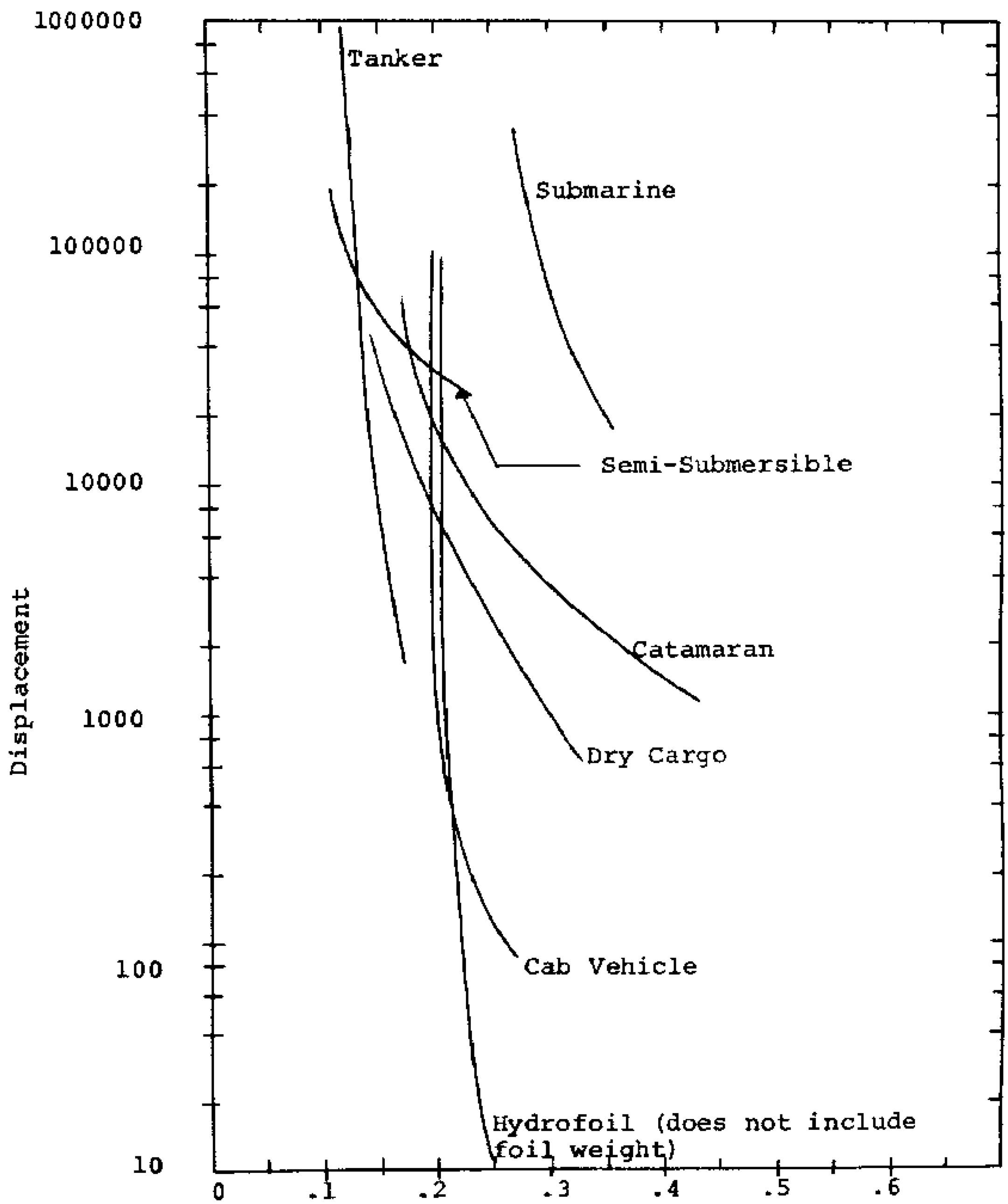
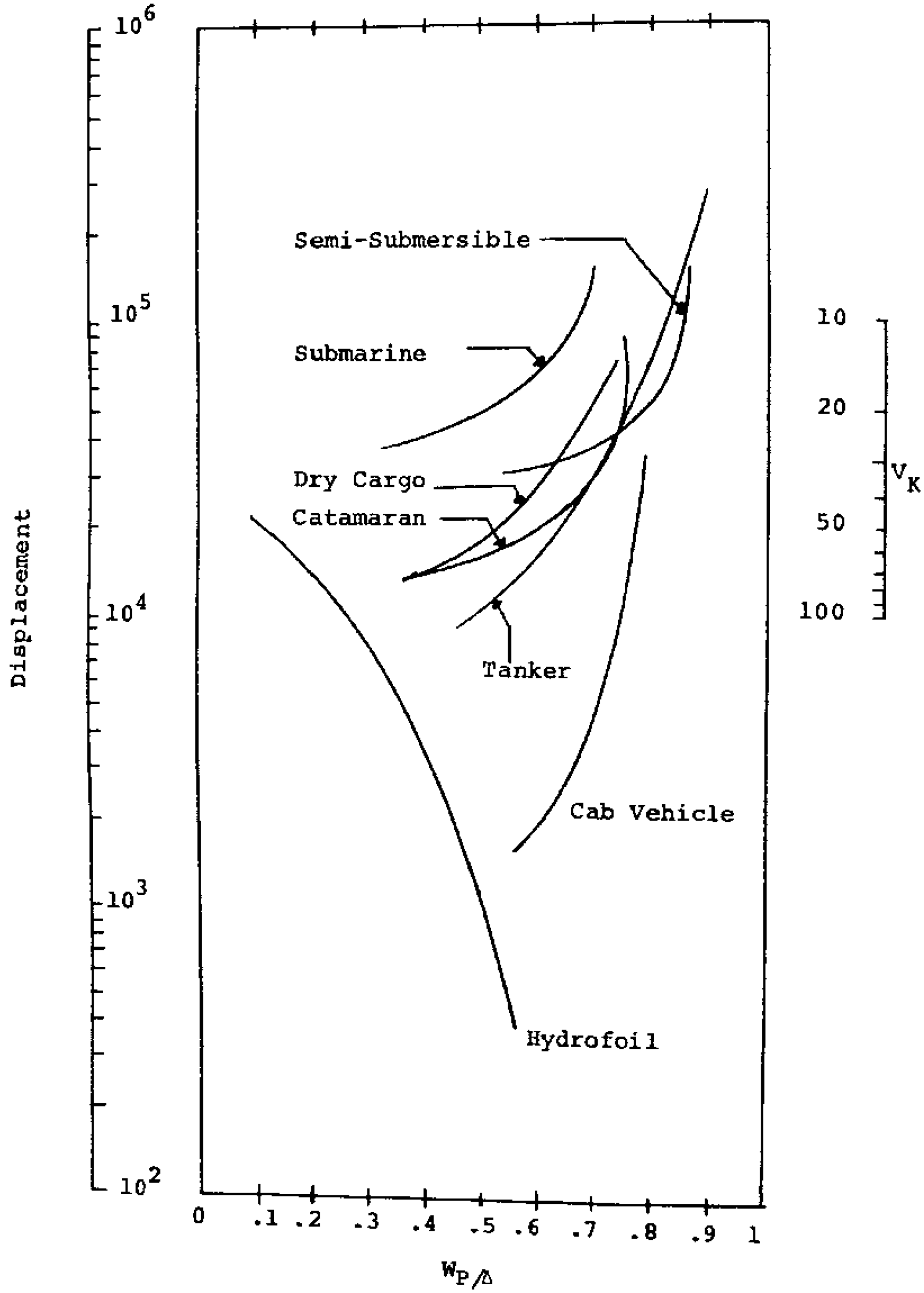


Figure III-3

Specific Payload

Key: For a Hydrofoil
Δ = 2000
V_K = 50
Read W_P/Δ = .37



Cargo Restrictions

A hull form, through its configuration and operational characteristics, is generally most suited for certain types of cargo. The hulls discussed in this chapter are in general limited by volume or cargo weight.

Volume limited ships are most suitable for the transportation of liquids and solids in bulk. Typical cargoes are petroleum products and mineral ores. Transportation of these cargoes is characterized by large consignments and speed requirements of less than 20 knots. The hull forms in this section which fit this mode of ocean transportation are tankers, semi-submersibles and submarines.

Tanker hull forms are currently used for both liquid and dry bulk carriers. Semi-submersibles and submarines are most suited for carrying liquid bulk cargoes. Semi-submersibles are not ideally suited for dry bulk cargoes because of hatch restrictions in the struts and stability problems if the cargo is stowed on the cross structure above the waterline. Submarines are not suited for the transportation of dry bulk. They require that cargo spaces be free flooding or else they incur large penalties in steel weight to strengthen the entire hull against hydrostatic pressure. Submarines are also restricted by the design cargoes. A narrow range of stowage factors gives more efficient utilization of displacement, hull weight, and power. Transportation of a cargo which exceeds the design limits of cargo density will impair the ability to achieve neutral buoyancy and severely degrade the performance of the submarine.

Hull forms which are weight limited carry generally smaller consignments and are powered for greater speeds. Typical cargoes include manufactured goods and foodstuffs. The current trend in these cargoes is towards containerization. For containerized cargo maximum deck stowage is desirable to limit handling difficulties and increase turn-around times. The use of deck stowage may present stability problems and requires that waves be kept from breaking on deck.

Dry cargo ships experience stability and seakeeping difficulties when extensive deck stowage is utilized. Careful design, however, can bring these problems to within acceptable limits. Catamarans overcome the stability problem and offer very large deck areas. Their seakeeping is somewhat better than that of dry cargo ships, yet catamarans may experience critical roll accelerations.

CAB vehicles also offer large deck areas and good seakeeping characteristics. Depending somewhat on performance requirements, the deck area can be increased almost arbitrarily.

The rigid side walls and air cushion provide good stability and seakeeping characteristics. Accelerations should be minimal.

Hydrofoils do not offer the large deck areas of catamarans and CAB vehicles, yet their seakeeping characteristics are excellent. When foil borne, the hull is completely clear of the water in waves of almost any height. Foil attitude control systems limit ship motions to within reasonable standards. Dynamic stability is also provided by the foil attitude control system.

Hull Displacement/Weight and Speed/Power

Analyzing hull weight versus displacement and power versus speed with block coefficient as a parameter, we obtain graphs which should aid in initial design studies by approximating block coefficient and power size for the speed and displacement requirements. When used with the section on power plants, these graphs facilitate the optimization of block coefficient and therefore hull weight, power, and deadweight. Tankers, ore carriers, general cargo ships, containerships, and barge carriers are chosen for this study as being representative of commercial shipping.

Figures III-4 through III-7 are plots of hull weight in long tons (W_H) versus displacement in long tons (Δ) with block coefficient (C_B) as a parameter. Figure III-4 is for tankers with typically large block coefficients of from .70 to .85. Figure III-5 gives W_H versus Δ for ore carriers which are chosen to represent dry bulk carriers. The hull weights for these ships are dependent upon the cargo. Since ore has a high density the steel weight for an ore carrier is large, and hull weights for other dry cargo ships should fall between those for ore carriers and tankers. Figure III-6 gives hull weight versus displacement and block coefficient for general cargo ships with block coefficients from .50 to .75. Figure III-7 gives the same information for containerships and Lash ships. The Lykes Seabee is also a barge carrier utilizing elevators instead of gantry cranes for the handling of barges. Some difficulty has arisen with vibrations in the Seabee and it is not felt that the hull weight for these ships has been finalized and therefore they are not included in this study.

Figures III-8 and III-9 of effective horsepower per ton of displacement (EHP/Δ versus a modified speed-length ratio $V_K/\Delta^{1/6}$) and block coefficient are based upon Taylor's Series. Figure III-8 of EHP/Δ versus $V_K/\Delta^{1/6}$ for C_B from .70 to .85 assumes that hull forms of liquid and dry bulk carriers are similar hydrostatically. The length-beam ratio was taken as 7.0, the beam-draft as 2.25, and the midship coefficient as .995. Displacements from 50,000 long tons to 500,000 long tons were considered. Figure III-9 is for general cargo, container, and Lash ships. Hull forms for these ships were considered similar with a length-beam ratio of 7.0, a beam-draft ratio of 3.50, and a midship coefficient of .98. Displacements of from 10,000 to 100,000 long tons were considered.

Figure III-4

Hull Weights for Tankers

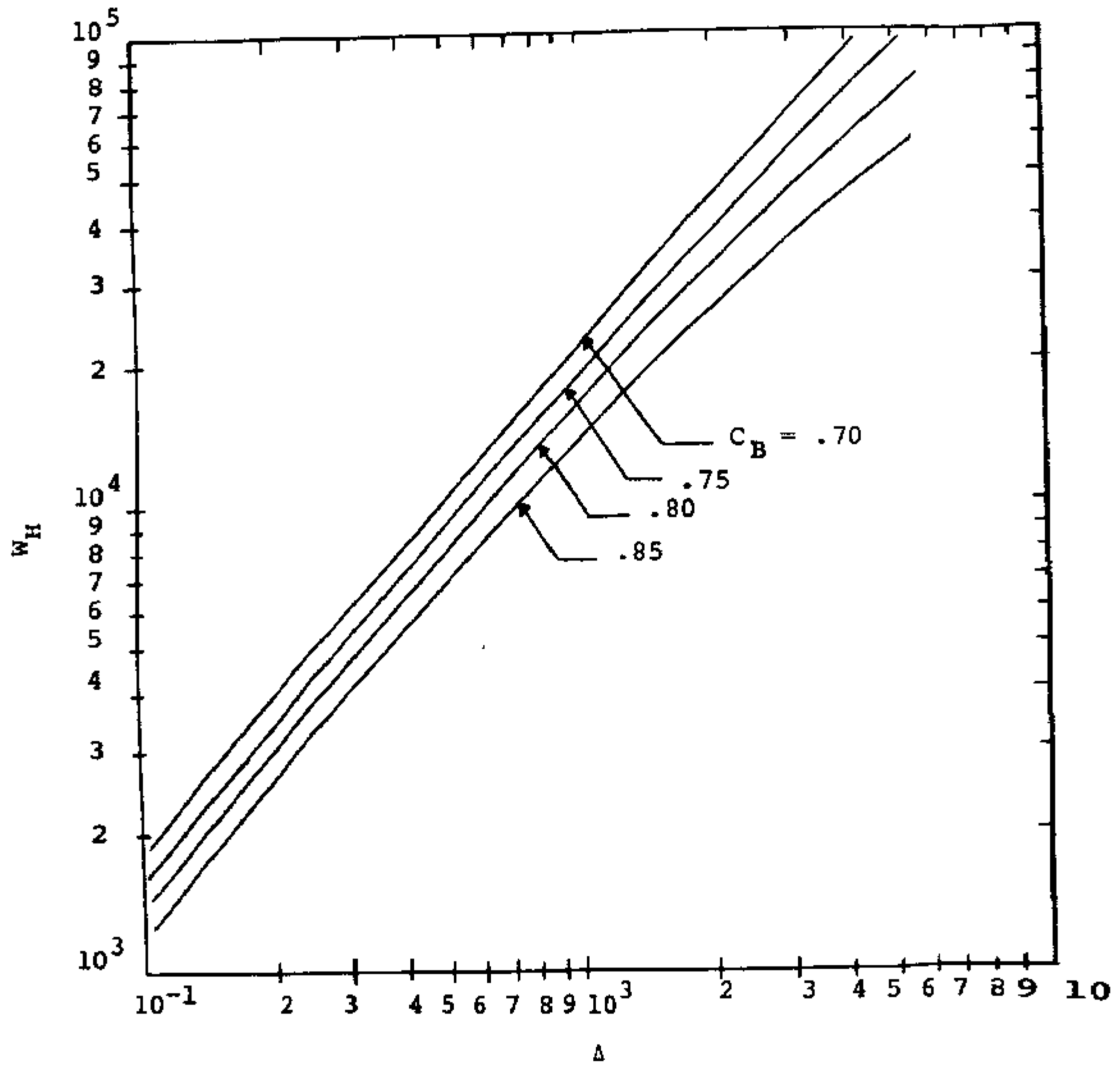


Figure III-5

Hull Weights for Ore Carriers

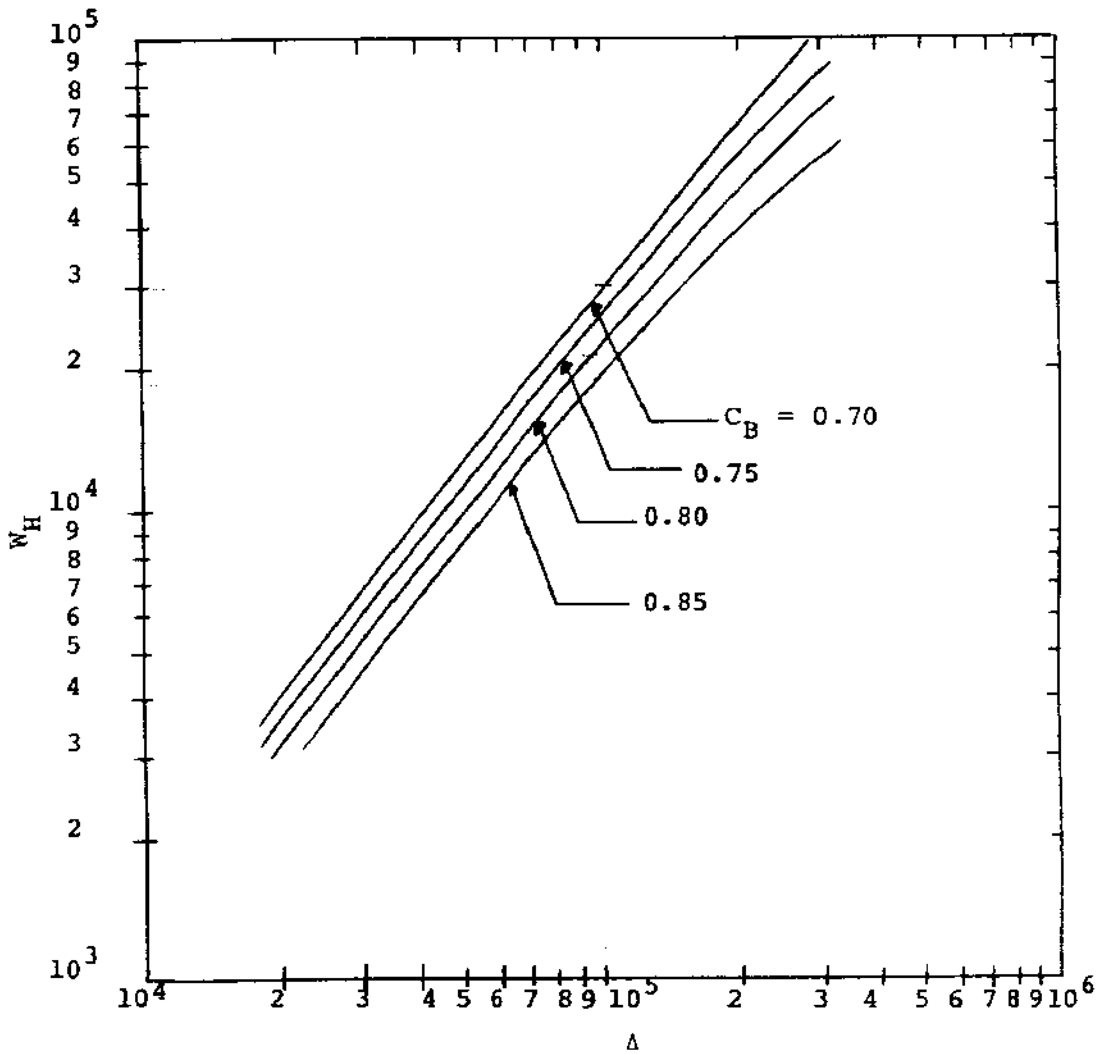


Figure III-6

Hull Weights for General Cargo Ships

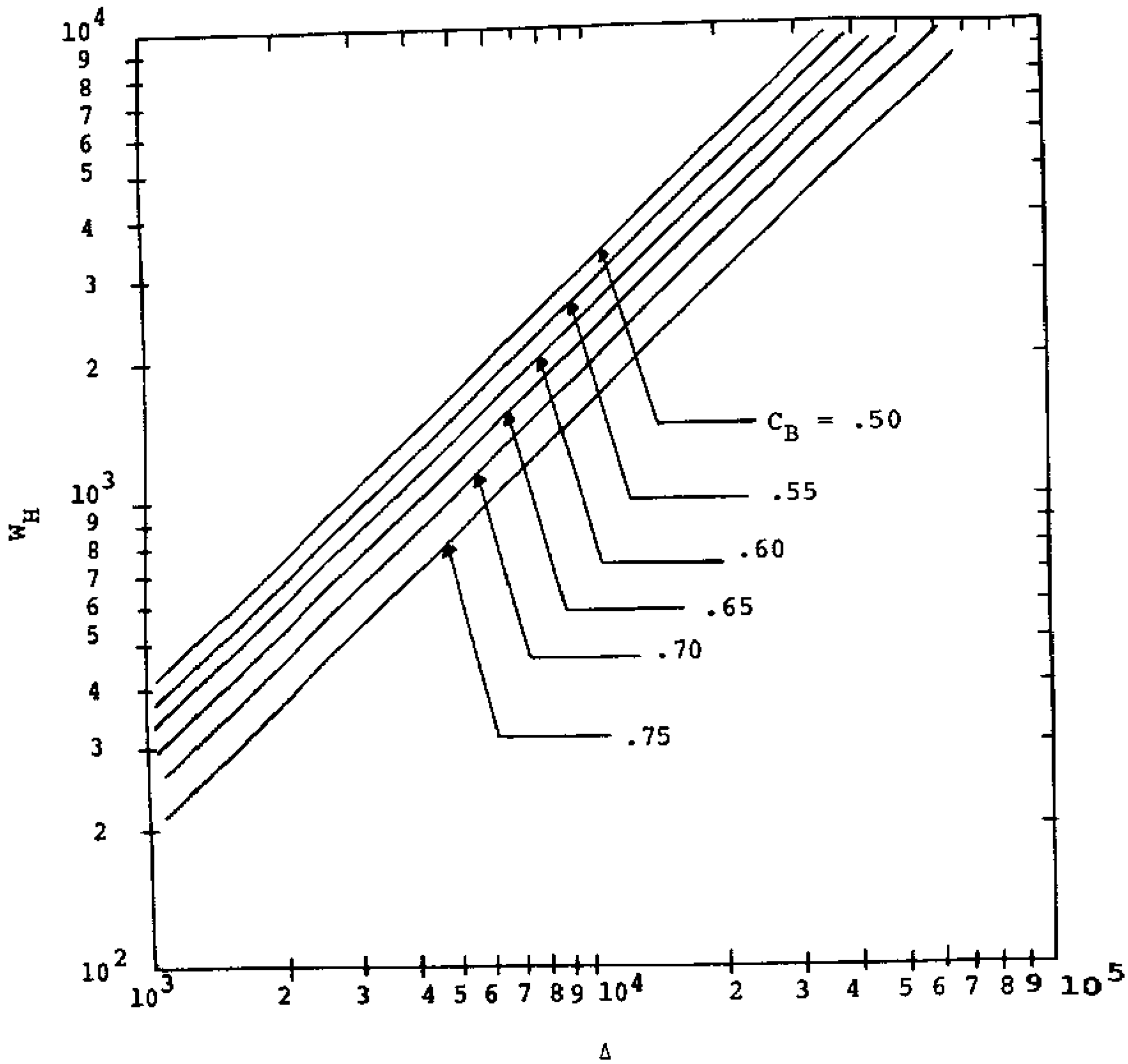


Figure III-7

Hull Weights for Containerships
and Barge Carriers

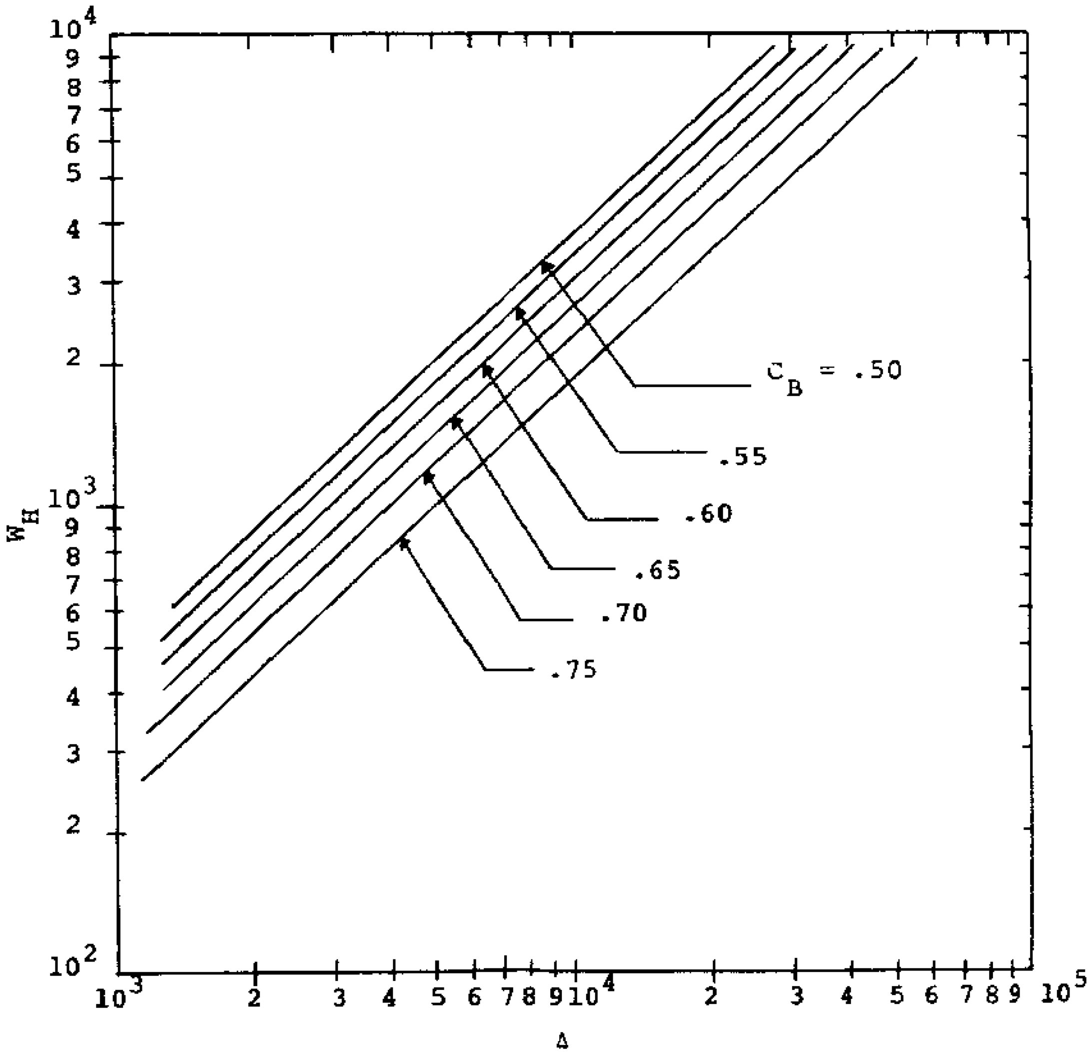


Figure III-8

Speed vs. Power for Bulk Carriers

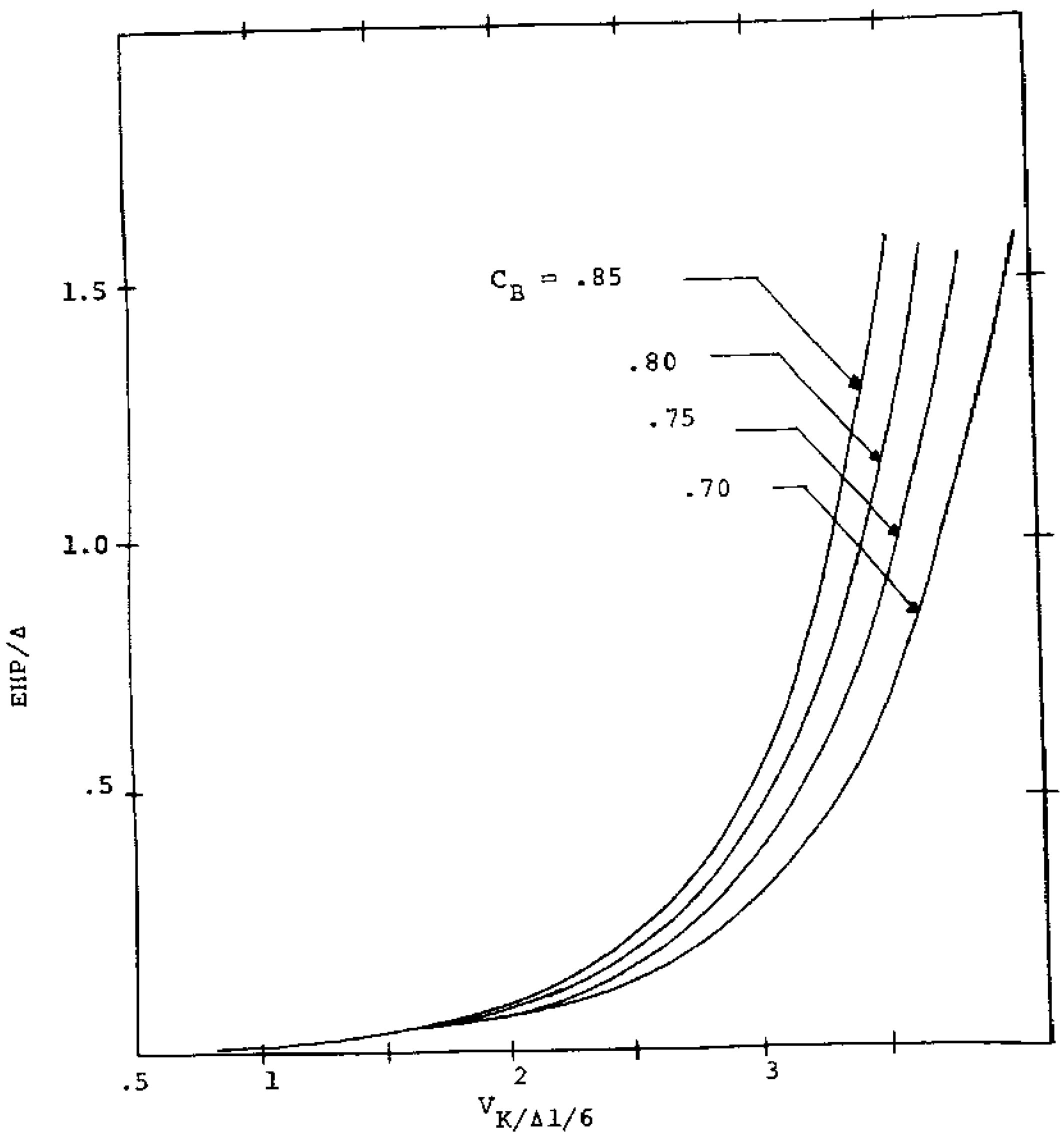
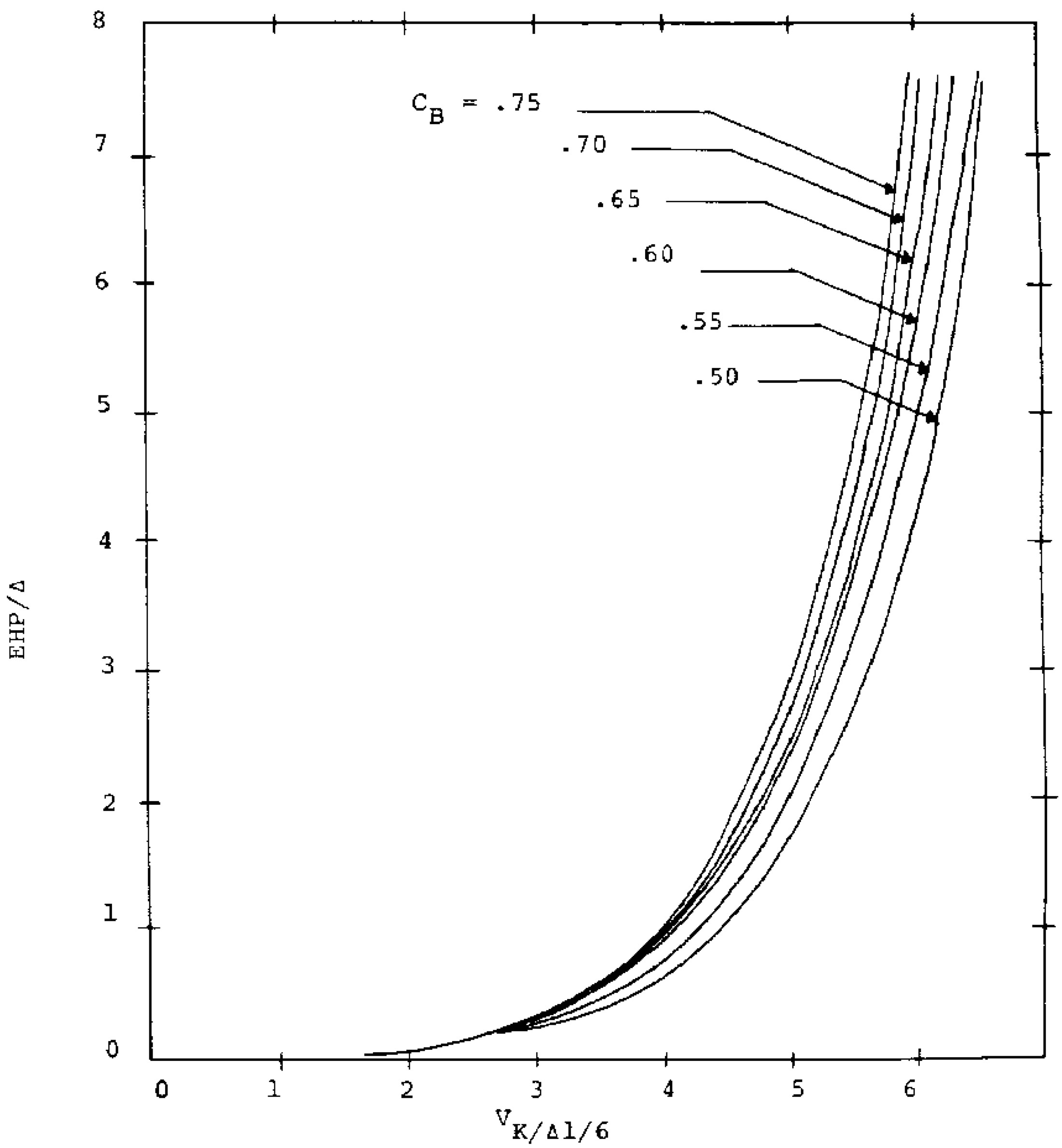


Figure III-9

Speed vs. Power for General Cargo, Container, and Barge Carrying Ships



Novel Hull Form Characteristics

Captive Air Bubble Vehicles

The CAB vehicles assumed vary in all up weight (AUW) (displacement) from 100 to 100,000 tons. Water jet propulsion was assumed because of the relatively high propulsive efficiencies and light machinery weights possible for these propulsive systems. The speed-power relationship was developed from a computer study of a series of CAB vehicles (Williams). The characteristics adopted from this study are: lenth to beam ratio = 2.0, duct and nozzle design-speed loss coefficient = .04, duct and nozzle static loss coefficient = .08, and specific cushion loading = 1.1. A one-foot wave height was also assumed.

Hull structural weight (W_H), outfit weight (W_O), and the machinery specific weight (WM/SHP) of 1.84 lbs/SHP were all taken from Booz Allen. The payload weight (W_p) was then calculated for a number of speeds based on the speed-power relationship already developed.

$$W_{pV_k} = AUW - W_H - W_O - SHP_{V_k}\left(\frac{W_M}{SHP}\right)$$

Hydrofoils

Hydrofoils from 10 to 10,000 long tons displacement or weight were considered. Water jet propulsion was assumed because of difficulties encountered when the transmission makes two right angle bends through the struts. A somewhat higher machinery weight (2.0 lbs/SHP) than for CAB vehicle machinery was assumed to account for foil attitude control systems. The foil weight is assumed to vary inversely with the speed squared. This is because the lift/unit area goes as the square of the speed. The speed-power relationship was taken from Comstock and from data on existing craft (McLeavy). Weight fractions are based on results reported by Hoerner.

Catamarans

Catamaran characteristics were based on two existing designs (Frankel). The speed-power relationship was based on results for these two ships. Payload was determined from hull weight (Mandel), outfit weight (Johnson & Rumble), and machinery weight.

Tankers and Dry Cargo

Design characteristics for these two hull forms were taken from a parametric study (Johnson & Rumble) and from existing ships.

Semi-Submersibles

Semi-submersibles of from 20,000 to 100,000 tons (Cooper) were studied. The speed-power relationship was taken from Cooper. The hull weight is also based on Cooper's results. In the calculation of payload, diesel machinery was assumed because of the high air requirements of turbines. Outfit weight was assumed to be similar to that for conventional surface tankers.

Submarines

The submarines considered varied in deadweight from 20,000 to 255,380 long tons. The speed-power relationship is based on results of Russo et al. A rectangular cross-section was assumed to avoid excessive drafts in the surfaced condition. The displacement was considered to be the operational or submerged displacement. This is about 10% higher than the surfaced displacement. Nuclear PWR power plants were also assumed. The outfit weight was needed to determine hull structural weight and was taken as being similar to that for conventional surface tankers of the same deadweight (D'Arcangelo).

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Chapter IV

PROPULSION SYSTEMS

Basic Considerations

Marine propulsion systems development traditionally lags behind hull form development. Until quite recently the choice of marine propulsion plants was limited to steam and diesel engines. The impact of propulsion machinery selection and design is all-encompassing and affects all facets of ship design, construction and operation, as shown in Figure IV-1. As a result, it is imperative that propulsion system selection and design form an integral part of the total ship system design effort. A possible stepwise propulsion system analysis approach is presented in Figure IV-2.

The basic elements of a propulsion system consist of:

1) energy source,
2) energy conversion - chemical or nuclear to thermal,
3) energy conversion - thermal to expandable gas,
4) energy conversion - thermal to mechanical power,
5) energy transformation - rotary reduction - linear to rotary - reversion, etc.
6) propulsion - thrust converters,

as shown in Figure IV-3.

The number of marine propulsion system alternatives has increased greatly in recent years and additional types of propulsion plants or systems are under active development. Our earlier preoccupation with fuel efficiency is now partially replaced with consideration of such characteristics as:

1) Controllability
2) Reliability
3) Availability
4) Total Plant and Fuel Weight
5) Automatability
6) Investment and Installation Cost
7) Operability (Manning - Maneuverability)
8) Maintainability
9) Producibility
10) Other Considerations (Environmental - Noise - Vibration, etc.)

Some of these considerations and their effects are presented in Figure IV-4.

Many of these considerations are affected by the long expected lifetime of marine power plants, decreasing availability of skilled manpower, increased use of automation, more

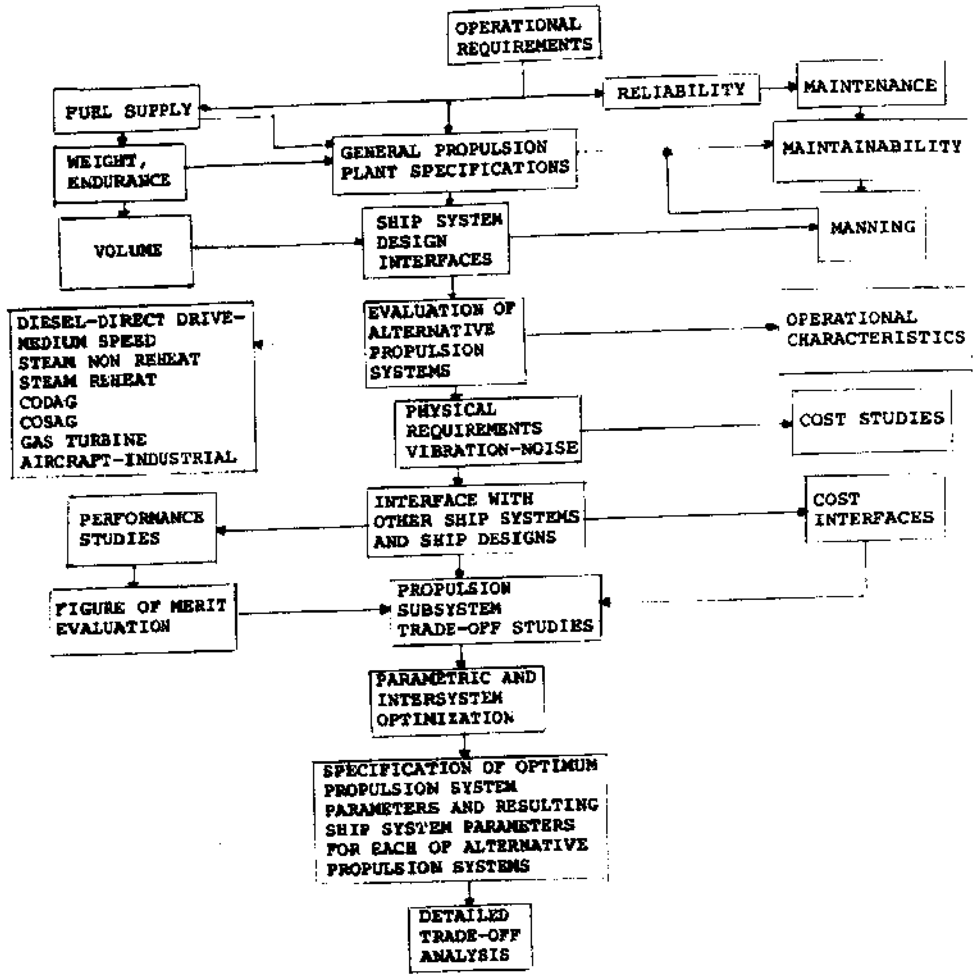


Figure IV-1 PROPULSION SYSTEM ANALYSIS METHOD

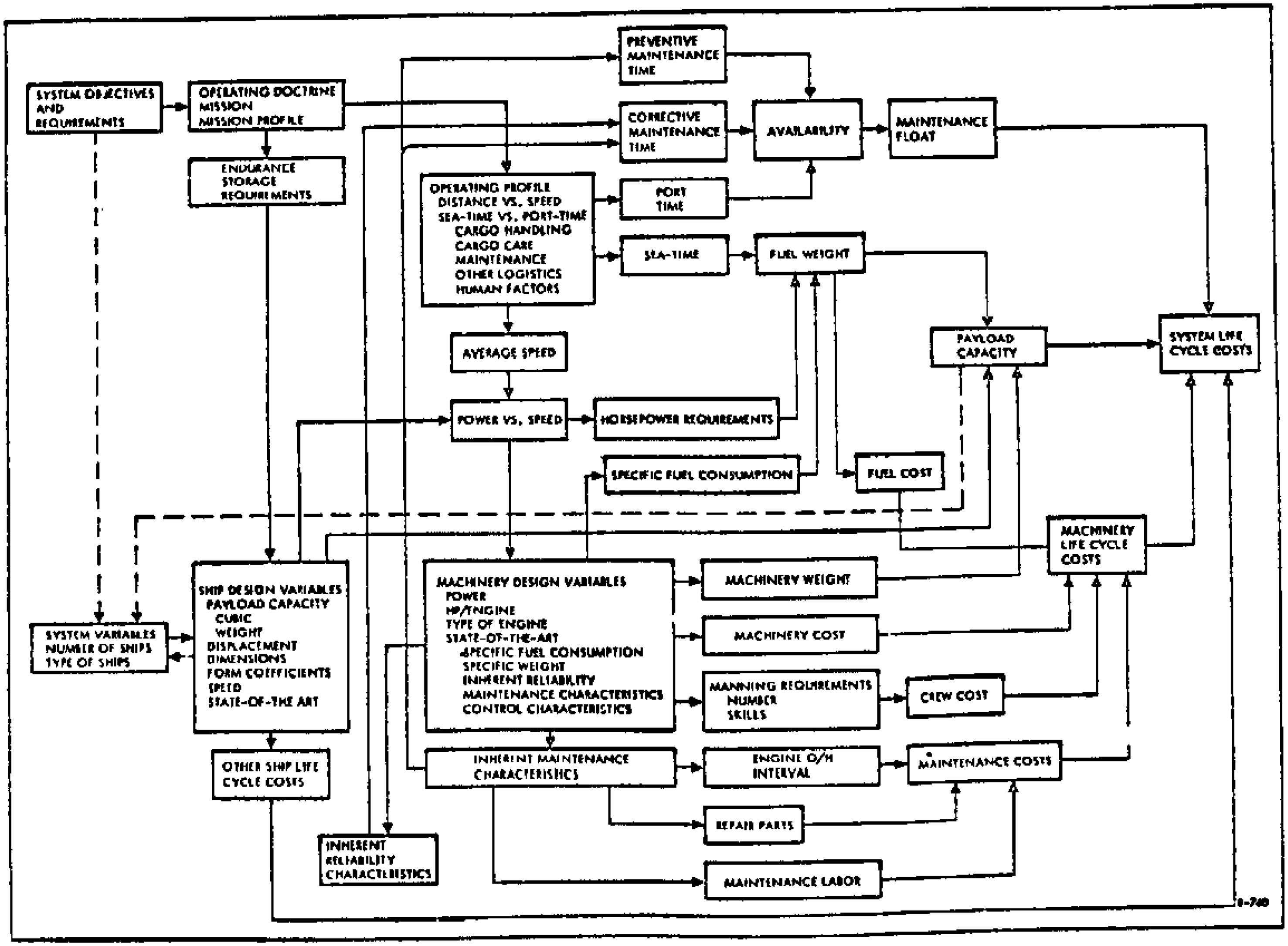


Figure IV-2 IMPACT OF MACHINERY ON SHIP DESIGN

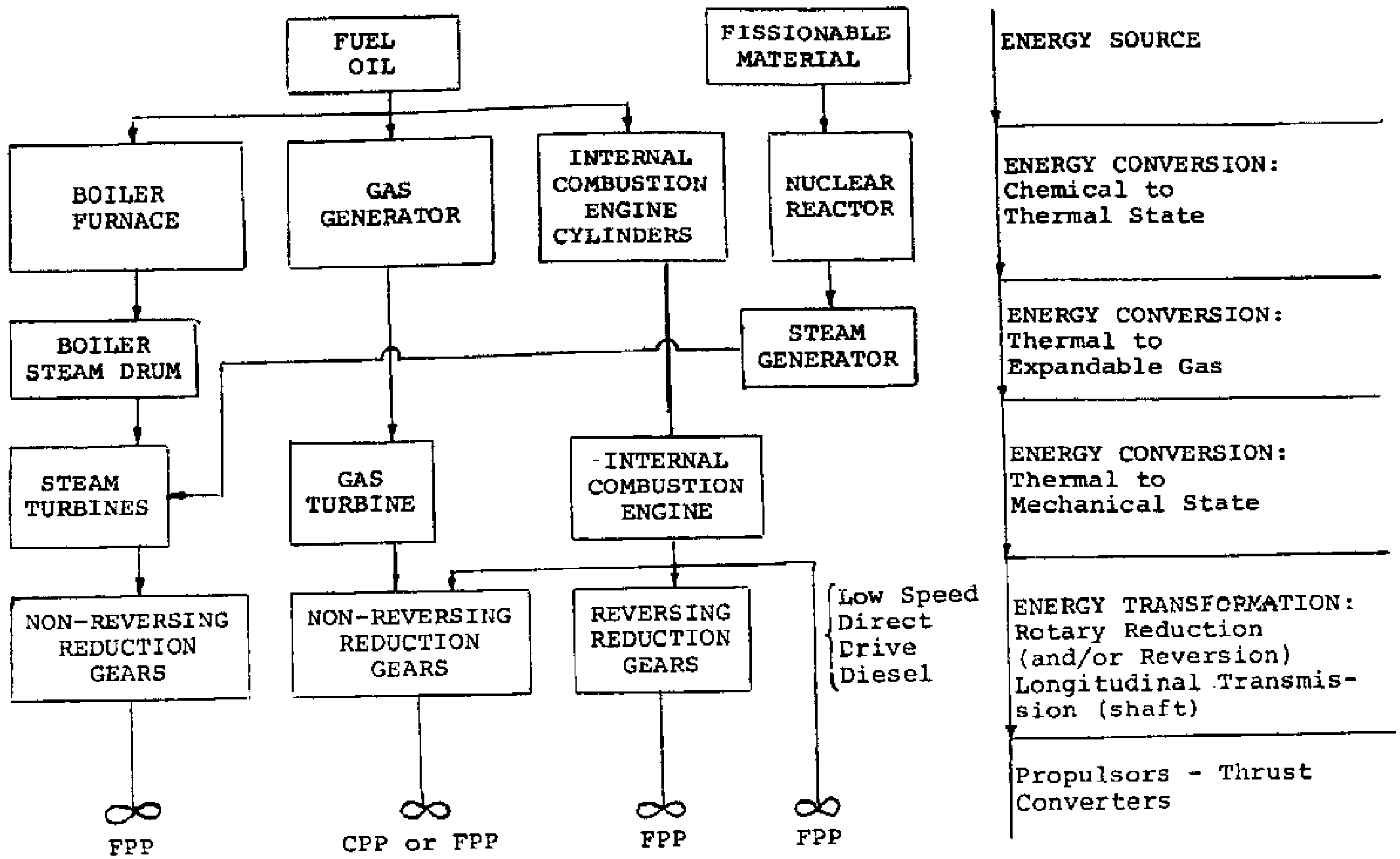


Figure IV-3 BASIC ELEMENTS OF PROPULSION PLANTS

	DESIGN PERFORMANCE	DEVELOPMENT STATUS	PRODUCIBILITY	INSTALLABILITY	AUTOMOBILITY	CONTROLLABILITY	OPERABILITY	RELIABILITY	MAINTAINABILITY	MANEUVERABILITY	REPAIRABILITY AND SUPPORTABILITY	HABITABILITY
PERFORMANCE	Thermal efficiency Mechanical efficiency State of art incorporation Materials Fabrication Operating environment Loss reduction	Commercial Req. R & D effort State of art incorporation Development experience Operating experience	Development status Component design Fabrication process Production capability Labor skills Quality assurance Erection procedure Assembly methods Trials, tests, etc. Production reputation Organization management	Size Weight Subassembly components Prefabrication Foundation requirements Materials handling	Machinery design & control characteristics Number of components Arrangements Skill requirements	Machinery characteristics Arrangements Redundancy Complexity Dynamic response characteristics Self-regulation Fault detection	Degree of automation Arrangement Number of controls Induced effects Fault detection Crew skills	Design State of art incorporation Number of wearing parts Number of stressed parts Thermal stresses Duty cycle Arrangement of components Redundancy of components Failure data Development Auxiliary reliability Personnel skill & training Self-regulation & fail safe Maintenance power Fault detection equipment.	Design Accessibility Complexity Automation Frequency of maintenance actions Skill requirements Time requirements	Machinery characteristics Reversing means	Maintainability Fuel requirements Spare parts Standard components Reliability Development status Manufacturer's service Skill requirements	Engine type Arrangements Space Treatment Installations Public health U.S. Coast Guard Final type
EFFECT	Fuel consumption Thermal stress Material selection Specific parcel Complexity	Ship availability Risk Maintenance cost Logistic support	Delivery schedule Return cost Production cost Performance requirements	Installation cost Installation time Installation labor Facility cost Safety	Human error Reliability Maintenance Cost & time Initial cost Manning requirements	Centralized control Manning requirements Initial cost Remote control	Smaller crew Reduced skills Crew efficiency Safety	Equipment cost Ship availability Maintenance cost Manning	Fault detection Fail safe features Improved access Spare parts Special tools Reduced manning Ship availability Maintenance plan	Response time Reverse time Power control requirements	Ship availability Bunker capacity Spare parts allowance Maintenance plan	Heat Noise Operational Hazard Harbor Contaminations Noxious fumes, gas & smoke Explosion and fire hazards Vibration
CRITERIA	Fuel cost Specific weight	Life cycle cost Risk of failure Operating facility	Timely delivery Profit Performance Reliability	Installation cost Installation time Facility burden Safety Construction schedule	Life cycle cost Reliability Maintenance costs	Life cycle cost	Life cycle cost Habitability Safety	Life cycle cost Figure of merit	Maintenance cost Maintenance time Crew cost	Owner's requirements Ship safety Initial cost	Ship availability Initial cost Maintenance cost	Crew Efficiency safety initial cost

Figure IV-4 POWER PLANT GENERAL REQUIREMENTS AND CONSIDERATIONS universal availability of different fuels, high cost of spares and maintenance, large cost of ship unavailability, environmental constraints, and more. No longer can we afford to select propulsion plants from the point of view of fuel efficiency, or the combined fuel and machinery weight. Even criteria such as total (present value) direct and indirect costs are not always effective measures of performance. The propulsion plant is but one of the subsystems of the ship system (which, in turn, may consist of more than a fleet of ships) and its optimum performance does not necessarily contribute to the selection and design of a most effective ship system. What is important is the consideration of the subsystem interfaces and the sensitivity of total system performance to variations in the selection and/or parameters, etc., of the different subsystems. The choice among marine propulsion plants is large today and is increasing. While some types of plants are not attractive for certain output ranges, none really has an absolute advantage over all competing types of plant, under all conditions, at any output level.

Other propulsion plants are only available in discrete output steps. These and other factors introduce additional complications into propulsion plant selection and design.

The types of marine power plants under present consideration and/or development are presented in Table IV-1.

Table IV-1

Types Of Power Plants

I. Diesel

   A. Low Speed
   B. Medium Speed
   C. High Speed

II. Gas Turbine

   A. Marine

      1. Simple cycle
      2. Regenerative

   B. Industrial

      1. Simple cycle
      2. Regenerative

III. Steam

   A. Conventional
      1. Natural circulation boilers
      2. Forced circulation boilers
      3. Once-through boilers

IV. Nuclear

   A. Water cooled
   B. Gas cooled

V. Fuel Cells

VI. Superconducting Electrical Machinery

VII. Thermoelectric Power Conversion

VIII. Thermo-Ionic Power Conversion

IX. Magnetohydrodynamic Propulsion

Propulsion System Performance Measures

The establishment of meaningful performance measures designed to assure effective, unbiased comparisons among propulsion plant alternatives is required in design and systems analysis of transportation systems. In this section, a precise definition of propulsion plant system boundaries or constraints is developed and intended to provide a uniform basis for the comparison of alternate propulsion plants, utilizing the same ship interfaces for all candidate plants and their associated auxiliary systems.

At the present time there is no standard methodology or procedure which the engineer or analyst can utilize effectively to evaluate alternative propulsion plant performance and other parameters to arrive at the most cost-effective power plant for a specific application. Two prime considerations are essential in this regard: (1) the establishment of standard propulsion plant boundaries to include all significant ship interfaces which relate to the propulsion plant, in whole or in part, and (2) the establishment of meaningful parameters as a basis for effective, unbiased comparison of propulsion plants.

In the past, generally speaking, an effective group of parameters has been used in the comparison of power plants, including weight (long tons), specific weight (pounds per SHP), fuel consumption (long tons per unit time), specific fuel consumption (in pounds per horsepower hour), material and installation costs (in dollars) and specific cost in terms of dollars per shaft horsepower. To these should be added volume and specific volume, for volume (in volume-limited ships) can be at a premium in terms of cargo which can be carried. It is in the first area where inconsistencies have abounded, precluding effective and unbiased comparisons between propulsion plants due to a lack of definition of standard plant boundaries. Such boundaries have ranged from the minimum of including only the propulsion units (main engine and reduction gears) to other extremes which included all machinery (excluding hull machinery: anchor windlass, winches, steering gear, etc.), including the electrical power generating plant and many auxiliary machinery systems not totally associated with the propulsion plant. Clearly, under such a wide range of plant boundaries it would be virtually impossible for the engineer or analyst to develop a meaningful comparison between propulsion plant alternatives.

The following examples may serve to illustrate the importance of developing standard boundaries for power plants. The total weight and volume of fuel to be carried is often a factor not considered in propulsion plant comparisons. In the comparison of a nuclear plant versus any plant utilizing fossil fuel, this can be a decisive factor in favor of the nuclear plant, whereby the greater weight and volume of fuel required by the fossil fuel plant can be utilized for the storage of other important logistics items, such as aviation fuel (in the case of aircraft carriers) and additional cargo in the case of merchant vessels. The distilling plant of a ship constitutes a second significant example. The size of these plants, and hence the cost, is affected significantly by the type of propulsion plant installed, the steam plant, obviously, dictating a requirement for larger evaporators, with internal combustion engine and gas turbine plants imposing a minimum requirement. Other examples include machinery space ventilation, compressed air (for control systems and air start systems) and tank heating requirements. The volume and cost requirements of the electrical power generating plant can be charged only partially to those of the propulsion plant, to that degree in which electrical power is required by the plant. For example, the electrical power requirements of the nuclear propulsion plant will be far in excess of those for a diesel or gas turbine plant, or for the conventional steam plant, for that matter. Quite approximately, therefore, the nuclear propulsion plant should bear a significantly greater portion of the burden of generators in any comparison with other types of propulsion plants.

To establish propulsion plant boundaries for performance measure determination various component classifications were considered. The U.S. Navy's system of weight classification is recognized as perhaps one of the most comprehensive and effective groupings of shipboard material, equipment and systems, including weights for nuclear propulsion plants. This classification system consists of nine major groups, as follows:

1) Hull Structure
2) Propulsion
3) Electric Plant
4) Communication and Control
5) Auxiliary Systems
6) Outfit and Furnishings
7) Armament
8) Design and Engineering Services
9) Construction Services

The Maritime Administration (MARAD), on the other hand, subdivides its weight groupings into three major groups: steel weight (with subgroups 1 through 9), outfit weight (with subgroups 10 through 19) and machinery weights (with subgroups 20 through 29). Though consisting of fewer major groupings, the MARAD system, too, is a comprehensive grouping system for merchant type vessels. It does not, however, contain separate subgroupings to cover nuclear propulsion plants.

The Navy's definition of "machinery weight" is depicted graphically in Table IV-2. Included therein are all of Group 2 (Propulsion), subgroups 300,301, 302, 350 and 351 of Group 3 (Electric Plant), all of subgroups 511, 514 and 517, those miscellaneous piping systems in subgroup 5.6 associated with the propulsion plant, those tank heating systems in subgroup 512 associated with lube oil or fuel oil tanks, those repair parts, etc., in subgroup 550 associated with the equipment in subgroups 511, 512, 514, 516 and 517, and those liquids contained in the components, units and systems in subgroups 511, 512, 514, 516 and 517, and those liquids contained in the components, units and systems in subgroups 511, 512, 514, 516 and 517. This grouping is reasonably all-inclusive of all items associated with propulsion plants with minor exceptions as follows:

a) Subgroups 11 and 113, foundations for propulsion plant machinery and for auxiliaries and other equipment, respectively, should be included since the size of these foundations will depend upon the type of propulsion plant.

b) Subgroup 501, ventilation system, should be included, since the size of the machinery space ventilation system will depend upon the type of plant.

c) Subgroup 513, compressed air system, similarly should be included, because of demands for control air and start air by propulsion plants.

Table IV-3 reflects the Navy grouping with the above additions entered and with subgroups 615 and 550 deleted since the effects of the latter groups are not considered significant between propulsion plant types. Table IV-3, further, reflects the comparable MARAD weight group numbers for convenience of comparison.

It is to be noted, at this point, that the Navy includes <u>all</u> of the subgroup weights cited above under major groups 300 and 500 under the classification of "machinery weight". This procedure is not truly reflective of the actual weights associated with the propulsion plant installation. For example, as noted previously, only a portion of the electrical power generated by generator sets is associated with the propulsion plant, the degree of association depending on the type of propulsion plant. The same is true of other weight groupings, such as ventilation, compressed air and distilling plants.

In order to provide the engineer or analyst with a tool for estimating with reasonable accuracy the portions of such weight groupings which can be charged to propulsion plants, Table IV-4 was developed. A "Utilization Factor," or U.F., has been derived for each of the propulsion weight groups

TABLE IV-2

U.S. NAVY DEFINITION OF MACHINERY WEIGHT

Navy No.	Component \ Plant Type
200	Boilers and Energy Converters (Non-Nuclear)
201	Propulsion Units
202	Main Condensers and Air Ejectors
203	Shafting, Bearings and Propellers
204	Combustion Air Supply System
205	Uptakes (Smoke Pipes)
206	Propulsion Control Equipment (Non-Nuclear)
207	Main Steam System
208	Feedwater and Condensate System
209	Circulating and Cooling Water Systems
210	Fuel Oil Service System
211	Lubricating Oil System
212	Nuclear Steam Generators
213	Reactors
214	Reactor Coolant System
215	Reactor Coolant Service Systems
216	Reactor Plant Auxiliary Systems
217	Nuclear Power Control and Instrumentation
218	Radiation Shielding (Primary)
219	Radiation Shielding (Secondary)
250	Propulsion Repair Parts
251	Propulsion Operating Fluids
300	Electric Power Generation
301	Power Distribution Switchboards
302	Power Distribution System (Cable)
350	Electric Plant Repair Parts
351	Electric Power Generator
511	Fuel and Diesel Oil Filling, Venting, Stowage, and Transfer Systems
512	Tank Heating System
514	Auxiliary Steam, Exhaust Steam, and Steam Drains
516	Miscellaneous Piping Systems
517	Distilling Plant
550	Auxiliary Systems Repair Parts

TABLE IV-3

PROPOSED DEFINITION OF PROPULSION PLANT WEIGHT

Navy No.	Marad No.	Component / Plant Type
112	7-0,1,3	Foundations for Propulsion Plant Machinery
113	7-2	Foundation for Auxiliaries
200	26-0,1,2	Boilers and Energy Converters (Non-Nuclear)
201	20-0,1,2 25-1,2 28-2	Propulsion Units
202	20-3,4	Main Condensers and Air Ejectors
203	23-0,1, 2,3	Shafting, Bearings and Propellers
204	26-3	Combustion Air Supply System
205	26-5	Uptakes (Smoke Pipes)
206	26-4 28-6	Propulsion Control Equipment (Non-Nuclear)
207	27-0	Main Steam System
208	21-0,1 22-0	Feedwater and Condensate System
209	20-5	Circulating and Cooling Water Systems
210	26-6	Fuel Oil Service System
211	24-0,1	Lubricating Oil System
212	-	Nuclear Steam Generators
213	-	Reactors
214	-	Reactor Coolant System
215	-	Reactor Coolant Service Systems
216	-	Reactor Plant Auxiliary Systems
217	-	Nuclear Power Control and Instrumentation
218	-	Radiation Shielding (Primary)
219	-	Radiation Shielding (Secondary)
250	23-4 28-5	Propulsion Repair Parts
251	29-1,2	Propulsion Operating Fluids
300	19-3A,B,C	Electric Power Generation
301	19-3D	Power Distribution Switchboards
302	19-3E	Power Distribution System (Cable)
350	28-5	Electric Plant Repair Parts
351	29-0	Electric Power Generator Fluids
501	28-3	Ventilation System (Machinery Space)
511	18-5	Fuel and Diesel Oil Filling, Venting, Stowage and Transfer Systems
512	18-5	Tank Heating System
513	25-0,1	Compressed Air System
514	27-1,2,3	Auxiliary Steam, Exhaust Steam, and Steam Drains
517	22-1,2	Distilling Plant

Component / Plant Type	Con-ventional Steam	Reheat Steam	Diesel Low Speed	Diesel Medium Speed	Gas Turbine Simple Cycle	Gas Turbine Regen. Cycle	Nuclear
1. Main Engines	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2. Reduction Gears	1.0	1.0	0.0	1.0	1.0	1.0	1.0
3. Shafting, Bearings & Propellers	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4. Main Condenser, etc.	1.0	1.0*	0.0	0.0	0.0	0.0	1.0
5. Desalination Plant	0.7	0.7**	0.0	0.0	0.0	0.0	0.7
6. Fuel Oil System (heaters)	1.0	1.0	1.0	0.0	0.0	0.0	0.0
7. Lube Oil System (coolers, purifiers, heaters)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8. Feed & Condensate System (DFT, stage feed heaters)	1.0	1.0	0.0	0.0	0.0	0.0	1.0
9. Boilers/Steam Generators	0.95	0.95	0.0	0.0	0.0	0.0	0.95
10. Forced Draft System	0.95	0.95	0.0	0.0	0.0	0.0	0.0
11. Control Air System	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Starting Air System	0.0	0.0	1.0	1.0	0.0	0.0	0.0
Hydraulic Start System	0.0	0.0	0.0	0.0	1.0	1.0	0.0
12. Pumps							
a. Main Feed	0.95	0.95	0.0	0.0	0.0	0.0	0.95
b. Main Circ.	1.0	1.0	0.0	0.0	0.0	0.0	1.0
c. Main Condensate	1.0	1.0	0.0	0.0	0.0	0.0	1.0
d. S.W. Service	0.0	0.0	0.0	0.0	0.0	0.0	0.0
e. L.O. Service	1.0	1.0	0.0	1.0	1.0	1.0	1.0
f. F.O. Service	0.95	0.95	0.0	0.0	0.0	0.0	0.0
g. F.O. Transfer	0.95	0.95	0.0	0.0	0.0	0.0	0.0
h. Primary Coolant	0.0	0.0	0.0	0.0	0.0	0.0	0.95
i. D.O. Service	0.0	0.0	0.95	0.95	0.95	0.95	0.0
j. D.O. Transfer	0.0	0.0	0.95	0.95	0.95	0.95	0.0
13. Electrical Power Generation***	0.45	0.45	0.25	0.30	0.30	0.30	0.65
14. Machinery Plant Control System	1.0	1.0	1.0	1.0	1.0	1.0	1.0

* With Shaft Driven Auxiliaries

** For Merchant Ships, as low as 0.3 for Combatants, Due to High Manning Requirements

*** SNAME Bulletin 3-11 (3.2.15) $Kw_{prop} = 0.022 \times shp$ or $0.015 \times shp$

Table IV-4: Marine Propulsion Plant Equipment Utilization Factors for Various Type Plants (A U.F. of 1.0 Reflects 100% Utilization For Propulsion) (Cargo Ship)

Component Plant Type	COSAG	CODAG	CODOG	COGAG	COGOG	COSAGE	COGAS	CONAG	CODAGE
1. Main Engines	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2. Reduction Gears	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3. Shafting, Bearings & Propellers	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4. Main Condenser, etc.	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0
5. Desalination Plant	0.7	0.0	0.0	0.0	0.0	0.7	0.5	0.7	0.0
6. Fuel Oil System (heaters)	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0
7. Lube Oil System (coolers, purifiers, heaters)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8. Feed & Condensate system DFT, stage feed heaters)	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0
9. Boilers/Steam Generators	0.95	0.0	0.0	0.0	0.0	0.95	0.0	0.95	0.0
10. Forced Draft System	0.95	0.0	0.0	0.0	0.0	0.95	0.0	0.95	0.0
11. Control Air System	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12 Starting Air System	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0
Hydraulic Start System	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12. Pumps									
a. Main Feed	0.95	0.0	0.0	0.0	0.0	0.95	0.95	0.95	0.0
b. Main Circ.	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0
c. Main Condensate	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0
d. S.W. Service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
e. L.O. Service	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
f. F.O. Service	0.95	0.0	0.0	0.0	0.0	0.95	0.0	0.0	0.0
g. F.O. Transfer	0.95	0.0	0.0	0.0	0.0	0.95	0.0	0.0	0.0
h. Primary Coolant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.95	0.0
i. D.O. Service	1.0	0.95	0.95	0.95	0.95	1.0	0.95	1.0	0.95
j. D.O. Transfer	1.0	0.95	0.95	0.95	0.95	1.0	0.95	1.0	0.95
13. Electrical Power Generation	0.45	0.30	0.30	0.30	0.30	0.45	0.35	0.60	0.30
14. Machinery Plant Control System	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table IV-4 (Continued)

Marine Propulsion Plant Equipment Utilization Factors for Various Type Plants

(A U.F. of 1.0 Reflects 100% Utilization for Propulsion)

(Cargo Ship)

listed in Table IV-3, reflecting the portion of each weight group which is considered to be associated with the propulsion plant. These factors were developed utilizing heat balances, electrical load analyses and good engineering judgment for guidance. A U.F. of unity indicates 100% association with the propulsion plant, etc. Application of these U.F.s to weight, volume, cost, or any other parameters, through simple multiplication, should yield reasonably realistic and reliable estimates.

To define major propulsion system related components, an analysis was performed of auxiliaries required for various types of marine propulsion plants. The results are listed in Tables IV-5a through IV-5c. Further detail is provided in the Master Equipment Lists for the major propulsion plants of interest in Table IV-6.

MAJOR PROPULSION RELATED COMPONENTS OF VARIOUS MARINE PROPULSION PLANTS

Component / Plant Type	CONVENTIONAL STEAM	STEAM REHEAT	DIESEL LOW SPEED	DIESEL MEDIUM SPEED	GAS TURBINE
1 Main Engines	HP/LP cross-compound steam turbines	Counterflow HP/LP and LP turbine	100-200 RPM large bore diesel reversible silencers Discon clutch	400-600 RPM medium bore diesel, nonreversing silencers Discon clutch	Simple cycle marinized aircraft gas turbine with free turbine demisters Discon clutch
2 Reduction Gears	Double reduction double helical locked train, non-reversing	Double reduction double helical locked train, non-reversing	None	Single reduction double helical locked train, reversing	Double reduction double helical divided train, reversing or non-reversing
3 Shafting, Bearings & Propellers	Line shafting & bearings, tail shafting stern tube & bearings thrust bearing propeller (F.P.P.)	Line shafting & bearings, tail shafting stern tube & bearings thrust bearing propeller (F.P.P.)	Line shafting & bearings, tail shafting stern tube & bearings thrust bearing propeller (F.P.P.)	Line shafting & bearings, tail shafting stern tube & bearings thrust bearing propeller (F.P.P.)	Line shafting & bearings, tail shafting stern tube & bearings thrust bearing propeller (FPP or CPP)
4 Main Condensers	Axial or vertical scoop injection, 1½"to 2" Hg ABS. 75°F sea water	Axial athwartship scoop injection 1½" to 2" Hg ABS. 75°F sea water, motor driven vacuum pumps	None	None	None
Air Ejection	2 element/2 stage Int./Aft/Gld. Cond.	Motor driven vacuum pumps	None	None	None
5 Desalination Plants	Low pressure subm. tube or flash type	Low pressure bleed steam from LP turbine distiller cond. served by vacuum pumps & cooled by main condensate	Vapor compression or flash type (aux. boiler steam) *Not required for propulsion	Flash type (aux. boiler steam) *Not required for propulsion	Flash type (aux. boiler steam) *Not required for propulsion
6 Feed Heaters	First stage DFT (2nd stage)	Up to 5 stages DFT (3rd stage	None	None	None
7 Steam Generators & Auxiliaries	Single furnace natural circ. supercht. boilers with economizer steam air htr. aux. steam desuper htrs. in drum. Alternates: pressure fired forced circ.	Combination superheat/reheat boiler with gas air heater, aux. steam desuphtrs in drum; low pressure steam generator using bleed steam	Package boiler or waste heat unit (not required for propulsion)	Package boiler or waste heat unit (not required for propulsion)	Package boiler or waste heat unit (not required for propulsion)
8 Pumps Main Feed	Turbine Driven horizontal/centr.	1) HP shaft driven 1) Aux. turb. driven	None	None	None
Main circulating	Motor driven Vertical/centr.	Motor driven Vertical/centr.	None	None	None
Main condensate	Motor driven vertical/centr.	Motor driven vertical/centr.	None	None	None
L.O. Service	Motor driven* vertical/rotary	Motor driven* vertical/rotary	Motor driven* vertical/rotary	Motor driven* vertical/rotary	Motor driven* vertical/rotary
F.O. Service (Residual Fuel)	Motor driven vertical/rotary	Motor driven vertical/rotary	None	None	None
F.O. Transfer (Residual Fuel)	Motor driven horiz./rotary	Motor driven horiz./rotary	None	None	None
D.O. Service (Diesel Oil)	None	None	Engine attached	Engine attached	Motor driven vertical/rotary
D.O. Transfer (Diesel Oil	None	None	Motor driven horiz./rotary	Motor driven horiz./rotary	Motor driven horiz./rotary
Primary Coolant	None	None	None	None	None
9 Elec. Power Generation	TG sets with aux. cond. air ejectors & pumps	1) shaft driven off LP turbine 1) diesel driven standby unit	Diesel driven generators	Diesel driven generators	Diesel driven generators
10 Machinery Control System	Engine room console Pilothouse console	Engine room console Pilothouse console	Engine room console Pilothouse console	Engine room console Pilothouse console	Engine room console Pilothouse console
11 Compressed Air System	Control air compressor	Control air compressor	Control air Starting air	Control air Starting air	Control air
12 Hydraulic Systems	None	None	None	None	Hydraulic Start Unit Units

*or (1) shaft driven and (1) motor driven standby

TABLE IV-5a

MAJOR PROPULSION RELATED COMPONENTS OF VARIOUS MARINE PROPULSION PLANTS

Component / Plant Type	COGOG	COSAGE	COGAS	CONAG
1 Main Engines	Lo-power GTs (base) Hi-power GTs only at F.P.	HP/LP cross compound steam turbine or single cyl. turb. (for base load), gas turbine electric (boost)	Gas turbine (base) Steam turbine or single cyl. turbine boost, driven by steam generated from GT exhaust heat	HP/LP cross compound Steam turbine (base) Hi-power GT (boost)
2 Reduction Gears	Double reduction single helical single train for lo-power GTs, locked train for hi-power GTs non-reversing	Double reduction double helical locked train non-reversing	Double reduction double helical locked train non-reversing	Double reduction double helical locked train non-reversing
3 Shafting, Bearings & Propellers	Line shafting & bearings, tail shafting stern tube & bearings thrust bearing propeller (C.P.P.)	Line shafting & bearings, tail shafting stern tube & bearings thrust bearing propeller (F.P.P.)	Line shafting & bearings, tail shafting stern tube & bearings thrust bearing propeller (C.P.P.)	Line shafting & bearings, tail shafting stern tube & bearings thrust bearing propeller (F.P.)
4 Main Condensers	None	Axial or vertical scoop injection 1¼" to 2" Hg ABS 75°F sea water	Axial or vertical scoop injection 1¼" to 2" Hg ABS 75°F sea water	Axial or vertical scoop injection 1¼" to 2" Hg ABS 75° sea water
Air Ejection	None	Air ejectors or vacuum pumps	Air ejectors or vacuum pumps	Air ejectors or vacuum pumps
5 Desalination Plants	Vapor compression or flash type (aux. boiler steam *Not required for propulsion	Low pressure subm. tube or flash type	Vapor compression or flash type	Low pressure subm. tube or flash type
6 Feed Heaters	None	None	DFT	DFT
7 Steam Generators & Auxiliaries	Package boiler or waste heat unit (not required for propulsion)	Single furnace natural circ. superht. boilers with economizer, steam or gas air heaters & aux. steam desup. Alternates: press. fired, forced circ.	Exhaust gas to steam heat exchanger	Steam generators consisting of heat exchanger & steam drum
8 Pumps Main Feed	None	Turbine driven, horizontal/centrifugal	Turbine driven, horizontal/centrifugal	Turbine driven, horizontal/centrifugal
Main Circulating	None	Motor driven vertical/centr.	Motor driven vertical/centr.	Motor driven vertical/centr.
Main Condensate	None	Motor driven vertical/centr.	Motor driven vertical/centr.	Motor driven vertical/centr.
L.O. Service	Motor driven* vertical/rotary	Motor driven* vertical/rotary	Motor driven* vertical/rotary	Motor driven* vertical/rotary
F.O. Service (Residual Fuel)	None	Motor driven# vertical/rotary	None	None
F.O. Transfer (Residual Fuel)	None	Motor driven# horiz./rotary	None	None
D.O. Service (Diesel Oil)		Motor driven vertical/rotary	Motor driven vertical/rotary	Motor driven vertical/rotary
D.O. Transfer (Diesel Oil)		Motor driven horiz./rotary	Motor driven horiz./rotary	Motor driven horiz./rotary
Primary Coolant	None	None	None	Canned-motor-driven vertical/centrifugal
9 Electrical Power Generation	Diesel or GT driven generators	TG sets with aux. cond., air ejectors & pumps	Diesel or GT driven generators	TG sets with aux. cond., air ejectors & pumps
10 Machinery Control System	Engine room console Pilothouse console	Engine room console Pilothouse console	Engine room console Pilothouse console	Engine room console Pilothouse console
11 Compressed Air System	Control air	Control air	Control air	Control air
12 Hydraulic Systems	Hydraulic start units	Hydraulic start units	Hydraulic start units	Hydraulic start units

*or (1) shaft driven and (1) motor driven standby #None, if distillate fuel (Marine D.O.) is used in boilers

TABLE IV-5b

MAJOR PROPULSION RELATED COMPONENTS OF VARIOUS MARINE PROPULSION PLANTS

Plant Type / Component	NUCLEAR	COSAG	CODAG	CODOG	COGAG
1 Main Engines	HP/LP cross-compound steam turbines, saturated steam operation	HP/LP cross-compound steam turbine or single cyl. turb. (for base load), gas turbine (boost)	Med. speed hi-power diesel (base), gas turb. (boost), diesel & GT operate together at high speed	Med. speed lo-power diesel (base), gas turb. only at high power	Hi-power GTs, one unit operating for cruising; all units at full speed
2 Reduction Gears	Double reduction double helical locked train, non-reversing	Double reduction double helical double input, non-reversing or reversing	2-speed or 1-speed diesel input gear double reduction double helical for gas turbine, non-reversing	Single reduction diesel input, double reduction GT input, double helical non-reversing	Double reduction double helical locked train non-reversing
3 Shafting, Bearings & Propellers	Line shafting & bearings, tail shafting, stern tube & bearings thrust bearing propeller (F.P.P.)	Line shafting & bearings, tail shafting, stern tube & bearings thrust bearing propeller (F.P.P.)	Line shafting & bearings, tail shafting, stern tube & bearings thrust bearing propeller (F.P.P. or C.P.P.)	Line shafting & bearings, tail shafting, stern tube & bearings thrust bearing propeller (C.P.P.)	Line shafting & bearings, tail shafting, stern tube & bearings, thrust bearing propeller (C.P.P.
4 Main Condensers	Axial or vertical scoop injection 1½" to 2" Hg ABS, 75°F sea water	Axial or vertical scoop injection 1½" to 2" Hg ABS, 75°F sea water	None	None	None
Air Ejection	Air ejectors or vacuum pumps	Air ejectors or vacuum pumps	None	None	None
5 Desalination Plants	Low pressure subm. tube or flash type	Low pressure subm. tube or flash type	Vapor compression or flash type (aux. boiler steam) *not required for propulsion	Vapor compression or flash type (aux. boiler steam) *not required for propulsion	Vapor compression or flash type (aux. boiler steam) *not required for propulsion
6 Feed Heaters	DFT	First stage DFT (2nd stage)	None	None	None
7 Steam Generators & Auxiliaries	Steam generators consisting of heat exchanger & steam drum	Single furnace natural circ., superht. boilers with economizer, steam or gas air heaters & aux. steam desup. Alternates: pressure fired, forced circ.	Package boiler or waste heat unit (not required for propulsion)	Package boiler or waste heat unit (not required for propulsion)	Package boiler or waste heat unit (not required for propulsion)
8 Pumps Main Feed	Turbine driven horizontal/centr.	Turbine driven horizontal/centr.	None	None	None
Main Circulating	Motor driven vertical/centr.	Motor driven vertical/centr.	None	None	None
Main Condensate	Motor driven vertical/centr.	Motor driven vertical/centr.	None	None	None
L.O. Service	Motor driven* vertical/rotary	Motor driven* vertical/rotary	Motor driven* vertical/rotary	Motor driven* vertical/rotary	Motor driven* vertical/rotary
F.O. Service (Residual fuel)	None	Motor driven* vertical/rotary	None	None	None
F.O. Transfer (Residual fuel)	None	Motor driven* horiz./rotary	None	None	None
D.O. Service (Diesel Oil)	None	Motor driven vertical/rotary			
D.O. Transfer (Diesel Oil)	None	Motor driven horiz./rotary			
Primary Coolant	Canned-motor vertical/centr.	None	None	None	None
9 Electrical Power Generation	TG sets with aux. cond., air ejectors & pumps	TG sets with aux. cond., air ejectors & pumps	Diesel driven generators	Diesel driven generators	Diesel or G.T. driven generators
10 Machinery Control System	Engine room console Pilothouse console	Engine room console Pilothouse console	Engine room console Pilothouse console	Engine room console Pilothouse console	Engine room console Pilothouse console
11 Compressed Air system	Control air	Control air	Control air Starting air	Control air Starting air	Control air
12 Hydraulic Systems	None	Hydraulic start units	Hydraulic start units	Hydraulic start units	Hydraulic start units

*or (1) shaft driven and (1) motor driven standby

TABLE IV-5c

TABLE IV-6

MASTER EQUIPMENT LISTS

MASTER EQUIPMENT LIST (Per Shaft)

STEAM PRESSURE FIRED BOILER PLANT

Equipment is same as for Conventional Steam Propulsion Plant with the following exceptions:

1) Forced Draft Blowers replaced by one gas turbine-driven supercharger (or air compressor) (Pressures up to 75 psig generated)
2) Pressure Fired or Supercharged Boilers replace conventional natural circulation boilers with forced draft blower air supply. PF boilers occupy less than half of volume of comparable conventional boilers and weigh half as much.

DIESEL PROPULSION PLANT

I. Low-speed, Large Bore Engine (100 to 200 RPM)

1. Main Engine

(1) Low-speed, large bore, direct-drive engine, with reversing features

2. Reduction Gear

None

3. Main Shafting and Propeller

(1) or more sections of Line Shafting
(1) section of Propeller Shafting
(1) or more line shaft bearings
(2) stern tube bearings, one forward and one aft
(1) main thrust bearing (separate or integral with engine
(1) Propeller (fixed pitch)

4. Vacuum Equipment

None

5. Desalination Plant

(1) Package Unit supplied with steam from Auxiliary Boiler, or motor or diesel-driven vapor compression unit, or waste heat unit

6. Fuel Oil System

(2) Steam Fuel Oil Heaters, 100 psig, 100°F
(2) Fuel Oil Purifiers, centrifugal type

7. Lubricating Oil System

    Main engine and Diesel Generator L.O. Systems are self-contained.

8. Feed and Condensate Systems

    Not applicable

9. Boilers

    (1) or (2) Auxiliary Boilers and associated auxiliaries

10. Forced Draft System

    Not Applicable

11. Compressed Air System

    (1) Control Air Compressor, 100 CFM, 125 psig
    (1) Diesel Starting Air Compressor, 3 CFM, 600 psig
    (1) Control Air Receiver 50 cu. ft.
    (1) Diesel Start Air Receiver 180 cu. ft.

12. Pumps

    a. Sea Water Service - (1) Motor-driven, horizontal, centrifugal
    b. Fuel Oil Transfer - (1) Motor-driven, horizontal rotary
    c. Diesel Oil Transfer-(1) Motor-driven, horizontal, rotary
    d. Lube Oil Transfer - (1) Motor-driven, horizontal, rotary
    e. Standby Lube Oil - (1) Motor-driven, horizontal, rotary
    f. Propulsion Diesel Prelube - (1) Motor-driven, horizontal, rotary

13. Electrical Power Generation

    (2) Diesel Generators and associated auxiliaries Switchboards and controls

14. Machinery Plant Control System

    (1) Machinery Control Console in Engineroom
    (1) Machinery Control Console in Pilothouse

15. Main Engine Disconnect Clutches

    (1) Zurn type maneuvering/disconnect clutch

16. Exhaust Silencer

    (1) Exhaust silencer with spare arrester, maxim or equal

17. Inlet Silencer

    (1) Inlet Silencer, Maxim or equal

II. Medium Speed Diesel Engine Plant (400-600 RPM)

Same as Low-speed Diesel installation except as follows:

1. <u>Main Engine</u>

   (1) or more medium speed diesel engines per shaft

2. <u>Reduction Gear</u>

   (1) Single reduction, double helical, locked train with turning gear and attached lube oil pump.

III. High-Speed Diesel Engine Plant (700-2300 RPM)
Same as medium speed plant except as follows:

1. <u>Reduction Gear</u>

   (1) Double reduction in lieu of single reduction for high rpm (1000) main engines

REHEAT STEAM PROPULSION PLANT (MST 14)

(1450 psig, 950°F 950°F)

1. <u>Main Engine</u>

   (1) Ccunter flow HP-IP Turbine and LP Turbine

2. <u>Reduction Gear</u>

   (1) Dual Torque-path, double reduction, double helical, locked train; with turning gear

3. <u>Main Shafting and Propeller</u>

   (1) or more sections of Line Shafting
   (1) section of Propeller Shaft
   (1) or more Line Shaft Bearings
   (2) Stern Tube Bearings, one forward and one aft
   (1) Main Thrust Bearing (separate)
   (1) Propeller (fixed pitch)

4. <u>Vacuum Equipment</u>

   (1) Main Condenser - Scoop injection, axial flow, athwartship installation, 28.5" Hg Vacuum, 75°F S.W.
   (2) Motor-driven vacuum pumps
   (1) Gland Vent Condenser - condensate cooled, with exhaust fan

5. <u>Desalination Plant</u>

   (2) Low-pressure units, receiving steam by bleeding from LP turbine
   (2) Distiller condensers with vacuum pumps, cooled by main condensate flow

6. <u>Fuel Oil System</u>

   (2) Steam Fuel Oil Heaters, 100°F-230°F oil temperature range

7. Lubricating Oil System
   - (2) Lube oil Coolers, horizontal shell and tube type single pass, 140°F-120°F, cooled by main condensate flow
   - (2) Lube Oil Purifiers, centrifugal type
   - (2) Lube Oil Purifier Heaters, horizontal shell and tube type, single pass, 105°F-160°F oil temperature range

8. Feed and Condensate Systems
   - (1) Deaerating Feed Heater, receiving steam from cross-overline
   - (1) First Stage Feed Heater, receiving steam from L.P. Turbine
   - (1) Second Stage Feed Heater, receiving steam from L.P. Turbine
   - (1) Fourth Stage Feed Heater, receiving steam from HP Turbine Exhaust
   - (1) Fifth Stage Feed Heater, receiving steam from HP Turbine 3rd Stage

   Note: The first and second stage feed heaters and gland exhaust condenser are combined in one enclosure or shell.

   - (1) Atmospheric Condenser (for condensing low pressure steam drains)

9. Main Boilers
   - (1) Combination Superheat-Reheat Boiler
   - (1) Gas-Air Heater
   - (1) Auxiliary Steam Desuperheater in boiler drum for steam to main auxiliaries
   - (1) Low Pressure Steam Generator receiving steam from HP Turbine exhaust
   - (1) Feed Water Sample Cooler
   - Fuel Oil burners as required

10. Forced Draft System
    - (2) Forced Draft Blowers per boiler, Steam turbine or motor driven

11. Compressed Air System
    - (1) Control Air Compressor, 125 psig discharge pressure
    - (1) Control Air Receiver, 50 cu. ft.

12. Pumps
    - a. Main Feed - (1) attached unit shaft-driven off HP Turbine 1st reduction pinion shaft extended
      (1) auxiliary unit turbine-driven
    - b. Main Circulating-
      (1) Motor-driven, vertical, centrifugal
    - c. Main Condensate -
      (2) Motor-driven, vertical centrifugal
    - d. SeaWater Service-
      (2) Motor-driven, horizontal, centrifugal

e. Boiler Test -
(1) Motor-driven, horizontal, triplex, reciprocating

f. Lube Oil Service-
(2) Motor-driven, vertical rotary or
(1) Motor-driven and (1) attached

g. Fuel Oil Service-
(2) Motor-driven, vertical, rotary

h. Fuel Oil Transfer -
(1) Motor-driven, horizontal, rotary

13. <u>Electrical Power Generation</u>

(1) Attached Generator driven off LP Turbine 1st reduction pinion shaft extended, with auxiliary turbine attached
(1) Diesel-driven standby unit
Associated switchboards and controls

14. <u>Machinery Plant Control System</u>

(1) Control Console in Engineroom
(1) Control Console in Pilothouse

MASTER MATERIAL LIST (per shaft)

GAS TURBINE PROPULSION PLANT

1. Main Engine

   (1) Simple Cycle Gas Turbine

2. Reduction Gear

   (1) Double reduction, double helical, locked train, with turning gear and attached lube oil pump

3. Main Shafting and Propeller

   (1) or more sections of Line Shafting
   (1) Section of Propeller Shafting
   (1) or more Line Shaft Bearings
   (2) Stern Tube Bearings, one forward and one aft
   (1) Main Thrust Bearing (Integral with Reduction Gear or separate)
   (1) Propeller (Fixed pitch or CPP)
   (1) CPP Hydraulic Unit (if CPP installed)

4. Vacuum Equipment

   None

5. Desalination Plant

   (1) Package Unit receiving steam from Auxiliary Boiler, or motor or diesel driven vapor compression unit, or waste heat unit

6. Fuel Oil System

   (2) Steam Fuel Oil Heaters, 100 psig, 100°F
   (2) Fuel Oil Purifiers, centrifugal type

7. Lubricating Oil System

   (2) Lube Oil Coolers - Horizontal shell and tube
   (2) Lube Oil Purifiers - centrifugal, with pumps and heater

8. Feed and Condensate Systems

   Not Applicable

9. Boilers

   (1) or (2) Auxiliary Boilers and associated auxiliaries

10. Forced Draft System

    Not Applicable

11. Compressed Air System

    (1) Control Air Compressor, 100 CFM, 125 psig
    (1) Control Air Receiver, 100 cu. ft.

12. Pumps

a.	Sea Water Service -	(1) motor-driven, horizontal, centrifugal
b.	L.O. Service -	(2) Motor-driven, horizontal, rotary
c.	F.O. Service -	(2) Motor-driven, horizontal, rotary
d.	F.O. Transfer -	(1) Motor-driven, horizontal, rotary
e.	Main Engine Hydraulic Start -	(1) Motor-driven, horizontal, rotary
f.	Diesel Oil Service -	(1) Motor-driven, horizontal, rotary
g.	Diesel Oil Transfer -	(1) Motor-driven, horizontal, rotary
h.	Stand-by Lube Oil -	(1) Motor-driven, horizontal, rotary

13. Electrical Power Generation

(2) Diesel, Gas Turbine or Shaft-driven generators and associated auxiliaries Switchboards and Controls

14. Machinery Plant Control System

(1) Machinery Control Console in Engineroom
(1) Machinery Control Console in Pilothouse

15. Main Engine Disconnect Clutches

(1) Zurn type maneuvering/disconnect clutch

16. Exhaust Silencer

(1) Exhaust Silencer - Maxim or equal

17. Inlet Silencer

(1) Inlet Silencer - Maxim or equal

18. Demister Equipment

MASTER EQUIPMENT LIST (per shaft)

CONVENTIONAL STEAM PROPULSION PLANT
(850 psig, 950°F)

*1. Main Engine

(1) HP&LP Cross Compound Steam Turbine (with astern blade elements in LP casing)

*2. Reduction Gear

(1) Double reduction, double helical, locked train; with turning gear

*3. Main Shafting and Propeller

(1) or more sections of Line Shafting
(1) section of Propeller
(1) or more Line Shaft Bearings
(2) Stern Tube Bearings, one forward and one aft
(1) Main Thrust Bearing (integral with reduction gear, or separate
(1) Propeller (fixed pitch)

**4. Vacuum Equipment

(1) Main Condenser - Scoop Injection, axial or vertical flow, 28.0 to 28.5" Hg Vacuum at 75° sea water temperature
(1) Main Air Ejector, twin element, two stage type mounted on one combined inter, after and gland exhaust condenser

5. Desalination Plant

(2) Package Units

6. Fuel Oil System

(2) Steam Fuel Oil Heaters, 100°F-230° oil temperature range

7. Lubricating Oil System

(2) Lube Oil Coolers, horizontal shell and tube type, single pass, 140°F-120°F
(2) Lube Oil Purifiers, centrifugal type
(2) Lube Oil Purifier Heaters, horizontal shell and tube type, single pass, 105°F-160°F oil temperature range

* Total propulsion
**Part propulsion

8. Feed and Condensate Systems

    (1) Deaerating Feed Heater
    (1) First Stage Feed Heater and Drain Cooler
    (1) Condensate Cooler (for fuel oil heating coils

9. Main Boilers

    (1) or (2) Single Furnace, Natural Circulation Superheated Steam Boilers
    (1) or (2) Steam Air Heaters
    (1) or (2) Auxiliary Steam Desuper heaters in boiler drum
    (1) Feedwater Sample Cooler
    Fuel Oil Burners as required

10. Forced Draft System

    (2) Forced Draft Blowers per boiler, steam turbine or motor driven

11. Compressed Air System

    (1) Control Air Compressor
    100 cfm, 125 psig discharge pressure
    (1) Control Air Receiver, 50 cu. ft.

12. Pumps

    a. Main Feed - (2) Steam turbine driven, horizontal, centrifugal
    b. Main Circulating - (1) Motor-driven, vertical, centrifugal
    c. Main Condensate - (2) Motor-driven, vertical, centrifugal
    d. Seawater Service - (2) Motor-driven, horizontal, centrifugal
    e. Boiler Test (1) Motor-driven, horizontal, triplex, reciprocating
    f. Lube Oil Service- (2) Motor-driven, vertical, rotary or (1) motor-driven and (1) attached
    g. Fuel Oil Service - (2) Motor-driven, vertical, rotary
    h. Fuel Oil Transfer - (1) Motor-driven, horizontal, rotary

13. Electrical Power Generation

    (2) Turbine-driven Generators and associated condensing and condensate handling equipment (auxiliary condenser air ejector, circulating water pump and condensate pump)
    Associated switchboards and controls

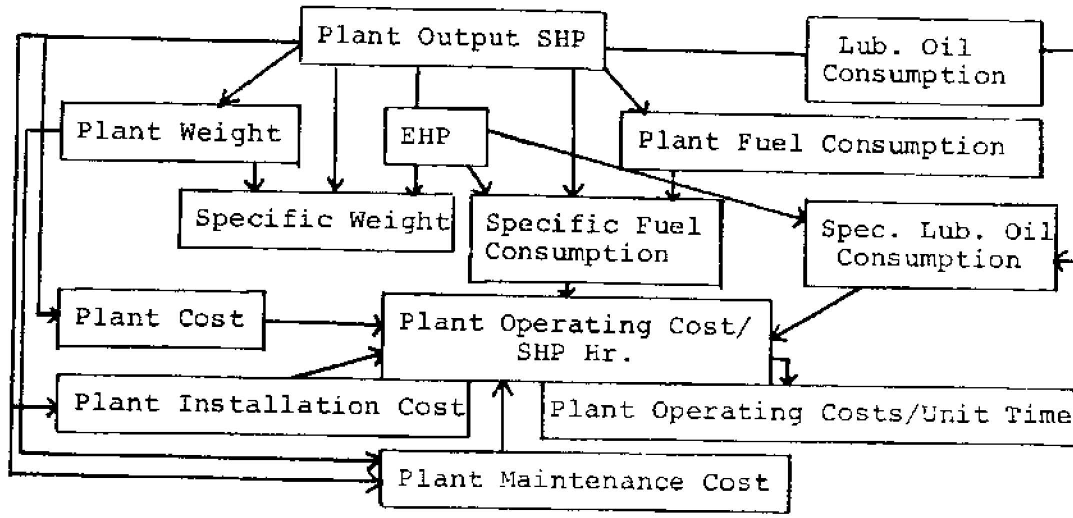
14. Machinery Plant Control Systems
    (1) Control Console in Engineroom
    (1) Control Console in Pilothouse

Propulsion System Performance Characteristics

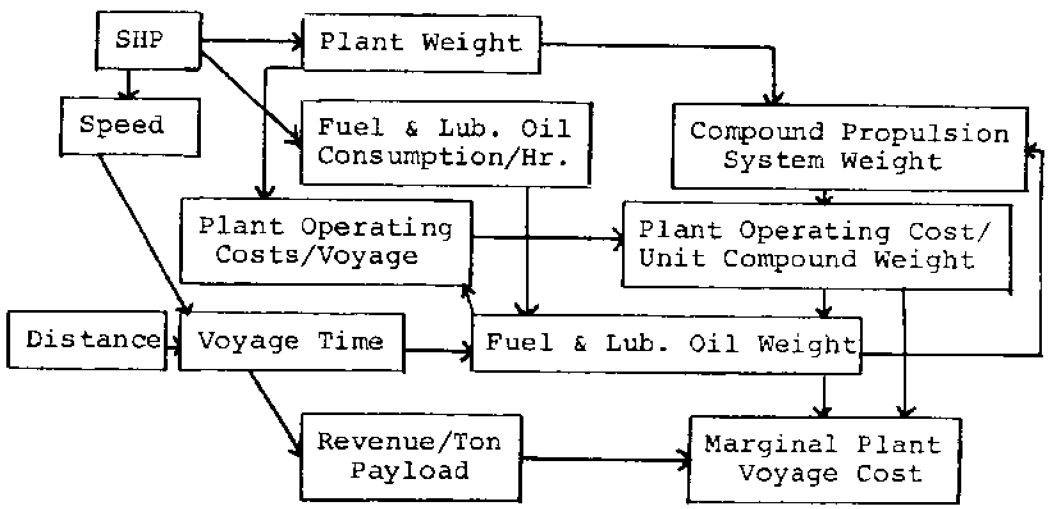
Propulsion system performance can be evaluated by a number of measures, as shown in Figure IV-5. Propulsion plant performance is usually compared as the basis of specific fuel consumption and specific weight or marginal specific fuel consumpsion and weight respectively. Specific fuel consumption bears a direct relationship to specific weight for each type of propulsion plant as shown in Figure IV-6. Specific fuel consumption for typical marine propulsion plants (main propulsion only) is presented in Table IV-7, while all-purpose steam propulsion plant specific fuel consumption rates are indicated in Figure IV-7. These, in turn, give the hourly all-purpose rates in Figure IV-8. Comparing the fuel rates of diesel and other propulsion plants, we obtain annual savings in fuel costs of diesel plants as shown in Figure IV-9. Typical main propulsion diesel characteristics are presented in Table IV-8.

Next considering propulsion plant weights, we note in Figure IV-10 typical all-inclusive propulsion plant weights (excluding shaft and propeller) for steam, diesel and gas turbine plants. Steam turbine weights are shown in Figure IV-11. Comparative weights of various types of transmission and speed reduction devices are presented in Figure IV-12, while steam plant reduction gear weights are presented in Figure IV-13 for both articulated and locked transmissions.

Figure IV-5
Propulsion System Performance Measures



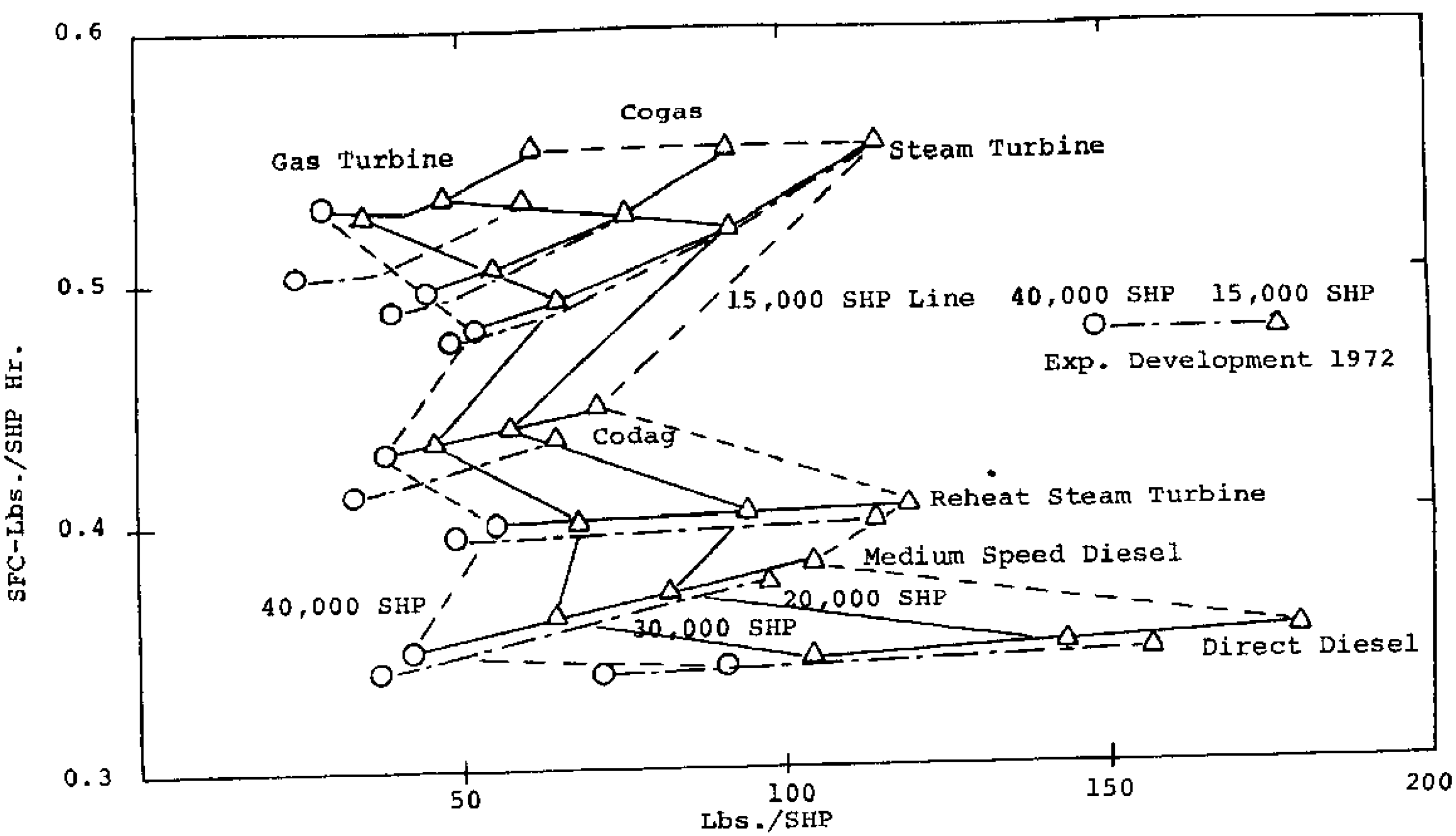
I. Simple Performance Measures



II. Compound Performance Measures

Figure IV-6

Specific vs. Lbs./SHP (Marine Propulsion Plants)



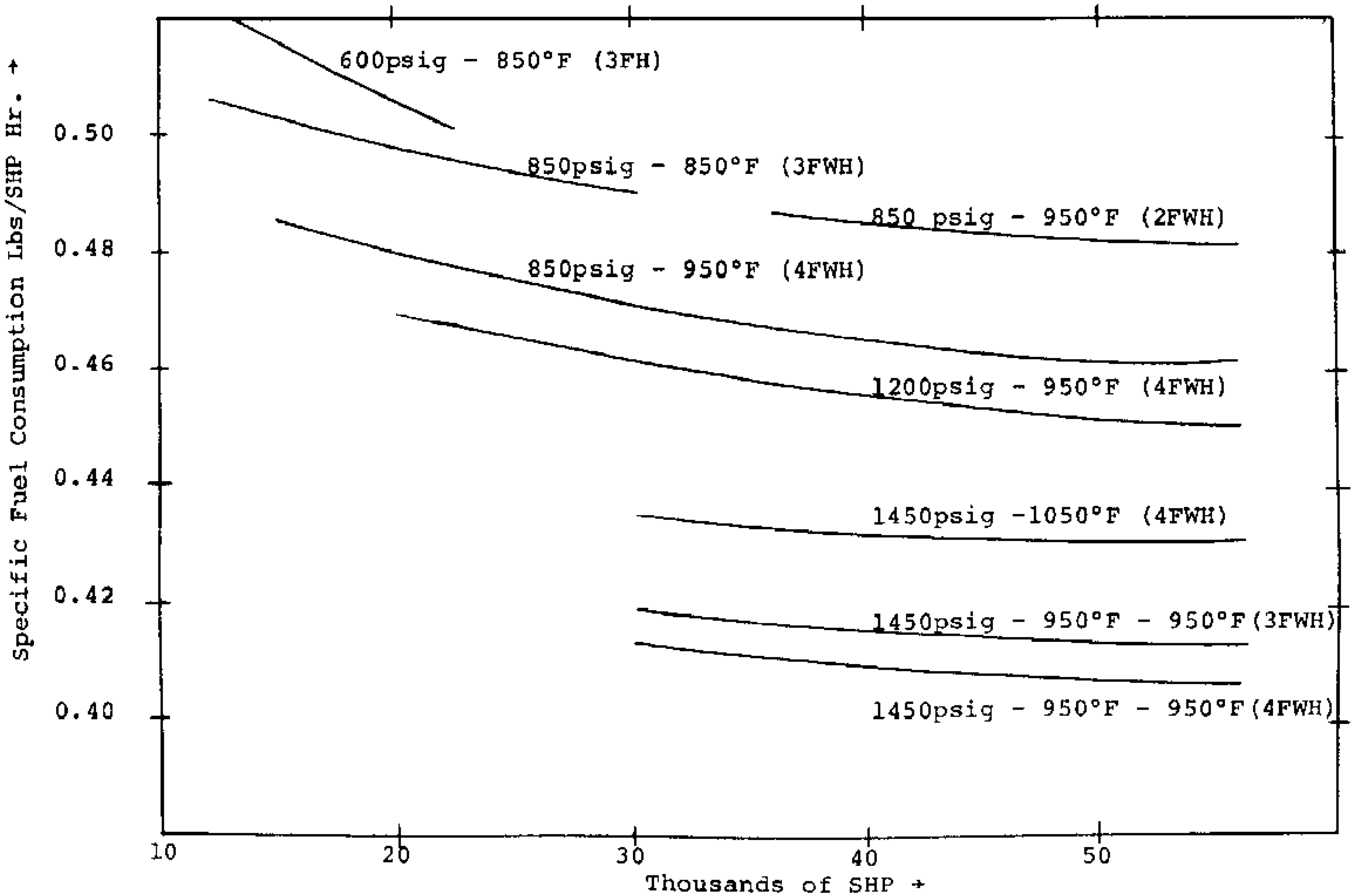


Figure IV-7: All Purpose Fuel Rates, Steam Turbine Plants

Figure IV-8

Fuel Consumption

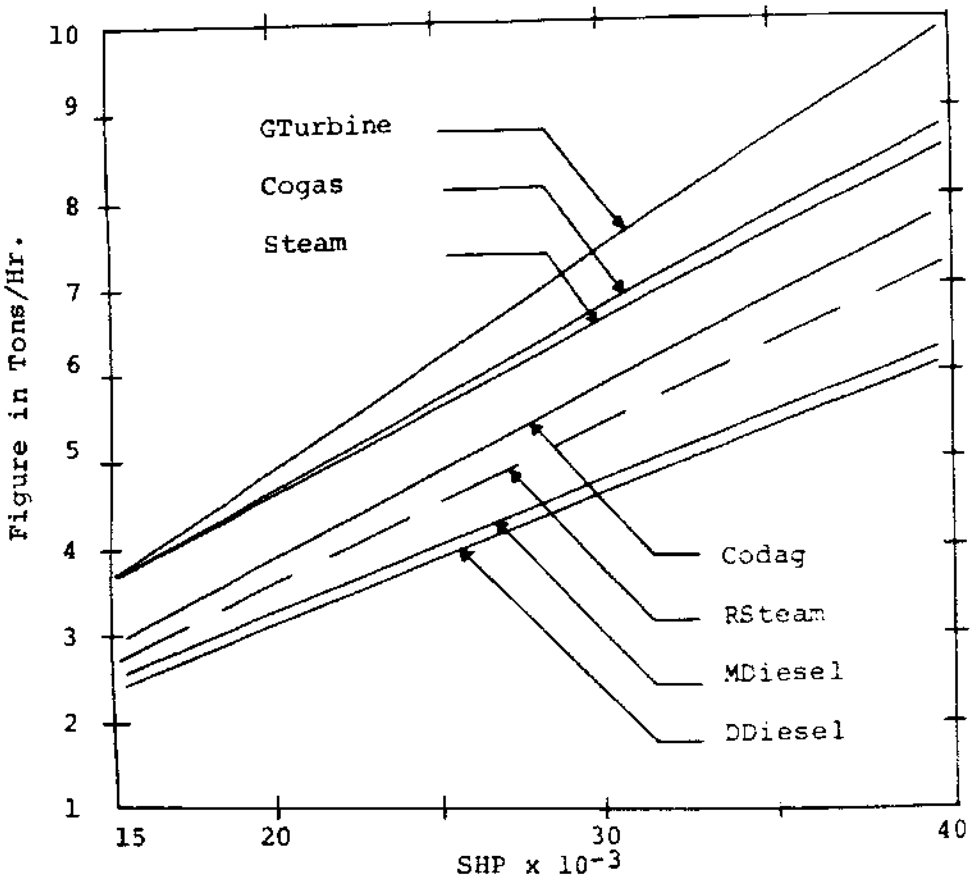


Figure IV-9

Fuel Cost Differentials
Between Diesel and Other Plant

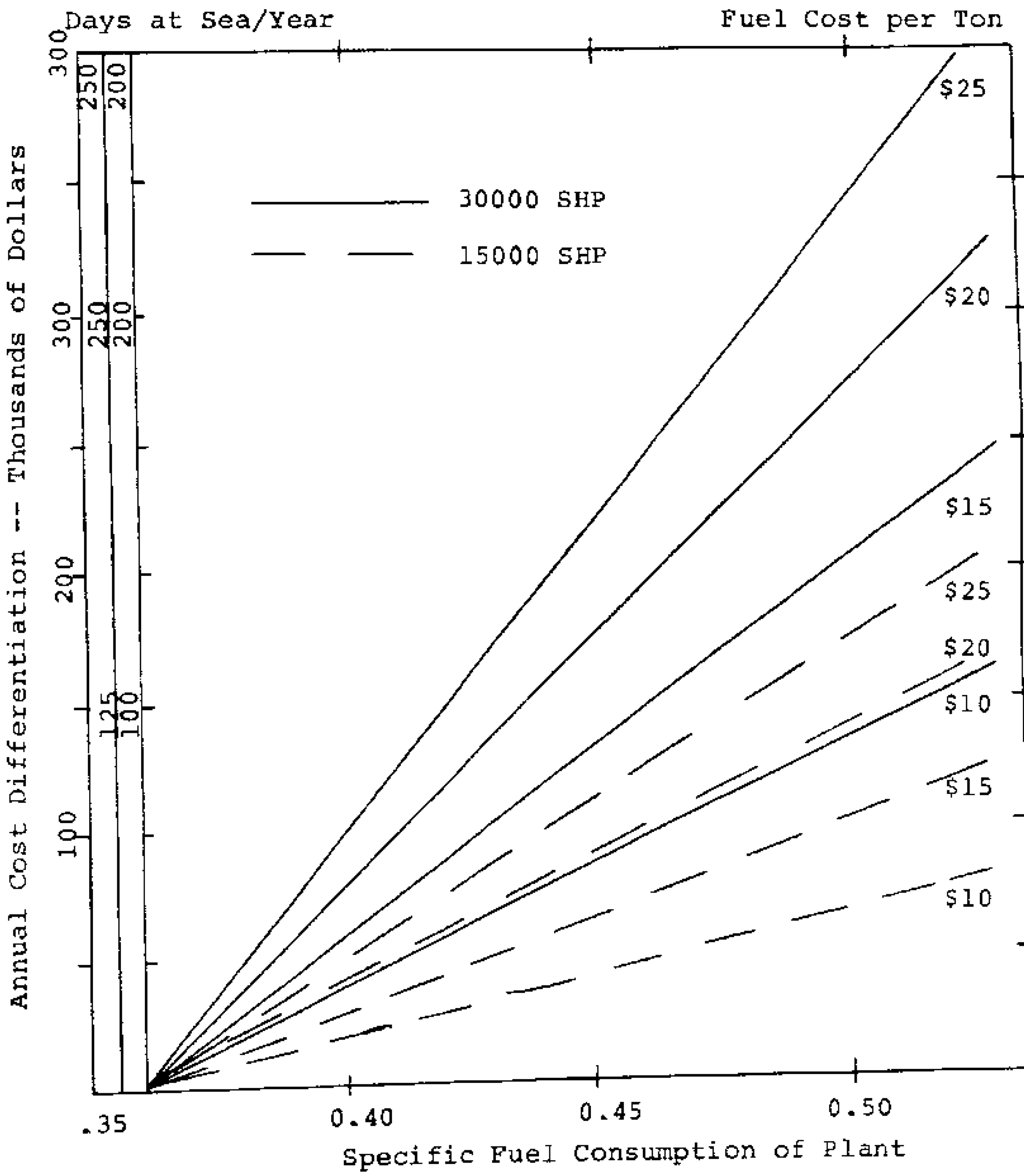


Figure IV-10

Typical Weight vs. SHP-Single Screw Ships
(Propulsion Only)

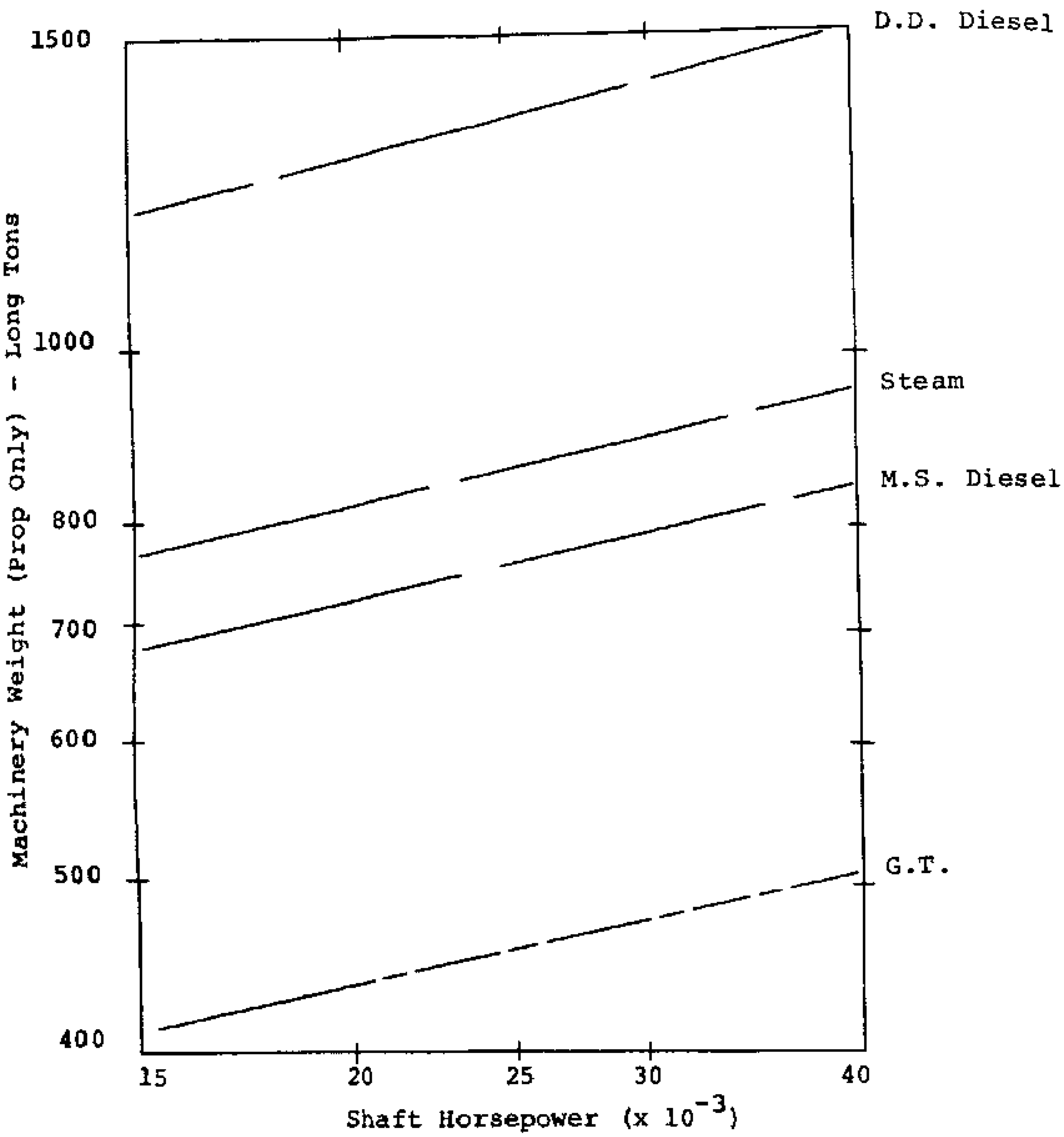


Figure IV-11

Approximate Weight of Cross Compound Steam Turbines Based on 600-850 PSIG-950°F Inlet 1.5 in HG. Exhaust

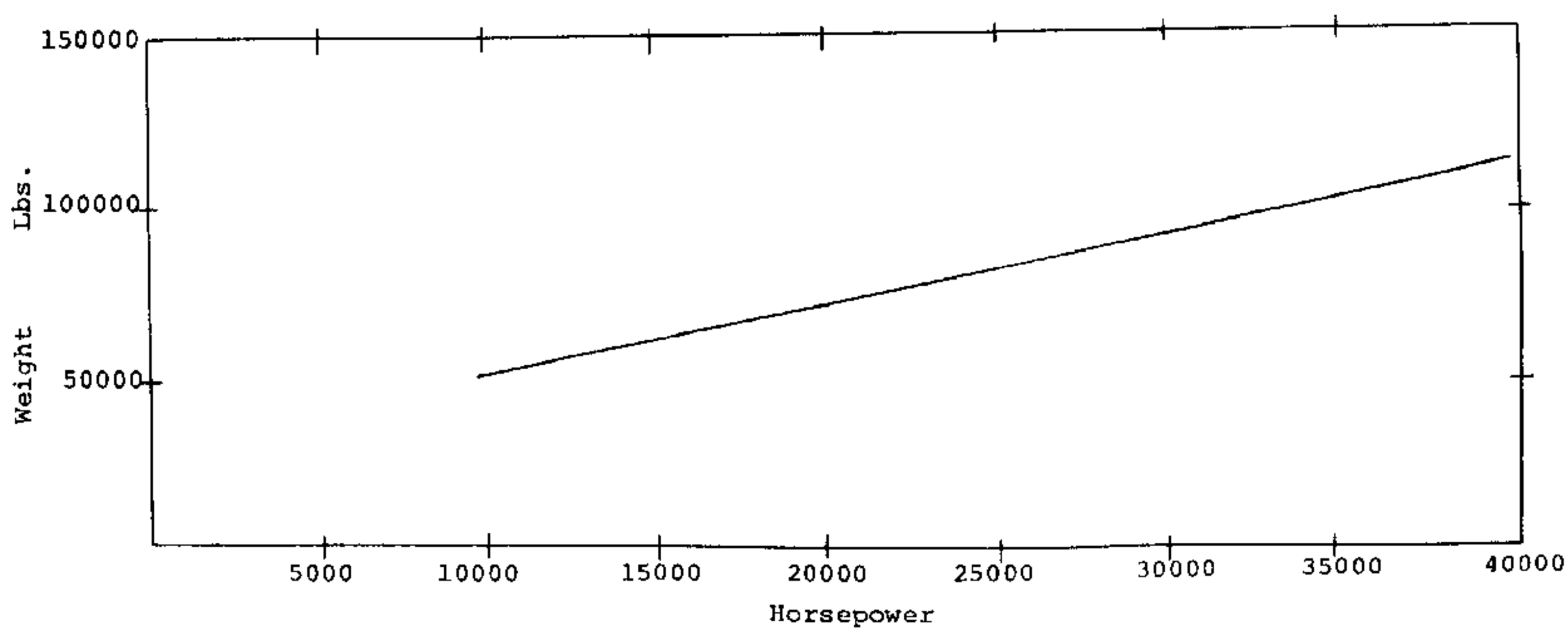


Figure IV-12

Comparative Weight of Transmissions

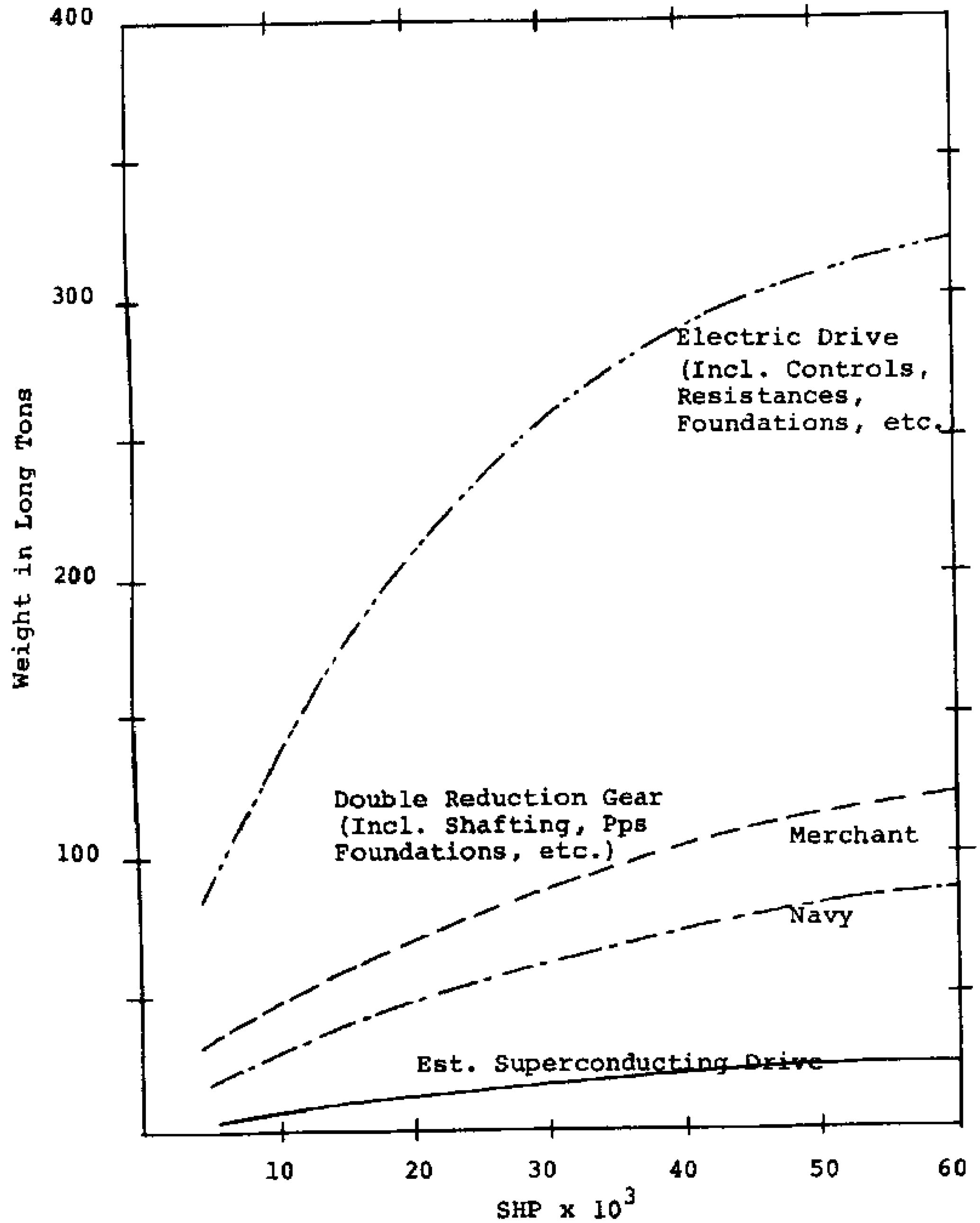


Figure IV-13

Steam Plant-Weight of Main Reduction Gear

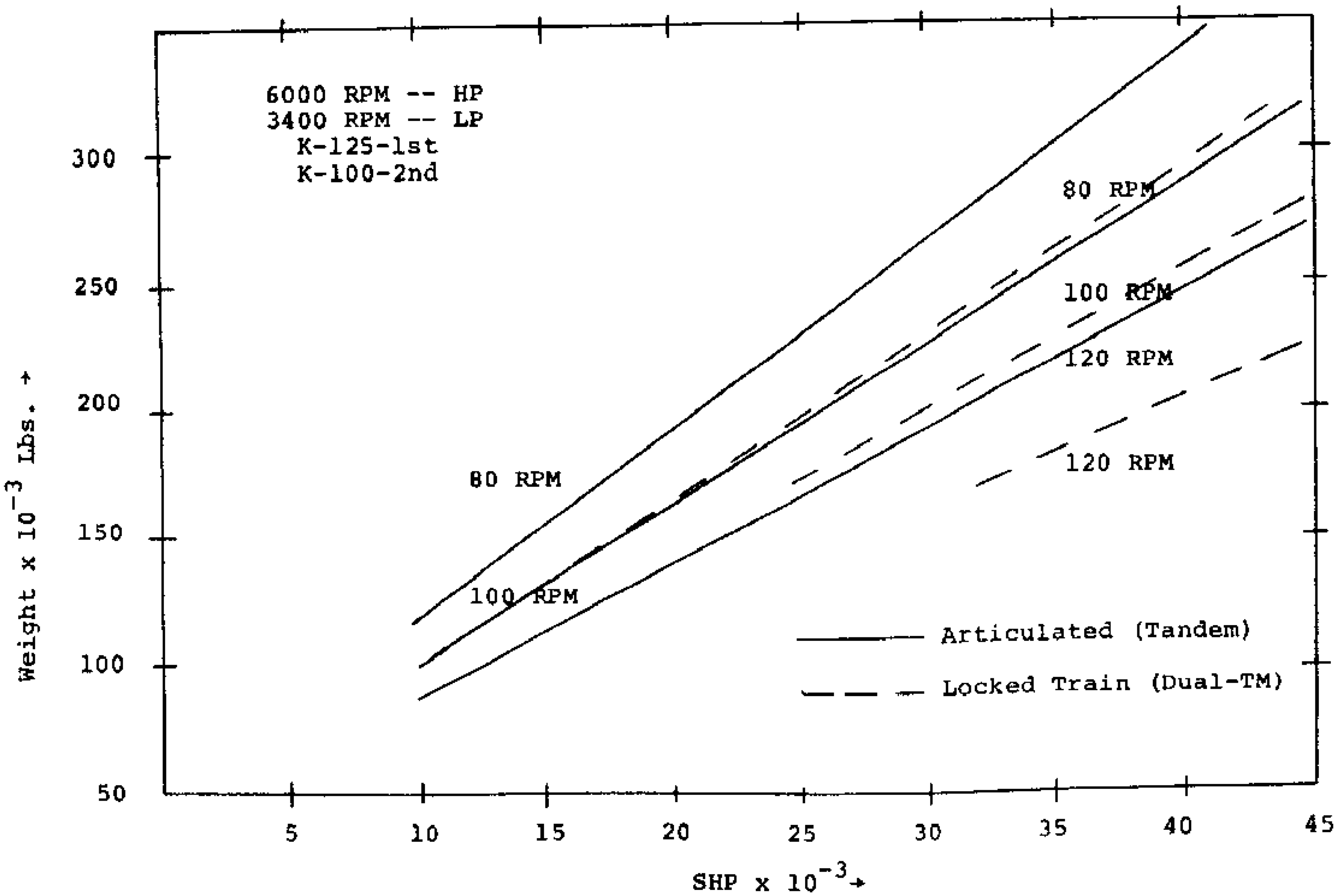


Table IV-7

Specific Fuel Consumptions
(Various Sources) (Main Propulsion Only)

Plant	Economic Comparison Diesel vs. Steam	Considerations in Making Economic Comparisons	Evaluation of Steam & Gas Turbine Power Plants	Frankel Simpson
MST-13				(conventional)
(850 psig, 950°F)		(600 psig conv.)		
20,000 SHP	0.462	0.462 (0.508)	60,000 - 0.439	0.504
25,000 SHP	0.455	0.456 (0.503	90,000 - 0.442	-
30,000 SHP	0.451	0.452 (0.498)	110,000 - 0.443	
40,000 SHP	-	-	-	0.470 0.490
MST-14 (Non-Reheat)	(1450 psig, 950°F)	(850 psig, 950°F)		
20,000 SHP	0.438	0.443	-	- -
25,000 SHP	0.432	0.439	-	-
30,000 SHP	0.428	0.435	-	-
40,000 SHP	-	0.431	-	-
50,000 SHP	-	0.430	-	-
MST-14 (Reheat)			Marine Reheat Cycles	
1450 psig, 950°F				
20,000 SHP	0.402	-	(5 stage fd ht)	0.392
25,000 SHP	0.397	0.403	-	-
30,000 SHP	0.395	0.400	0.402	0.417
40,000 SHP	-	0.394	0.397	0.397
50,000 SHP	-	0.391	0.394	-
75,000 SHP	-	0.387	0.390	-
100,000 SHP	-	0.386	0.387	-
Large Bore Diesel				
20,000 SHP	-	-	-	0.336
30,000 SHP	0.35	-	--	0.321
40,000 SHP	-	-	-	0.333
48,000 SHP	-	-	-	-
Medium Speed Diesel				
20,000 SHP	-	-	-	0.347
30,000 SHP	0.355	-	-	0.351
40,000 SHP	-	-	-	0.347
Gas Turbine				
20,000 SHP	-	-	-	0.549
30,000 SHP	-	-	-	0.541
40,000 SHP	-	-	FT4 A-2 / FT4 A-14 / LM2500	0.549
50,000 SHP	-	-	-	-
60,000 SHP	-	-	0.560 0.679 0.455	-
90,000 SHP	-	-	0.585 0.582 0.453	-
110,000 SHP	-	-	0.542 0.542 0.434	-

	BHP cont/max cont	Weight (L-Tons)	Specific Weight #/HP	S.F.C. (Guaranteed) #/BHP HR	Price $
I. LOW SPEED OR LARGE BORE DIESEL					
A. Burmeister & Wain					
Model 12K98GF 89'-8" x 16'-2" x 43'-2" 100/104 RPM	44,400/49,200	1865	83.5	0.36	
B. Fiat					
Model 10612S 1142.9" x 334.6" x 515.6" 106 RPM	48,000	1900	89.1	0.342	
C. Gotaverken					
Model DM960/1900VGS-U 112 RPM	43,200			0,37	
D. M.A.N.					
Model KSZ105/180 15100 mm x 530 mm x 14625 mm 106 RPM	48,000	1630	75	0.354	
E. Sulzer					
Model RND105 108 RPM	48,000	1686	77.5	0.36	
II. MEDIUM SPEED DIESELS					
A. Fairbanks Morse (temporarily discontinued)					
38A20 6 cyl. 400/450 RPM	6,000/ 7,500	72	26/21	0.35	535,000/ 670,000
38A20 9 cyl. 400/450 RPM	9,000/11,250	120	28.5/23	0.35	
38A20 12 cyl. 400/450 RPM	12,000/15,000	135	24.5/19.5	0.35	1,000,000/1,300,000
38A20 18 cyl. 400/450 RPM	18,000/22,500	220	26.5/21	0.35	1,500,000/1,900,000
B. Colt-Pielstick					
8PC2V400 8 cyl. 520 RPM	4,000				440,000
10PC2V400 10 cyl. 520 RPM	5,000				525,000
12PC2V400 12 cyl. 520 RPM	6,000				600,000
14PC2V400 14 cyl. 520 RPM	7,000				685,000
16PC2V400 16 cyl. 520 RPM	8,000				760,000
18PC2V400 18 cyl. 520 RPM	9,000				810,000

Table IV-8 TYPICAL MAIN PROPULSION DIESEL ENGINES

Projected Trends in Novel Propulsion Systems

Efforts in propulsion systems development are expected to concentrate on one or more of three major areas: 1) improvements in specific fuel consumption, 2) improvements in specific weight, and 3) improvement in power transmission, speed reduction and reversing devices. In addition, increasing demand for a larger degree of prefabrication or modularization of propulsion systems and resulting reduction in installation costs and time, as well as improvements in maintainability of marine plants, will result in changes in design approach. Emphasis is now increasingly being given to a total systems approach in marine propulsion plant design, with prime responsibility assumed by the major energy conversion device supplier. It is felt that only in this way can effective overall responsibility be assumed and specifications as well as guarantees be maintained.

To improve the specific fuel consumption of steam turbine propulsion systems, the degree and number of stages of reheat are expected to increase. Similarly, supercharged and 'once-through' boilers may regain popularity. The latter is more attractive and feasible as a result of advanced and sensitive control equipment available now at relatively low cost. Diesel engines may similarly be subjected to increased supercharging. Gas turbine plants will probably also deviate from the simple direct cycle to more complex configurations which may include reheat at various stages. As a result, it is expected that by 1980 large marine steam turbine plants may achieve a specific fuel rate (all inclusive) of 0.42 lbs/SHP-hour, while marine gas turbines at that time may be available with consumptions as low as 0.43/SHP-hour. Large diesel engines may achieve a slight improvement in consumption rate to 0.35/SHP-hour. The various combined plants under consideration and mentioned earlier in this section are generally too complicated to be attractive. It appears that the main concentration will be placed on improving the cycle efficiency of simple, comparatively inexpensive plants that are easily built, installed, maintained, operated and controlled.

The specific weight of propulsion plants is of particular importance to high performance ships such as SES, hydrofoils, multi-hull vessels, planing craft, and detachable propulsion pods. Although the weight and volume requirement of medium speed diesels and gas turbines marine propulsion is a fraction of the more traditional propulsion plants, some of this weight and volume advantage is usually consumed by the requirements for speed reduction, transmission, and reversing devices. Of particular interest in a high performance ship is the possible elimination of long and heavy hull penetrating propeller shafting. One of the important voids in propulsion machinery development is the unavailability of high efficiency, low weight and volume transmissions. Recent developments in superconducting motor generator devices, both DC and AC, may offer an opportunity for the renewed adoption of electrical transmission with a vast reduction in motor generator weight and volume. This, in turn, may permit elimination of hull penetrating shafting by incorporating superconducting propulsion motors in a bracket supported nacelle whose diameter does not exceed that of the usual propeller hub. Parallel developments are currently taking place in the design of powerful hydraulic motor-generator sets to serve the same purpose.

The large variations in machinery space location and configuration introduced into modern ships impose a demand for separable propulsion plants in which the energy conversion unit is placed far from the torque or thrust developing unit. For example, multihull displacement or semisubmerged vessels usually require placement of the energy conversion unit on the main transverse deck level both for space reasons and to provide for effective air breathing.

Nuclear ship propulsion has vanished from the limelight in recent years notwithstanding successful German and Japanese applications in experimental merchant ships. This is largely due to the lay-up of the first commercial nuclear ship "Savannah" and the basic disinterest of owners. Although nuclear fuel costs have continued to show increasing advantages compared to fossil fuel costs, initial plant and operating crew costs have continued to be non-competitive. Even the large fuel cost gap can only hope to justify the vastly larger investment and manning cost for ships requiring at least 120,000 SHP and whose operating profile includes more than 90% full power seatime.

Advances made in the development of integrated pressurized water reactors and automatic control may result in certain improvements in investment and operating cost which, combined with larger fuel cost differentials, may make nuclear ship propulsion a reasonable alternative for very large tankers, LNG carriers, and containerships within this decade.

Chapter V

AUTOMATION AND CONTROL

Effects of Control on Operability, Reliability and Efficiency

Automation and control of ocean transportation has advanced rapidly in recent years, and technology is today available for the implementation of largely unmanned ships. An increasing number of oceangoing vessels operate with unmanned machinery spaces and only 2-man bridge watch. The large amount of work currently under way in the development of controlled sea lanes is aimed at parallel development to existing air traffic control systems which ultimately may lead to the introduction of automatic piloting of ships to maintain not only course, but also traffic lanes in a comparatively narrow sense. Under these circumstances computerized lane allocation and ship separation may result in the introduction of full automation of the majority of barge control functions. Similar developments are currently underway in the area of communications which are largely facilitated by the ready availability of satellite communication systems and the greater efficiency of radio communications.

The experience with automation and control on operability, reliability and efficiency of ocean transportation vehicles has been good and, in general, has resulted in an improvement over manual control approaches. The reliability of automated propulsion machinery systems, including ship steering, is shown to be superior to manually operated systems. Similarly, the reliability of automated navigating systems has been found to be satisfactory. From an operability point of view most existing automation and control systems provide sufficient flexibility for all operating conditions and vastly reduce operating skill as well as routing decision or control requirements. Both the operating efficiency and availability have been significantly improved in a large number of such automated systems as a result of a reduction of human errors and the adoption of preplanned and calculated operating conditions which are not subject to on-the-spot judgment, but are the result of formal programmed analysis.

The effects of automation and control in ocean transportation can be divided into five major areas:

1) Propulsion machinery systems control.

2) Ship navigation and maneuvering control.

3) Control of communications.

4) Cargo handling storage and environment control.

5) Ship scheduling, routing and operations control.

This, in turn, leads to study of the effects of automation of the following functions or items:

1)* a) Steam Powered Vessel

Boilers, Turbines, Turbogenerators, Condensate Water System, Circulating Water System, Lubricating Oil System, Fuel Oil System, Distillation System, Supporting Auxiliaries.

b) Gas Turbine Powered Ship

Fuel Control, CRP Control, Fuel Oil Service and Transfer, Fuel Oil Treatment, Auxiliary Steam System, Electrical Power Plant, Lubricating Oil System, Supporting Auxiliaries.

c) Diesel Engine Powered Ship

Fuel Control, Fuel Oil Service and Transfer, Lubricating Oil System, Auxiliary Steam System, Electrical Power, Fuel Oil Treatment, Supporting Services.

2) a) Navigation
b) Collision Avoidance
c) Ship Steering Control
d) Radar
e) Trim, List and Stability
f) Damage Detection
g) Traffic Control
h) Navigational Aids
i) Computer - Centralized

3) a) Radio Communication
b) Satellite Communication
c) Interior Communication
d) Recording and Monitoring
e) Information Storage, Retrieval and Aggregation
f) Reporting

*Supporting auxiliaries consist of compressed air, fresh water, salt water, fire sanitary, CO_2, vapor protection, ventilation and similar systems.

4) a) Cargo Stowage, and Planning
   b) Cargo Control
   c) Cargo Transfer Requirement
   d) Environmental Control of Cargo and Other Spaces
   e) Cargo Handling Systems Control

5) a) Ship Routing
   b) Traffic Control
   c) Ship Scheduling
   d) Docking and Mooring Including Approach to Berth
   e) Ship Supply
   f) Accounting and Personnel Services
   g) Ship Operations and Assignments

Considering automation and control of these functions, in turn, the following effects are noted:

1) Propulsion machinery systems control is highly advanced and available now to effect a basically unmanned machinery room. More than 100 ships are sailing at this time without continuous engine room watches, although most of these vessels are provided with a watch during one regular 8-hour day period. The prime function of this is systematic inspection and preventive maintenance. The resulting crew requirements and cost of automatic control equipment are listed in Table V-1.

Table V-1

PROPULSION SYSTEM AUTOMATION COSTS AND CREW REQUIREMENTS

Machinery Type	SHP	Engine Crew (All Inclusive)	*Installed Cost of Automatic Control Equipment (U.S.)
Steam Turbine	20-50,000 Single Screw	6	$595,000
Steam Turbine	30-120,000 Twin Screw	8	$695,000
Gas Turbine	20-40,000 Single Screw	4	$325,000
	40-120,000 Twin Screw	6	$390,000
Diesel Direct	10-40,000 Single Screw	6	$380,000
	30-80,000 Twin Screw	8	$475,000
Diesel Geared	10-40,000 Single Screw	6	$420,000
	30-80,000 Twin Screw	8	$510,000

*This is the cost differential between an automated and non-automated ship propulsion plant.

The degree of automation reflected in these typical examples represents utilization of 25% of crew time for inspection and supervision, while 75% of crew time is spent in performance of scheduled preventive maintenance and corrective actions during emergency situations. Currently used propulsion machinery automation and control systems consist generally of local and centralized remote controls in which main propulsion machinery functions are largely programmed. These usually consist of remote function controllers, continuous (analog) displays, demand (analog) displays, demand (digital) displays, alarm annunciation, status signals, alarm loggers, performance loggers and miscellaneous test switches and communication actuators.

The results of the performance of automated ships without continuous engine room watch indicate:

a) Plant or systems reliability and availability is at least equal to that of manned propulsion machinery systems.

b) Plant or systems efficiency is marginally improved.

c) Repair and maintenance costs are generally equal to that of similar manned propulsion machinery systems.

d) Crew, spare part, and supply costs are reduced by as much as 40%.

As a result, it is usually possible to amortize the additional capital investment over a 2-4 year period.

2) Automation of ship navigation and maneuvering control greatly affects position taking, plotting, lookout and steering functions. It permits a maximum of time for assessment of situations and decision making by reducing time-consuming routine tasks and providing a complete and real time information in a situation. The resulting savings in manning are smaller than those achievable by propulsion machinery plant automation, but the consequent improvements of navigational and maneuvering functions and resultant reduction of collision, grounding or other navigational hazards, fully justify such investments.

Projected Trends in Control and Automation

Advances in automation and centralized control of modern ships have led to full acceptance of the 'periodically' unattended engine room by most major classification societies. Rules for the design and operation of such vessels are now available and nearly 100 ships are presently operating under "EO" (Det Norske Veritas) or similar classifications for unattended engine rooms.

Remote control and automation equipment is now available for completely unmanned engine rooms. Experience with 'periodically' unattended machinery spaces has shown no reduction in reliability and a definite improvement in responsiveness resulting in better navigational and maneuvering control. Many of the ships designed for 'periodically' unattended operation are manned by watchkeeping officers with dual deck/engine licenses and qualifications. This has been shown to provide definite advantages and improved decision-making, particularly in casualty or critical maneuvering situations. The infrequency of required engine room attendance and comparatively short duration of stay during such visits permits a different approach to machinery system design. In the future the environmental (ambient) requirements or condition for most effective equipment operation will become the predominant consideration in machinery space design and layout. While accessibility will remain a prime objective, it will probably emphasize rapid replacement of parts or complete system (for shoreside overhaul). On the other hand, temperature, humidity and roominess will not be controlled by operator but machinery requirements. It can be readily shown that a higher temperature (and pressure) environment will improve effectiveness of most types of machinery plants. The approach may similarly allow elimination and/or reduction of air intake ducts and similar conduits leading to major volume and cost savings.

While recent developments concentrated primarily on machinery control and automation, parallel developments have occurred in the automation of many ship control or navigation and cargo system handling. Satellite navigation systems and automatic course setting and control are today available as are computerized cargo handling systems (largely for tankers and other liquid bulk carriers). Complete on-board computer systems controlling machinery, navigation and cargo handling functions are in use today. Developments are expected to lead to systems which allow at-sea ship operations without human interference (except for casualty conditions). Perfection of anti-collision control devices and traffic control systems (similar to air traffic control systems) are top priority efforts at this time. As a result, future shipboard navigational control systems may permit largely automatic bridge (ship) control from pierside to pierside.

The only major ship function which requires major development for effective control and/or automation is ship docking and mooring. Although several laser assisted docking approach control systems are available, much work is yet required to eliminate the labor intensive and basically obsolete conventional method of ship mooring by lines and/or wires.

Similarly, more effective cargo handling and/or stowage system control methods are required for dry bulk and break bulk (including unitized) cargo. While many computer programs for cargo stowage and handling optimization are available, they are only used to develop plans for loading/unloading sequence and cargo stowage. In the future these operations may well be directly computer controlled.

Chapter VI

TERMINAL INTERFACE

Ports and Terminals

The functions and as a result physical facilities of ports and terminals have changed drastically in recent years. The preoccupation with providing effective ship to shore cargo transfer and ship handling facilities has been broadened by the introduction of true modal interface facilities. Ports in general no longer serve as cargo consolidation and distribution points, but as effective intermodal transfer facilities in which a minority of operations are involved in local cargo consolidation and distribution.

Similarly, port and terminal facilities have become more specialized from the point of view of both ship and cargo type (or form) handled. As a result, we have today, in addition to specialized liquid and dry bulk terminals, facilities designed to handle containerized, palletized, barge loaded, rolling (vehicular) and similar cargo forms. Although most liquid bulk carriers carry their own cargo discharge equipment, dry bulk and containerships are generally non-selfsustaining and depend on shoreside loading and unloading equipment. Barge and pallet ships, on the other hand, usually have shipboard cargo transfer equipment.

The requirements for effective cargo transfer from these different types of ships also include vastly different configurations of terminal layout, access, equipment, and operational policies. These are imposed by the form and dimension of ship used, physical form of cargo, and inland feeder method or mode used.

Basic port requirements are listed in Table VI-1 which shows the major considerations imposed on modern ports. Port facility and operating policy development is also increasingly affected by consideration of inventory or cargo holding form and costs. Many cargoes are today shipped as through cargoes from inland to inland point with a resulting concern for total through cost and time. Therefore port design and operation can often not be performed on the basis of optimizing port effectiveness or efficiency alone. As a result, traditional measure of port effectiveness or productivity seldom applies. Historic port effectiveness measures were based on cargo handling rates per unit of facility such as berth or berth length without consideration of the inland feeder interface effectiveness. To be truly effective, a modern port must provide for balanced flow and overall intermodal transfer effectiveness which include buffer, access and other considerations.

Table VI-1

SEAPORT FACILITY SURVEY REQUIREMENTS

Piers

Area (Total)
Covered Area
Apron Width
Surface Condition
Bulkhead Condition
Load Carrying Capability
Access (Rail-Road-Barge, etc.)
Security Fence
Water Depth Adjacent Piers
Ship Mooring Facilities (Berths)
Distance to Open Water
Channel Depth and Width
Equipment Cranes (Life Capacity)
Container Facilities
Passenger Accommodations

Other Seaport Resources

Port Organization and Management
Mobile Equipment
Office Space
Employees

- Categories
- Organization

Security Organization
Supporting Services

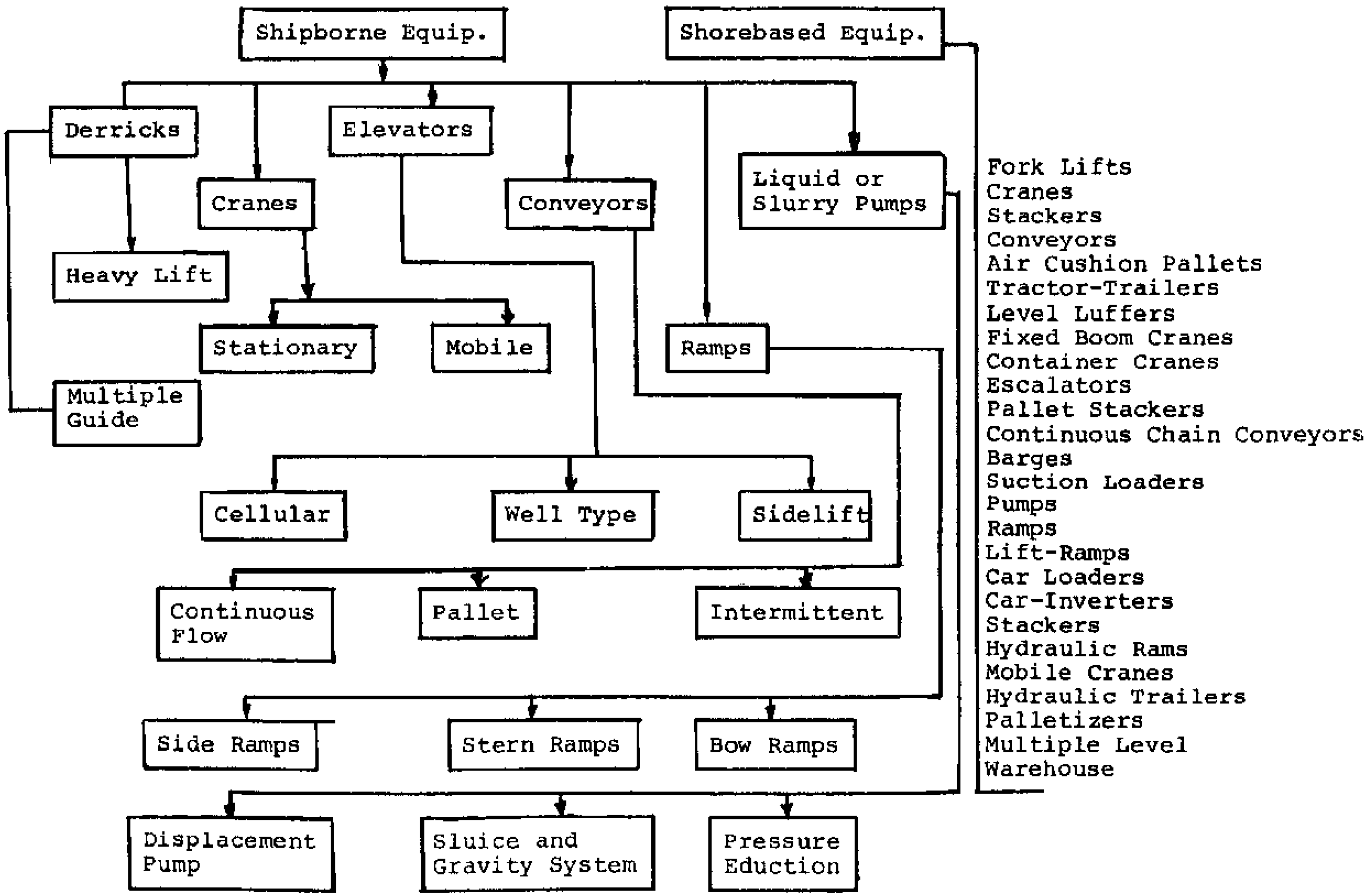
Other Considerations

Type of Cargo Handled
Volume of Cargo (Import/Export)
Potential for Expansion
Utilization
Geographical Area

The trends in the use of cargo transfer equipment are presented in Figure VI-1. It will be noted that the emphasis is on efficient operations in which cargo transfer and transport (including in-port transport) are separated.

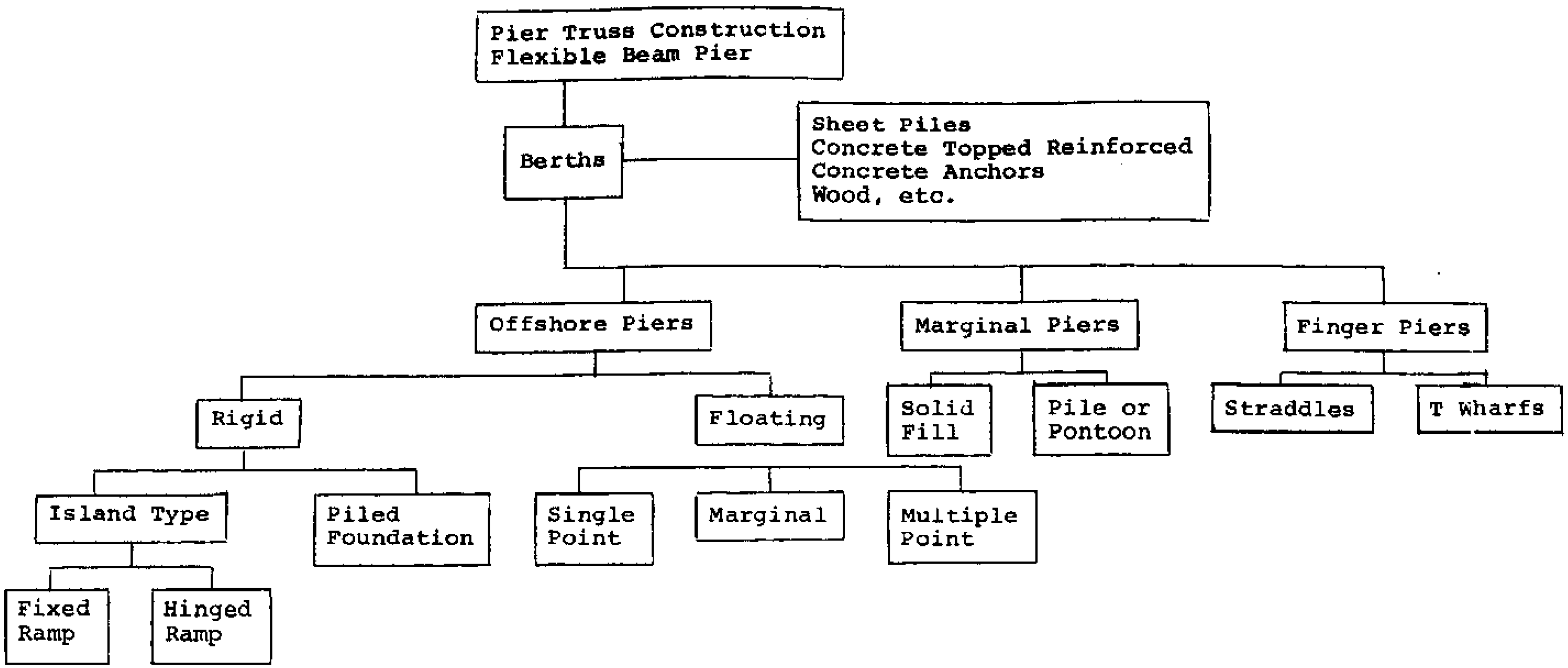
In line with the diversity in terminal requirements, pier or berth design has been subjected to major developments. Various types of piers (berths) and their basic forms are shown in Figure VI-2.

The large increase in ship dimensions (particularly bulk carriers) has resulted in the development of many types of deep draft ports or terminals. Tables VI-2and VI-3 show the present status and expected availability of deep water terminals for tankers. Similar developments are expected to occur to serve dry bulk carriers.



TRENDS IN CARGO TRANSFER EQUIPMENT

Figure VI-1



TRENDS IN PORT TECHNOLOGY

Figure VI-2

Table VI-2

Terminal Facilities for VLCC's
(150,000 DWT plus)

	Loading	Unloading
Middle East		
Persian Gulf	15	-
Mediterranean	6	1
Red Sea	-	1
Africa		
North Africa (Med.)	9	-
West Africa	8	-
Europe		
Mediterranean	-	18
Western Europe	-	25
Asia		
Japan	-	26
Singapore	-	1
Korea	-	1
America		
North America		
U. S.	1	-
Canada	-	3
South America	-	2
Caribbean	-	1
TOTAL (1972)	39	79

Table VI-3

Growth of Deep Tanker Terminals

	1966		1970		1975	
	Foreign	U.S.	Foreign	U.S.	Foreign	U.S.
Berth between 50' and 70'	103	6	160	6	168	3
Berth in excess of 70'	4	-	26	2	56	4

Terminals with drafts in excess of 70' will serve both ends of World Tanker Routes on which 80% of the world's crude oil is transported by 1975.

Similarly, over 50% of crude movements will be served by terminals with draft in excess of 80' at both ends of their route.

As a result, adoption of tankers of 350,000 DWT and above is planned and inevitable -- at least 50% of all crude transport is expected to be performed by such tankers by 1980.

Physical Form and Packaging of Commodities

Unitization of dry general cargo in containers, on pallets, in barges, and in trailers has become accepted practice on all major trade routes between industrialized nations. It is less attractive when large imbalance in cargo form and quantity exist such as in trades between industrialized and developing nations when return flow consists largely of bulk commodities.

Containers were initially used to handle dry general cargo more effectively. Many other cargoes are now carried in containers of container sized pallets, bins, tanks, boxed tracks, etc, as shown in Table VI-4. Containerization affects packaging and handling of commodities, with resulting benefits in packaging costs, volume, and cargo damage in transit. Similar advantages can be claimed by floating containers or barges, usually capable of accommodating a vastly large unit volume and weight. Palletization, though effective in some trades, only introduces limited standard unitization without the other benefits of either the container or barge approach.

Dry bulk cargoes are handled by mechanical methods in dry form. Physical form change of traditional dry bulk cargoes is of increasing interest. Many bulk commodities such as ores, coal, salts, etc., can be mixed with a carrier such as water in suspension to form a highly saturated slurry. Such slurries can then be handled similarly to liquid cargoes by pumps and through pipelines at rates far in excess of those achievable by dry bulk handling equipment. Similarly, transfer and transport costs of slurries are a fraction of those incurred using dry bulk mechanical handling equipment. The additional liquid weight carried varies from 20-80% of total weight and 5-30% of volume. Mixing can be performed before loading (or at the origin) or just before discharge (Marcom System).

Many dry cargoes which are traditionally carried as break bulk (packaged) cargoes are today handled in bulk by specialized vessels served by specialized terminals. Among these are commodities such as cement, sugar, pulp, lumber, ore, coal, plastics, fertilizer, gypsum, grain, paper, etc. Special loading and unloading equipment, ship designs, and terminal facilities are today available to satisfy the needs of these trades effectively. In many instances transfer and transport requirements introduce the need for physical form change.

Liquid bulk cargoes consist of petroleum, petroleum products, liquified gas, chemicals, wine, milk and many others. The handling of liquid cargoes is performed by large pumping systems discharging into specialized receiving terminals.

Table VI-4

CONTAINER TYPES AND CARGOES

Container Type	Cargo
Standard Container	General Cargo
Tank Container (usually on Container Pallet)	Liquid Small Bulk (Paint, Wine, Chemicals, etc.)
Open Container Bin	Dry Small Bulk
Container Pallet or Tracked Container Structure	Vehicles
Ventilated and/or Insulated Container	Perishable Cargo
Reefer Container	Refrigerated or Frozen Cargo
Trailer Van	All Types
Strongback Container	Ammunition

Projected Trends in Cargo Handling Technology

Container transfer rates of up to 30-35 containers (or 300-500 tons) per hour are today achieved by container gantry cranes. As a result transfer rates of up to 1200 tons per berth served by 2-3 gantry cranes have been noted. Similar transfer rates are achievable by barge carriers served by shipboard equipment. Future developments are expected to involve automated container transfer and storage equipment serving an automated container terminal which includes automatic container transfer to and from trucks, railcars, and barges. Automatic container identification using computerized read-off equipment is already available and can be readily adapted to existing transfer sequence programs. Various designs of continuous flow container terminals in which all operations are automatically and/or remotely controlled are available and are expected to be built before the end of this decade.

Break bulk and palletized cargo will continue to form a significant portion of all dry break bulk commodities handled in ocean transportation. It is expected that the traditional boom (derrick or crane) hoisting transfer will be replaced by combinations of horizontal and vertical mechanical conveyers, monorails or similar devices which permit more continuous flow of transfer and stowage operations and as a result large increases in transfer rates. By 1980, it is expected that transfer rates of several hundred tons/hr per hatch will be achievable for most commodities. Most of the equipment for these operations will probably be shorebased to achieve meaningful equipment utilization. Dry bulk cargoes can now be transferred at rates of up to 5000 ton/hr depending on equipment and commodity. In slurry form transfer rates of up to 12000 tons/hr of slurry can be achieved. These rates are expected to double before 1980.

Liquid bulk carriers have benefited by the largest increase in handling rates. Some existing tankers offer rates in excess of 20000 tons/hr now. Only marginal increases in transfer rates are expected here, though the method of transfer may change appreciably. Increasing use of mammoth tankers and remote offshore deepwater terminals, for example, may require multistage pressure boosting on board and ashore.

The most extensive cargo transfer developments are expected to occur in the handling of LNG and other liquified gas. The reliquification, cryogenic and other requirements make this a particularly interesting problem. Transfer rates of 5000 m^3/hr are achievable today, a rate that is expected to double by 1980.

Additional developments will occur in specialized handling such as lumber, newsprint, petrochemicals, etc.

Chapter VII

TECHNOLOGY TRENDS AND VOIDS

Ship or Ocean Transportation Systems Requirements.

Recent technological and resulting operational developments impose a host of new ocean transportation systems requirements. No longer is a meaningful or sufficient to design to criteria such as minimum resistance, minimum ship operating costs, maximum ship or subsystem efficiency or similar restricted objective functions. Useful criteria now encompass a total ocean transportation system and include various relationships which express the dependence of the different components of such a system. In the most general sense ocean transportation systems requirements can be divided into:

1) Ship System
   a) Hull Subsystem
   b) Propulsion Subsystem
   c) Cargo Containment Subsystem
   d) Cargo Handling Subsystem
   e) Auxiliary Service Subsystem
   f) Habitation and Life Subsystem
   g) Navigation and Communication Subsystem
   h) Environmental Control Subsystem
   i) Steering and Maneuvering Subsystem
   j) Automation and Control Subsystem
   k) Mooring Subsystem
2) Terminal system
   a) Traffic Control Subsystem
   b) Berth Subsystem
   c) Decking Subsystem
   d) Cargo Transfer Subsystem
   e) Cargo Storage Subsystem
   f) Feeder Interface Subsystem
   g) Communication Subsystem
   h) Environmental Control Subsystem

The requirements imposed by the criteria of the system affect all the subsystems and are affected by them.

The criteria, in turn, can no longer be minimum ship costs, ocean transportation costs, or maximum profit from ship operations based on the assumed ship operating conditions. Modern ships are intimately dependent on terminal and feeder interface operation. Ship productivity depends on terminal productivity which, in turn, depends on feeder interface and vice versa. Increased specialization and capital intensity which, in turn, leads to faster port turn-around and increased transport (underway) utilization imposes increased interdependence. Ship or ocean transportation systems requirements must therefore be expressed in terms of all affected and/or dependent subsystems and the relationship of design and/or operating variables must be explicitly stated.

Projected Technology Development

Technology developments in ocean transportation progress at an increasing speed. The time between technological innovations in ship form, type or operation constitutes today a fraction of the expected lifetime of a vessel. It is therefore more important then ever to project the future technological developments and estimate their corresponding probabilities of occurrence and time of occurrence. Such studies lead to technological impact assessment evaluations which are used to estimate the effect on future competitiveness of current technology. Considerations and approaches of impact assessment are increasingly used to assist in rational decision making on timing and technology selection for ocean transportation systems. Technological developments are usually designed to fill an existing void. Voids may be established by lack of technology or operational/economic insufficiency of existing technology. Emphasis of some technological development by research funding has produced vastly different progress in diverse areas of marine technology. Similarly, while much public expenditure has been devoted to hydrodynamic, novel ship types, automation and isolated power plant studies or research, private initiative was largely responsible for advances in ship and cargo handling systems developments.

The rapid changes in technology and operations of ocean transportation, introduce many new technological requirements. These are largely needed to assure effective use of recently developed technology. A review of recent technological discussions or polling(Delphi) experiments performed in some of the major maritime countries combined with independent analysis and predictions by the author of this report resulted in the ocean transportation technology forecasts presented in Table VII-1. It will be noted that the vast majority of the forecasted developments is in the area of environmental, safety, cargo handling, ship handling, power transmission, and terminal systems. It is a fact that less emphasis will be placed on hydrodynamic improvements of ship performance then on ship operating, cargo handling and propulsion systems.

Table VII-1

Ocean Transportation Technology Forecasts

A. Predicted as Realizable in This Decade (by 1980)

* Anti-Collision and Anti-Grounding Devices
* Oil Spillage Containment and Clean-up Techniques
* Oily Water Separator
* Continuous and Automated Unitized Cargo (Pallet or Container) Loader/Unloader
* Detachable Lifesaving Bridge and/or Deckhouse Structure
* Completely Automated Propulsion Plants
* Completely Automated Bulk Cargo Loading/Unloading Systems
* Completion of Oceangoing Trimaran Vessel
* Completion of Oceangoing Surface Effect Ship
* Completion of First 750,000 DWT Tanker
* Development of Submerged Tanker Terminal with Bottom Loading/Unloading System
* Development of Maring Gas Turbine with Specific Fuel Consumption of 0.42 Lbs/SHP-hr
* Development of Effective Smoke Emission Device for Ships
* Development of Truly Effective Oceangoing, Detachable Tug-Barge or Barge-Ship Coupling System
* Draft Reducing Device for Mammoth Tankers
* Sea Traffic System Controls and Automatic Navigation System
* Automatic Ship Mooring and Docking Systems
* Catamaran Containerships
* Semisubmerged Catamaran Ships
* Effective Tanker Safety (Fire, Explosion, etc.) System
* Floating Offshore Container Terminals
* Superconducting Ship Power Transmission System

B. Predicted as Realizable in the 1980's

* One Million Ton Tanker
* Automatic Port and Harbor Navigation and Maneuvering System
* Large Oceangoing Surface Effect Ship
* Fuel Cell Ship Propulsion System
* Completion of First Ship with Batteries for Propulsion
* Completion of Submarine Tanker
* Ships Built with Automatic 'Cold' Steel Joining Techniques
* Completion of Unmanned Merchant Ship
* Completion of Tanker Loading-Unloading System without Hose Connection
* Economic Nuclear Marine Propulsion
* Overland Ship Transfer Systems
* Inflatable-Deflatable Ships

Technological Challenges for the Seventies

Although many doubts may be raised concerning the implementation of many of the technological and operational forecasts, all the projected developments mentioned:

1) Are theoretically feasible.

2) Solve known problems.

3) May offer economic and operational advantages.

4) Provide great opportunities for the basically risk-oriented ocean transportation investor.

5) Introduce the step increase in capability or capacity needed to meet future demand.

Ocean transportation as an industry is unique in many ways. It is at the same time among the most traditional and progressive of human endeavors. It is both labor intensive and extensive. It provides opportunities to the small operator and large corporation with equal chances of success and failure. It is an international yet highly nationalistic industry. While among the most essential of services, it is basically an engima to the average citizen, who maintains a romantic illusion about shipping. It is a highly capital intensive industry yet undercapitalization predominates. Though many of the great fortunes of the world have and are being made in shipping, it remains a highly protected and/or subsidized industry. It is a major tool of economic warfare, particularly by nations jealously guarding the freedom of the seas and free competition in ocean shipping. It is supposedly a highly competitive, free enterprise industry yet is subject to more cartelization, rate fixing, conferences discounts and other restrictive approaches designed to reduce free competition than most industries.

Notwithstanding all these, ocean shipping is today cheaper in a relative sense than ever before, while the quality of service is generally better. It provides larger margins in capacity and greater flexibility, yet offers more specialization.

At the same time, many problems have arisen which require prompt action. Among these are:

1) Labor availability and skill. Working and living conditions. Labor relations. Demands for elimination of arduous tasks without their replacement by monotonous tasks.

2) Environmental protection. Prevention of air and water

pollution. Reduction of noise and vibration as well as control of temperature and humidity within vessels. Containment of spills, etc.

3) Integration with other modes. Terminal interface, through documentation, through billing, cargo consolidation. Capacity balancing.

4) Physical form change of cargoes and packaging and resulting effects on ship form, operation, cargo transfer and storage.

5) Unit lot size of cargoes. Ship size and inventory holding costs.

6) Navigation and traffic control on open sea lines and in congested waters.

7) Fuel cost and availability. Rising fossil fuel costs and potential shortages may hasten development and adoption of more efficient energy conversion and/or alternate energy sources. It will also affect the size of vessels as fuel consumed per ton-mile becomes a more relevant factor.

8) Port accessibility and availability. The concept of the urban port is outmoded and may have to be replaced by efficient and independent port complexes with free access to open sea lanes and inland transportation routes, while simultaneously providing ample storage and consolidation capacity.

9) Investment requirements in ocean transportation have risen to a level where private investors can no longer generate the capital and/or assume the risks. Large investment companies, banks, major corporations, governments, international agencies and other non-shipping interests are increasingly involved. Similarly, shipping companies tend to merge into fewer and larger entities. Not only has the unit cost risen appreciably, but it is increasingly essential to invest in a transportation system instead of a vessel. Total movement control is becoming an important consideration.

10) Traditional maritime law, rate and operational regulation and ship classification, though jealously guarded, is increasingly attacked. Some attacks are based on economic and nationalistic reasons, such as demands for "equal" opportunity or rate control by developing countries. Others concern environmental control, operating conditions and terms of carriage.

11) Transportation system management is becoming too complex to permit educated or experienced intuitive judgements. The science of transportation management lags behind developments in other industries.

At a lower level of detail we confront many operational deficiencies such as:

1) Insufficient maneuverability.

2) Excessive stopping distance of large ships.

3) Lack of training and commitment of crews.

4) Lag in development of efficient lightweight, low volume marine propulsion systems.

5) Efficient and reliable thrusters, particularly for higher speed.

6) Effective full power reversing devices for high powered unidirectional propulsion plants.

7) Obsolescent docking and mooring methods.

8) Lack of effective berth approaching methods independent of outside (tug) assistance.

9) Outdated ship supply and strikedown systems.

10) Ineffective maintenance and repair methods.

11) Cumbersome conversion of rotational energy into thrust inefficient thrust transmission.

12) Fouling and corrosion of external surfaces. Corrosion of internal surfaces.

13) Handling and storage of general cargo.

14) Ship Safety Devices.

15) Ship Navigation Systems.

16) Ship Communication Systems.

17) Personal Transfer Systems.

There are obviously many more areas where improvements are required. Although safety of life at sea is still of predominant concern, it is today only one of many concerns in the development of new technology for more effective ocean transportation. The technological challenges of the seventies are numerous. The means for the solution of many of the problems, though are at hand.

Ocean transportation trends are toward ever larger, safer and more efficient ocean vehicles. Largely unmanned ships, with computer controlled navigation, propulsion plant, and cargo handling systems may well be with us before the end of this decade. Half million ton deadweight ton capacity ships are on order. Transmissions without hull penetrating shafts are offered by superconducting and hydraulic energy transmission devices under development now. Laser controlled berth approach techniques and automated mooring devices are being designed. Cargo ships exceeding the speed of fast passenger liners ply the sea lanes now. Ocean traffic control systems could be implemented within a few years, given international agreement. Anti-collision and anti-grounding devices could be developed in very little time.

These and many more developments will invariably come into being. They will change the traditional approach to ship design, construction and operation. They will also affect the requirements and function of ports and justify or demand deep water ports different from any past port concept. They will change our conventional concepts of interface requirements as transportation tends toward a more efficient, continuous and systematic flow of goods from origin to destination.

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PART 3

DEVELOPING AND USING DATA ON TRADE COMMODITY FLOWS

by

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Introduction

A person in need of certain commodity flow statistics may easily become buried under huge volumes of data produced from various sources. However, quite often the data will not be in a suitable form to meet the research requirements. In addition, the information from more than one source may be incompatible. That is, because of different definitions of commodity groups or port areas, the data from one source cannot be used in conjunction with information from another source.

This study tries to bring together the results of various research concerning commodity flow information so that a researcher needing information in this area will have a better understanding of what data will be available in the future and where he can find the information he requires. The first chapter shows how present data can be used to estimate a breakdown of the various types of cargo moving through major Atlantic ports which comprise the busiest seacoast in the United States. Unfortunately, subjective assumptions relating to the grouping of commodities by various cargo handling methods and many tedious hours of calculations are required to produce these results.

Chapter II explains how government-sponsored research will improve this procedure with a new type of commodity coding. This system will facilitate predictions of trade flow by commodity groups as well as by cargo handling methods.

Chapter III focuses on probably the one largest gap in present data on commodity flows--the origin and the destination of international shipments. Although volumes of data exist on the port-to-port movement of goods, knowledge concerning the inland origin and destination is extremely limited. This chapter will analyze a government-sponsored survey in this area and describe the outputs to be expected from this research.

CHAPTER I

TRADE FLOW THROUGH ATLANTIC PORTS

This first chapter shows how existing data can be used to analyze cargo flow through the Atlantic Ports, which comprise the busiest seacoast in the United States. For this purpose we used the statistics contained in Waterborne Commerce of the United States Part I, (Calendar Year 1969) by the Department of the Army, Corps of Engineers. Data on the foreign commerce were supplied to the Corps of Engineers by the Bureau of the Census; data for the compilation of the domestic statistics were collected by the several offices of the Corps of Engineers, Department of the Army.

The statistics by the Corps of Engineers include a comprehensive array of trade figures for both major and small ports and harbors. To have a more practical and realistic study, only the larger ports were considered. We decided to include in our analysis only those ports with an annual cargo flow greater than 10 million (short) tons. Consequently, we examined the following nine ports: Portland, Boston, Providence River and Harbor, New Haven Harbor, New York, the Delaware River, Baltimore, Hampton Roads and Jacksonville.[1]

A complete list of the commodities handled is given in Appendix A. In the preliminary work, the outstanding and obvious items such as crude petroleum, coal, coke, and petroleum products which we termed "energy sources" were separated out. The total tonnage and percentage figures of these energy sources for each port of the nine ports are shown in Table I-1. From this table, it can be seen that, apart from the Port of Baltimore and the Port of Jacksonville, energy sources constitute more than 70% of the total tonnage handled at each port.

Next, items having tonnage greater than or equal to ($\geq$) 100,000 tons were added to these "energy sources" figures, and the new percentage value was computed. The result was a surprisingly high figure, as shown in Table I-2. The lowest percentage of the "energy sources" and items $\geq$ 100,000 of a port in the study came to 88.67% of the total in the case of Jacksonville Harbor. It can be seen from Table I-3 that the number of items $\geq$ 100,000 was relatively small for each port with the exception of the Port of New York and the Port of Baltimore. In order to reduce the workload of calculations, we decided that further compilation of data at each port would include only those items that comprised an annual tonnage $\geq$ 100,000 tons at that specific port.

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[1]Delaware River traffic comprises Trenton to the sea including Philadelphia. Hampton Roads includes Norfolk Harbor, Port of Newport News (including Newport News Creek), Hampton Creek and channel from Phoebus to deep water in Hampton Roads, Virginia.

Table I-1

Total Tonnage and Percentage Breakdown of Energy Sources

Port	Total (short tons)	% Petroleum Product (1)	% Crude Petroleum (2)	% Coal & Coke (3)	% (1) + (2) + (3)
Portland	27,831,851	23.51	75.86	-	99.37
Boston	24,818,746	87.88	0.02	0.62	88.52
Providence River and Harbor	10,153,951	88.13	3.18	-	91.31
New Haven Harbor	10,182,573	88.19	-	0.14	88.33
New York	171,244,008	56.20	11.00	4.00	71.20
Delaware River (Trenton to sea, includes Philadelphia	94,585,236	26.31	50.89	0.73	77.93
Baltimore	43,917,369	23.95	1.29	25.43	50.67
Hampton Roads	58,484,378	15.80	0.69	70.18	86.67
Jacksonville	11,413,072	63.64	-	0.60	64.24

Table I-2

PERCENTAGE VALUE OF THE 'ENERGY SOURCES' AND ITEMS ≥ 100,000 (SHORT) TONS OF EACH PORT

Port	% of Petroleum Product Crude Petroleum Coal and Coke + ≥ 100,000 Items Tons
Portland	99.37
Boston	96.49
Providence River and Harbor	95.28
New Haven Harbor	95.64
New York	98.73
Delaware River (Trenton to the sea including Philadelphia)	97.45
Baltimore	96.27
Hampton Roads	96.75
Jacksonville	88.67

Table I-3

NUMBER OF ITEMS ≥ 50,000 / 75,000 / 100,000 (SHORT) TONS OF EACH PORT

Port	No. of Items ≥ 50,000	75,000	100,000*
Portland	1	1	0
Boston	8	7	6
Providence River and Harbor	5	4	4
New Haven Harbor	8	6	4
New York	76	66	57
Delaware River (Trenton to the sea including Philadelphia)	36	24	17
Baltimore	41	36	33
Hampton Roads	26	21	16
Jacksonville	15	11	8

*Short Tons

Another relevant and important aspect of the study was to classify the commodities into the following categories with reference to the method of handling: dry bulk, liquid bulk, containerized, non-containerized and special handling. The categories of items, dry bulk and liquid bulk were fairly obvious to derive. In the case of containerized cargo, all items that were deemed physically and economically 'containerizable' were grouped into this category. The remaining commodities fell into the non-containerized group. However, some items require special handling and these were classified as such, e.g., radioactive materials, liquid sulphur, liquefied gases, motor vehicles, salt and sugar. A list of items in each category is shown in Appendix B.

For each port, the total tonnage was broken down into different components such as:

FOREIGN	COASTWISE	INTERNAL	LOCAL
Import/Export	Receipt/Shipment	Receipt/Shipment	

The description and definition of these headings as given in the Corps of Engineers publication are shown in Appendix C.

The tonnage figures of dry bulk, liquid bulk, containerized, non-containerized and special handling for foreign and coastwise trade of each port are given in Appendix D.

Figures I-1 through I-9 show diagrammatically the breakdown of total cargo by handling method for each port. As expected, liquid bulk dominates in every port except Hampton Roads and the Port of Baltimore, where dry bulk takes the lead.

We attempted to find the U.S. origin and destination of the cargo data analyzed; however, a careful perusal through the various literature and information available revealed that it is not possible to delve directly into the origin and destination of the commodities handled. This is a common problem, as typified by the Arthur D. Little, Inc. company in their work on 'Port Management Problem Study' which stressed the importance of such information, but found it scarce:

> "Origin and destination data are one of the most valuable types of information needed by port managers. Their primary use in planning container facilities and developing well planned promotional and marketing campaigns. Unfortunately, there are no good sources of origin and destination data currently available to port managers."

It may be suggested that the ship's manifest would be useful source of such information, but it would involve a vast

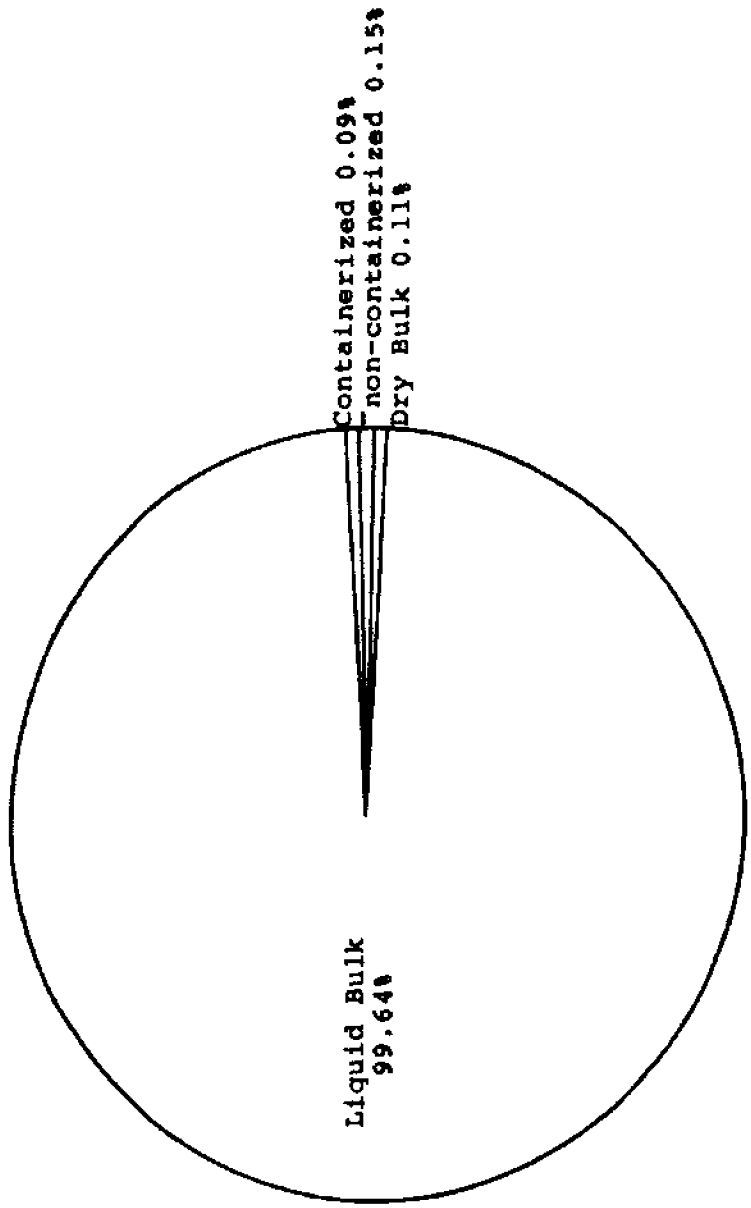

Figure I-1

Port of Portland: Percentage Tonnage Breakdown by Handling Method

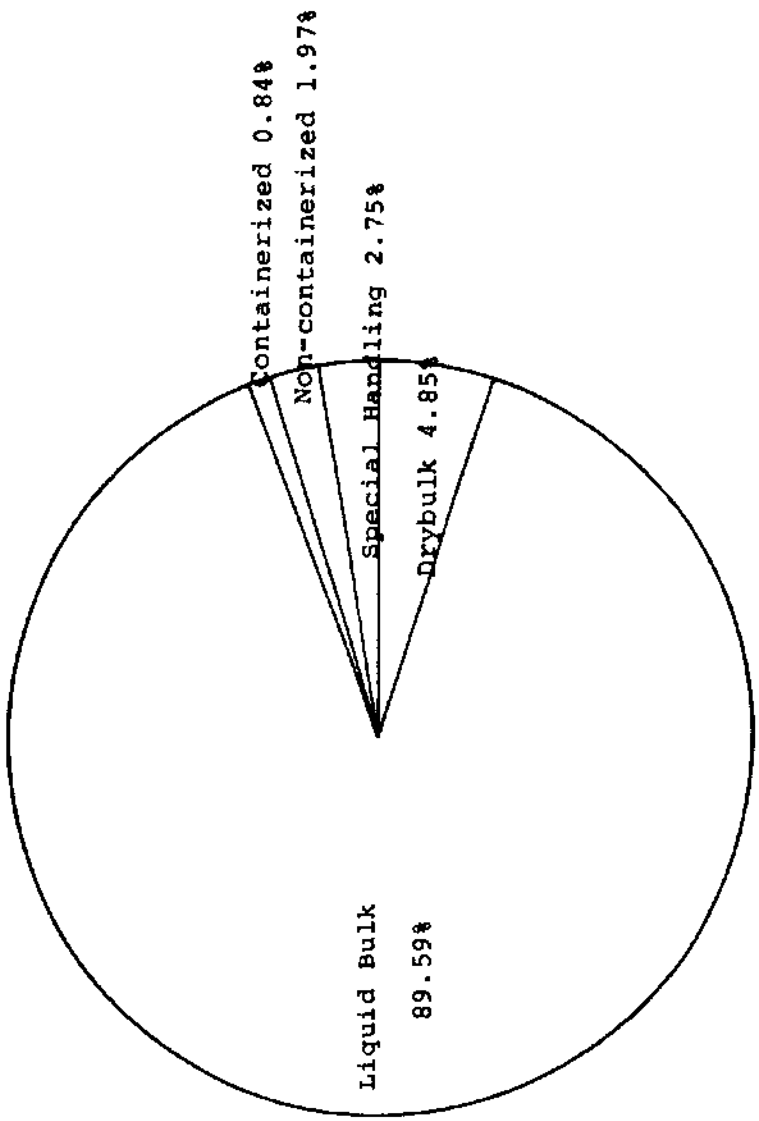

Figure I-2

Port of Boston: Percentage Tonnage

Breakdown by Handling Method

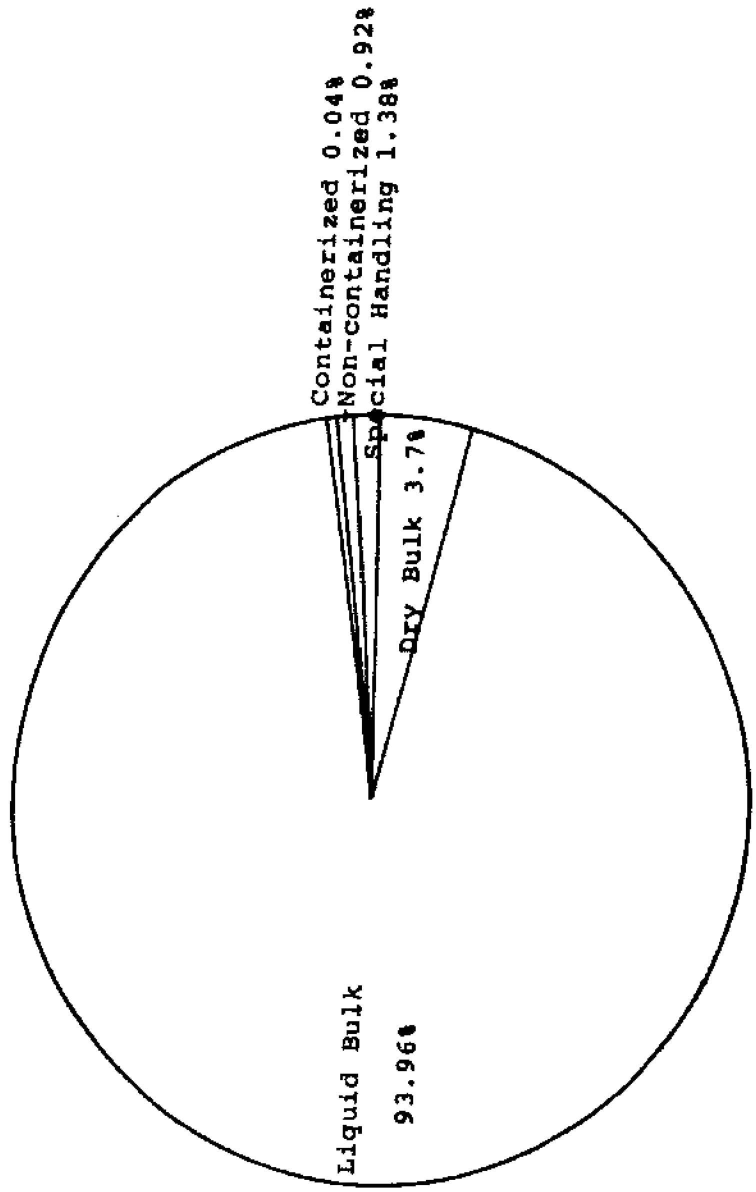

Figure I-3

Providence River and Harbor: Percentage Tonnage Breakdown by Handling Method

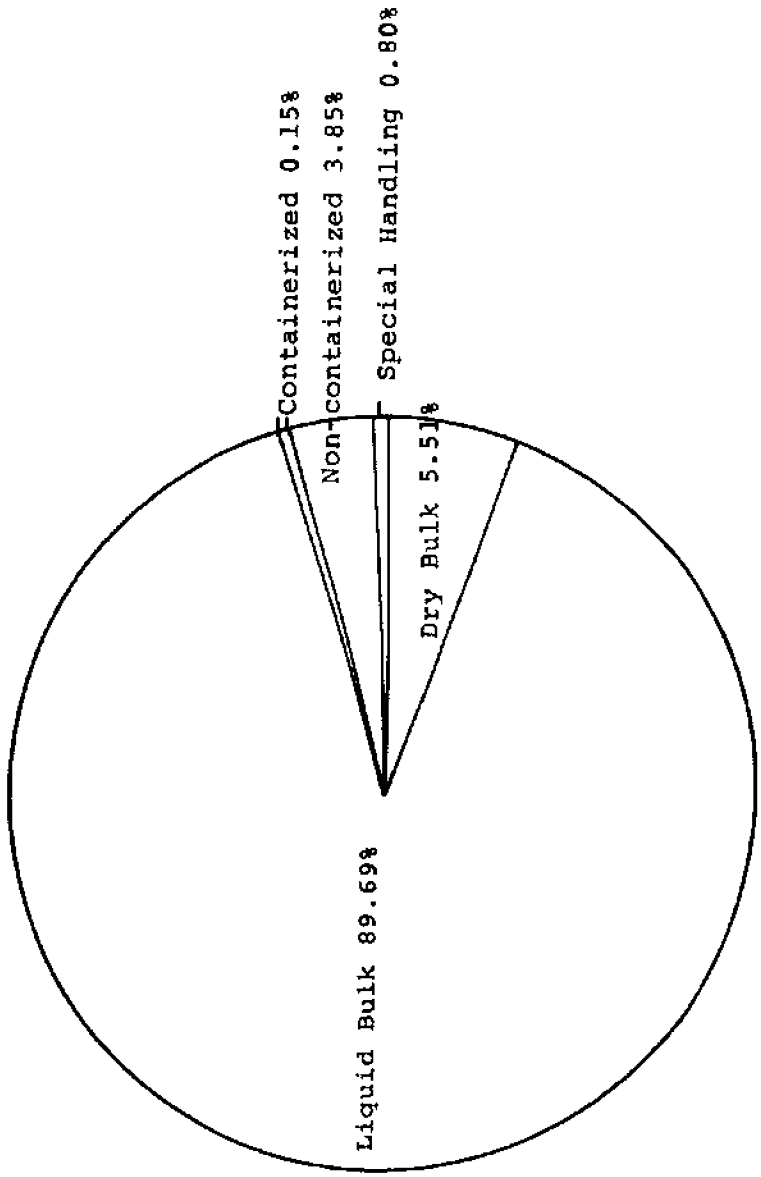

Figure I-4

New Haven Harbor: Percentage
Tonnage Breakdown by Handling Method

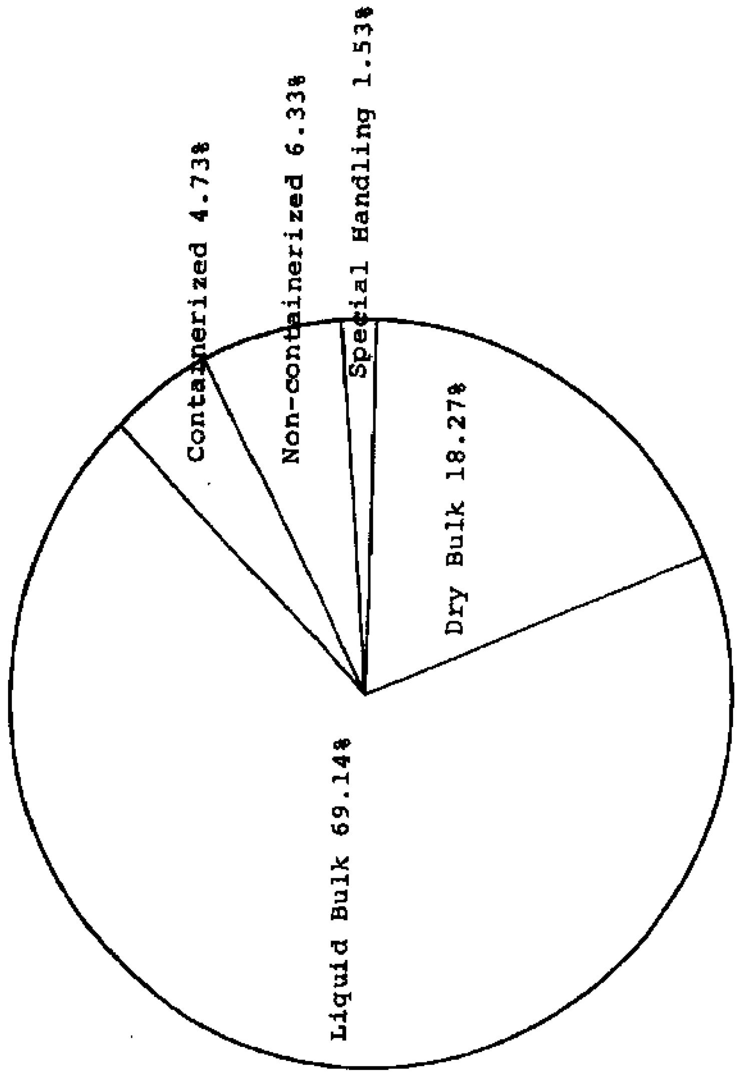

Figure I-5

Port of New York: Percentage Tonnage Breakdown by Handling Method

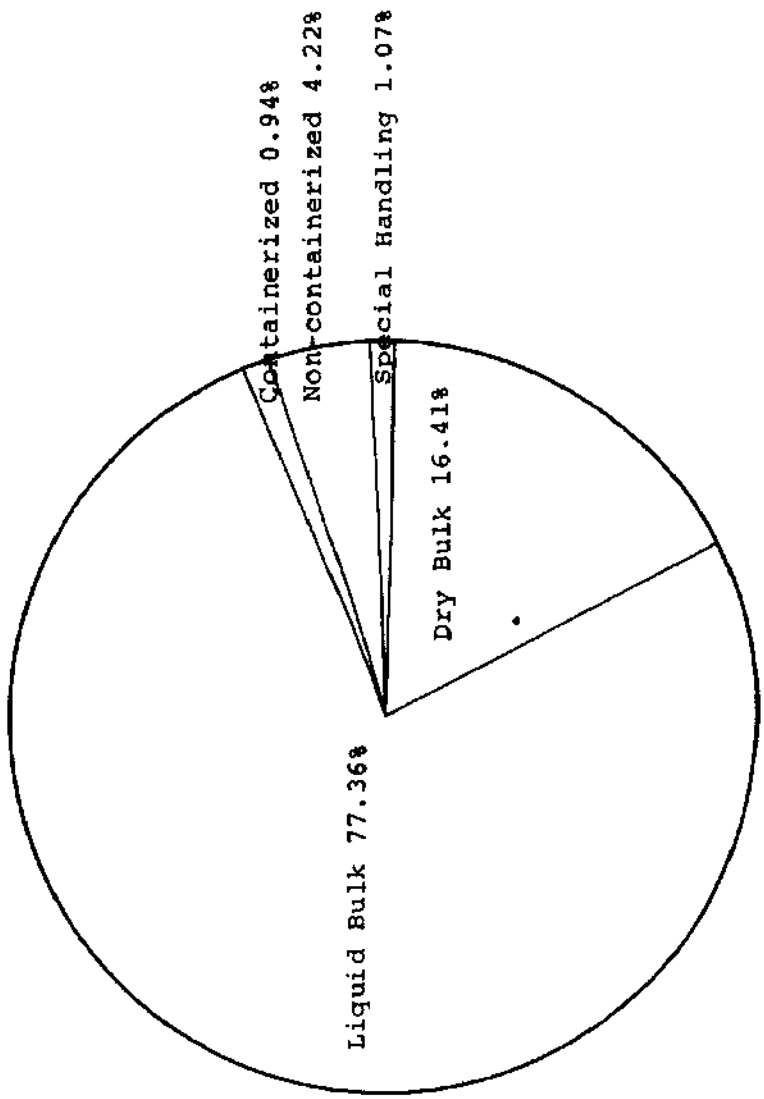

Figure I-6

Delaware River (Trenton to the Sea):
Percentage Tonnage Breakdown by
Handling Method

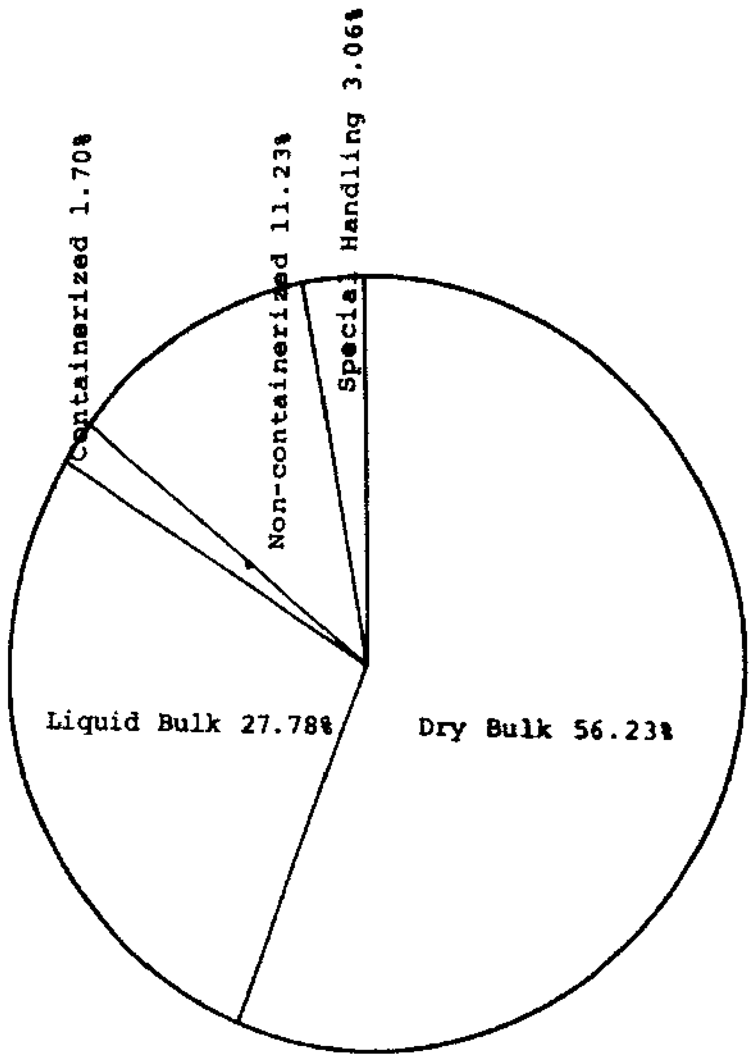

Figure I-7

Port of Baltimore: Percentage Tonnage

Breakdown by Handling Method

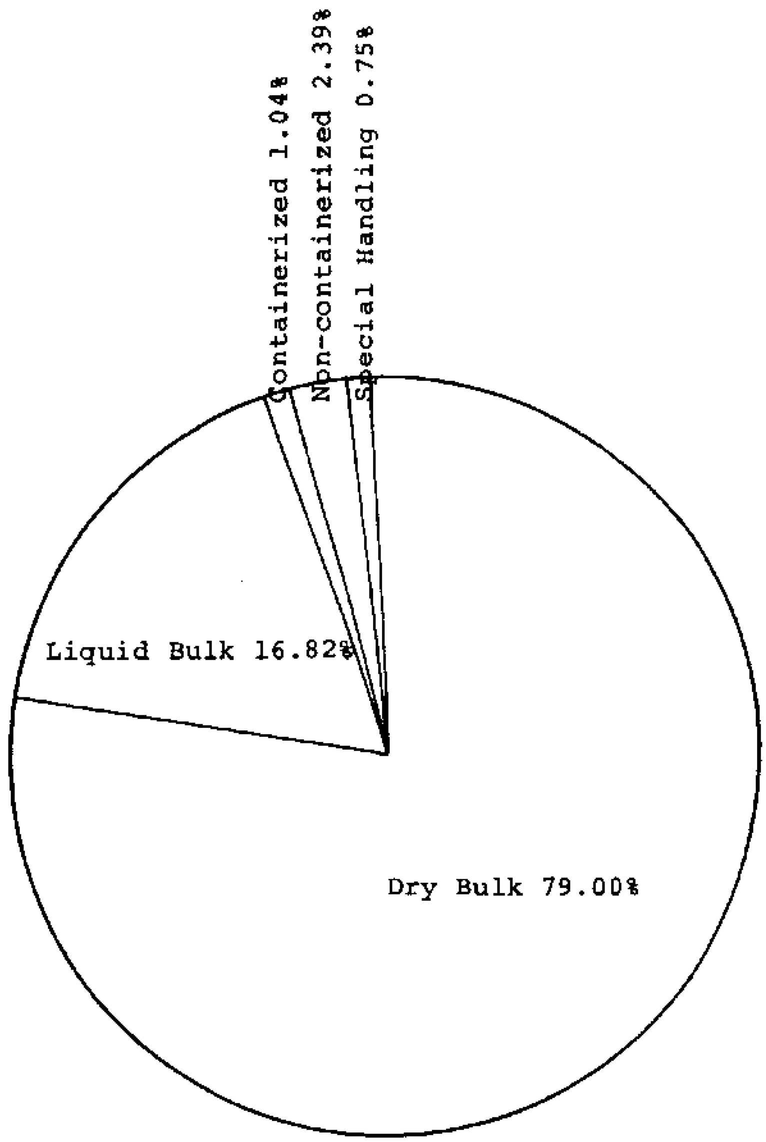

Figure I-8

Hampton Roads: Percentage Tonnage

Breakdown by Handling Method

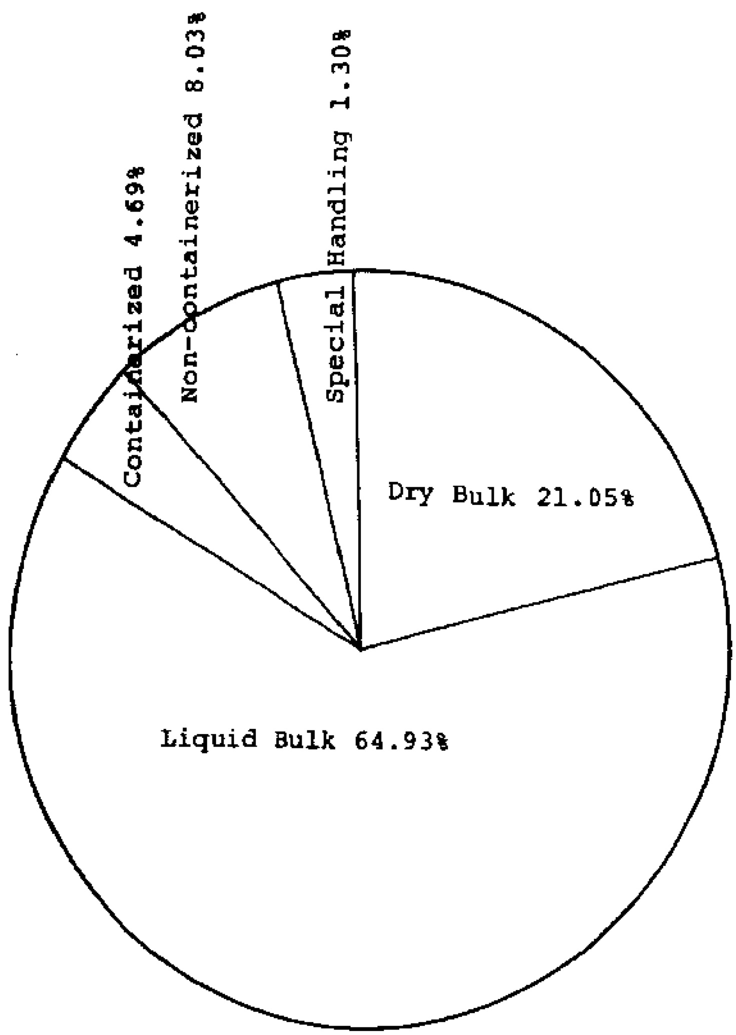

Figure I-9

Jacksonville Harbor: Percentage Tonnage

Breakdown by Handling Method

expenditure of manpower to collect and sift through the ship's manifest information in order to reduce it to useful data. In addition, such documents do not state explicitly the origin and final destination of the cargo; instead, intermediary forwarders, brokers, agents, etc., are given.

Chapter III provides more information on origins and destinations of cargo flows. The next chapter shows how the analysis performed here will be greatly simplified in the future by charges in the government commodity coding system.

APPENDIX A

COMPLETE LIST OF ITEMS IN COMMODITY GROUPS

Group 01 - Farm Products

Cotton, raw
Barley and Rye
Corn
Oats
Rice
Sorghum Grains
Wheat Soybeans
Flaxseed
Oilseeds, not elsewhere classified
Tobacco, leaf
Hay and Fodder
Field Crops, not elsewhere classified
Fresh Fruits and Tree Nuts, except bananas & plantains
Bananas and Plantains
Coffee, green and roasted (including instant)
Cocoa Beans
Fresh & Frozen Vegetables
Live Animals (livestock) except zoo animals, cats, dogs, etc.
Animals & Animal Products, not elsewhere classified
Miscellaneous Farm Products

Group 08 - Forest Products

Crude Rubber & Allied Gums
Forest Products, not elsewhere classified

Group 09 - Fresh Fish and Other Marine Products

Fresh Fish, except shellfish
Shellfish, except prepared or preserved
Menhaden
Marine Shells, unmanufactured

Group 10 - Metallic Ores

Iron Ore and Concentrates
Copper Ore and Concentrates
Bauxite & Other Aluminum Ores and Concentrates
Manganese Ores & Concentrates
Nonferrous Metal Ores & Concentrates, not elsewhere classified

Group 11 - Coal

Coal and Lignite

Group 13 - Crude Petroleum

Crude Petroleum

Group 14 - Nonmetallic Minerals, Except Fuels

Limestone Flux & Calcareous Stone
Building Stone, unworked
Sand, Gravel & Crushed Rock
Salt
Sulphur, dry
Sulphur, liquid
Gypsum, crude and plasters

Group 14 - Nonmetallic Minerals, Except Fuels (continued)

Clay, ceramic and refractory materials
Phosphate Rock
Natural Fertilizer Materials, not elsewhere classified
Nonmetallic Minerals, except fuels, not elsewhere classified

Group 19 - Ordnance and Accessories

Ordnance and Accessories

Group 20 - Food and Kindred Products

Meat, fresh, chilled, or frozen
Meat & Meat Products prepared or preserved including canned meat products
Fish and Fish Products, including shellfish, prepared or preserved
Fruits and Fruit and Vegetable Juices, canned and otherwise prepared or preserved
Wheat Flour & Semolina
Prepared Animal Feeds
Grain Mill Products, not elsewhere classified
Sugar
Molasses
Alcoholic Beverages
Tallow and Lard
Animal By-Products, not elsewhere classified
Dairy Products, except dried milk and cream
Dried Milk and Cream
Vegetables and preparations, canned and otherwise prepared and preserved
Vegetable Oils, all grades; margarine and shortening
Animal Oils & Fats, not elsewhere classified, including marine
Groceries
Ice
Miscellaneous Food Products

Group 21 - Tobacco Products

Tobacco Manufactures

Group 22 - Basic Textiles

Basic Textile Products, except textile fibers
Textile Fibers, not elsewhere classified

Group 23 - Apparel and Other Finished Textile Products, Including Knit

Apparel and Other Finished Textile Products, including knit

Group 24 - Lumber and Wood Products, Except Furniture

Logs
Rafted Logs
Fuel Wood, Charcoal & Wastes
Timber, Posts, Poles, Piling, & Other Wood in the Rough
Pulpwood, log
Wood Chips, Staves, Moldings and Excelsior
Lumber
Veneer, Plywood & other worked wood
Wood Manufactures, not elsewhere classified

Group 25 - Furniture and Fixtures

Furniture and fixtures

Group 26 - Pulp, Paper and Allied Products

Pulp
Paper and paperboard
Standard Newsprint paper
Pulp, paper & paperboard products, not elsewhere classified

Group 27 - Printed Matter

Printed Matter

Group 28 - Chemicals and Allied Products

Sodium hydroxide (caustic soda)
Crude products from coal tar, petroleum, & natural gas, except benzene & toluene
Dyes, organic pigment, dyeing & tanning materials
Alcohols
Radioactive & associated materials, including wastes
Benzene & toluene, crude & commercially pure
Sulphuric acid
Basic chemicals & basic chemical products, not elsewhere classified
Plastic materials, regenerated cellulose & synthetic resins, including film, sheeting, & laminated
Synthetic rubber
Synthetic (man made) fiber
Drugs (biological products, medicinal chemicals, botanical products & pharmaceutical preparations)
Soap, detergents, & cleaning preparations; perfumes, cosmetics & other toilet preparations
Paints, varnishes, lacquers, enamels, & allied products
Gum & wood chemicals
Nitrogenous fertilizer & fertilizer materials, manufactured
Potassic fertilizer materials
Superphosphate
Insecticides, fungicides, pesticides, & disinfectants
Fertilizers & fertilizer materials, not elsewhere classified
Miscellaneous chemical products

Group 29 - Petroleum and Coal Products

Gasoline, including natural gasoline
Jet fuel
Kerosene
Distillate fuel oil
Residual fuel oil
Lubricating oils & greases
Naphtha, mineral spirits, solvents, not elsewhere classified
Asphalt, tar, & pitches
Coke, including petroleum coke
Liquefied petroleum gases, coal gases, natural gas, & natural gas liquids
Asphalt building materials
Petroleum & coal products, not elsewhere classified

Group 30 - Rubber and Miscellaneous Plastics Products

Rubber and Miscellaneous plastics products

Group 31 - Leather and Leather Products

Leather and leather products

Group 32 - Stone, Clay, Glass, and Concrete Products

Glass and glass products
Building cement
Structural clay products, including refractories
Lime
Cut stone and stone products
Miscellaneous nonmetallic mineral products

Group 33 - Primary Metal Products

Pig iron
Slag
Coke (coal & petroleum), petroleum pitches & asphalts, & naphtha & solvents
Iron & steel ingots, & other primary forms including blanks for tube & pipe, & sponge iron
Iron & steel bars, rods, angles, shapes & sections, including sheet piling
Iron and steel plates and sheets
Iron and steel pipe and tube
Ferroalloys
Primary iron & steel products, not elsewhere classified, including castings in the rough
Nonferrous metals primary smelter products, basic shapes, wire, castings & forgings, except copper, lead, zinc & aluminum
Copper & copper alloys, whether or not refined, unworked
Lead and zinc including alloys, unworked
Aluminum and aluminum alloys, unworked

Group 34 - Fabricated Metal Products, Except Ordnance, Machinery, and Transportation Equipment

Fabricated metal products, except ordnance, machinery, and transportation equipment

Group 35 - Machinery, Except Electrical

Machinery, except electrical

Group 36 - Electrical Machinery, Equipment and Supplies

Electrical machinery, equipment and supplies

Group 37 - Transportation Equipment

Motor vehicles, parts and equipment
Aircraft and parts
Ships and boats
Miscellaneous transportation equipment

Group 38 - Instruments, Photographic & Optical Goods, Watches & Clocks

Instruments, photographic and optical goods, watches and clocks

Group 39 - Miscellaneous Products of Manufacturing

Miscellaneous products of manufacturing

Group 40 - Waste and Scrap Materials

Iron and steel scrap
Nonferrous metal scrap
Textile waste, scrap, and sweepings
Paper waste and scrap
Waste and scrap, not elsewhere classied

Group 41 - Special Items

Water
Miscellaneous shipments not identifiable by commodity
LCL freight
Materials used in waterway improvement, government materials

Department of Defense controlled cargo and special category items

APPENDIX B

TABULATED LIST OF ITEMS CLASSIFIED INTO DRY BULK, LIQUID BULK, CONTAINERIZED, NON-CONTAINERIZED, SPECIAL HANDLING

ENERGY SOURCES: COAL, CRUDE PETROLEUM, PETROLEUM & COAL PRODUCTS

Dry Bulk

Coal and lignite
Coke including petroleum coke

Liquid Bulk

Gasoline, including natural gasoline
Jet fuel
kerosene
Distillate fuel oil
Residual fuel oil
Lubricating oils and greases
Crude petroleum

Non-Containerized

Petroleum and coal products nec
Coke (coal and petroleum) petroleum pitches
Crude products from coal tar, petroleum, etc.

COMMODITIES $\geq$ 100,000

Dry Bulk

Corn
Wheat
Soybeans
Iron ores and concentrates
Bauxite and other aluminum ores and concentrates
Manganese ores and concentrates
Nonferrous metal ores and concentrates, nec
Limestone flux and calcareous stone
Sand, gravel and crushed rock
Clay, ceramic and refractory material
Phosphate rock
Sulphur, dry
Nonmetallic minerals, except fuels, nec
Pulpwood, log
Fertilizers and fertilizer materials, nec
Building cement
Structural clay products including refractories
Slag
Iron and steel scrap
Textile waste, scrap and sweepings

Liquid Bulk

Molasses
Sodium hydroxide (caustic soda)
Alcohols
Sulphuric acid
Naptha, mineral spirits, solvents, nec
Asphalt, tar and pitches

Containerized

Fresh fruits and tree nuts (except bananas and plantains)
Meat, fresh, chilled or frozen
Meat and meat products prepared or preserved, including canned
Fish and fish products, including shellfish, prepared or preserved
Vegetables and preparation, canned, prepared or preserved
Fruits, fruit & vegetable juices, canned, prepared or preserved
Alcoholic beverages
Miscellaneous food products
Basic textile products except textile fibers
Apparel and other finished textile products including knitted
Plastic materials, regenerated cellulose, synthetic resins
Soap, detergents, cleaning preparations, perfumes, etc.
Rubber, miscellaneous plastics products
Leather and leather products
LCL freight
Department of Defense controlled cargo

Non-Containerized

Cotton, raw
Tobacco leaf
Hay and fodder
Live animals (livestock)
Animals and animal products nec
Miscellaneous farm products
Forest products nec
Fresh fish, except shellfish
Shellfish, except prepared or preserved
Menhaden
Marine shells, unmanufactured
Animal By-products nec
Wheat flour and semolina
Prepared animal feeds
Animal oils and fats nec
Ice
Logs
Rafted logs
Timber, posts, poles, piling, etc.
Dyes, organic pigment, dyeing and tanning material
Benzene, toluene, crude and commercially pure
Synthetic rubber
Synthetic (man made) fiber
Gum and wood chemicals
Insecticides, fungicides, pesticides
Asphalt building materials
Cut stone and stone products
Machinery except electrical

SPECIAL HANDLING

Dry Bulk

Salt
Sugar

Liquid Bulk

Sulphur, liquid

Non-Containerized

Motor vehicles, parts and equipment

COMMODITIES < 100,000

Dry Bulk

Barley and Rye
Oats
Rice
Sorghum grains
Flaxseed
Oilseeds nec
Copper ore and concentrates
Building stone unworked
Natural fertilizer materials nec
Gypsum, crude and plasters
Woodchips, staves, moldings and excelsiors
Nitrogenous fertilizer and fertilizer materials
Potassic fertilizer materials
Superphosphate
Lime
Nonferrous metal scrap
Paper waste and scrap
Waste and scrap nec

Liquid Bulk

Pulp

Containerized

Field crops nec
Fresh and frozen vegetables
Ordnance and accessories
Dairy products except dried milk and cream
Dried milk and cream
Groceries
Tobacco manufactures
Textile fibers nec
Veneer, plywood, other worked wood
Wood manufactures nec
Furniture and fixtures

Pulp, paper and paperboard products nec
Printed matter
Drugs, biological, pharmaceutical
Paints, varnishes, lacquers, etc.
Miscellaneous chemical products
Aircraft, parts
Miscellaneous transportation equipment
Instrument, photographic and optical goods
Coffee, green and roasted (including instant)
Cocoa beans
Glass and glass products
Electrical machinery, equipment and supplies
Miscellaneous product of manufacturing
Miscellaneous shipment not identifiable by commodity

Non-Containerized

Bananas and plantains
Crude rubber and allied gums
Tallow and lard
Grain-mill products nec
Vegetable oils, all grades margarine and shortening
Fuel wood, charcoal and wastes
Lumber
Standard newsprint paper
Paper and paperboard
Basic chemical and basic chemical products nec
Miscellaneous nonmetallic mineral products
Iron and steel ingots, other primary forms
Iron and steel bars, rods, angles, shapes, etc.
Iron and steel plates and sheets
Iron and steel pipe and tubes
Primary iron and steel products nec
Nonferrous metals, primary smalter products
Copper and copper alloys, refined, unworked
Fabricated metal products except ordnance, M/C and transportation equipment
Pig iron
Ferroalloys
Lead and zinc including alloys, unworked
Aluminum and aluminum alloys, unworked
Ships and boats
Materials used in waterway improvement (govt.)
Water

Special Handling

Radioactive and associated materials including wastes
Liquefied petroleum gases, coal gas, natural gas

APPENDIX C

DESCRIPTION AND DEFINITION OF HEADING

Terms for Kind of Traffic

The terms applied to the kinds of traffic as used in the study are explained as follows:

PERTAINING TO PORTS:

Imports and Exports:- These terms apply to traffic between the United States and foreign ports, including the Canal Zone.

Coastwise Receipts and Shipments:- These terms apply to domestic traffic receiving a carriage over the ocean, or the Gulf of Mexico, e.g., New Orleans to Baltimore, New York to Puerto Rico. Traffic between Great Lakes ports and seacoast ports, when having a carriage over the ocean, is also termed 'coastwise'. The Chesapeake Bay and Puget Sound are internal bodies of water; therefore confined to these areas traffic is termed 'internal' rather than 'coastwise'.

Internal Receipts and Shipments:- These terms apply to traffic between ports or landings wherein the entire movement takes place on inland waterways. Also termed as internal are movements involving carriage on both inland waterways and waters of the Great Lakes; inland movements that cross short stretches of open waters that link inland systems; marine products, sand and gravel taken directly from beds of the oceans, the Gulf of Mexico and important arms thereof; and movements between off-shore installations and inland waterways.

Local:- Movements of freight within the confines of a port whether the port has only one or several arms or channels, except car ferry and general ferry, are termed 'local'. The term is also applied to marine products and gravel taken directly from the Great Lakes.

APPENDIX D

TONNAGE VALUE FOR FOREIGN AND COASTWISE TRADE OF THE NINE PORTS BY METHOD OF HANDLING
(short tons)

DRY BULK CARGO

Port	Total*	FOREIGN Import	FOREIGN Export	COASTWISE Receipt	COASTWISE Shipment
Portland	29,925	29,925	-	-	-
Boston	1,203,072	180,696	606,925	262,211	153,240
Providence R. & Harbor	375,916	120,011	169,911	187,864	6,140
New Haven Harbor	560,757	220,310	293,797	45,175	1,475
New York	31,289,135	1,716,690	2,070,312	4,048,429	2,172,832
Delaware R.	15,525,407	13,701,034	1,146,173	33,920	135
Baltimore	24,693,708	12,368,490	3,487,921	359,373	71,042
Hampton Roads	46,594,174	1,084,077	38,799,200	215,226	2,544,380
Jackson-ville	2,402,039	1,206,595	1,055,997	31,341	97,780

LIQUID BULK CARGO

Port	Total*	FOREIGN Import	FOREIGN Export	COASTWISE Receipt	COASTWISE Shipment
Portland	27,733,102	22,197,393	-	3,921,353	1,030,139
Boston	22,236,422	7,795,018	1,468	11,193,495	1,831,331
Providence R. & Harbor	9,541,035	1,981,520	-	5,995,314	716,234
New Haven Harbor	9,132,941	1,987,683	-	5,958,368	1,025,202
New York	118,391,739	38,235,226	121,016	22,636,928	17,017,001
Delaware R.	73,172,132	36,274,819	433,448	14,317,856	4,819,060
Baltimore	12,201,916	4,258,940	9,227	2,574,007	125,000
Hampton Roads	9,920,985	3,986,385	40,172	1,346,722	43,007
Jackson-ville	7,410,001	2,705,538	41,262	3,318,061	24,374

*Total includes internal and local.

CONTAINERIZED CARGO

Port	Total*	FOREIGN		COASTWISE	
		Import	Export	Receipt	Shipment
Portland	27,308	4,988	33	9,676	12,239
Boston	208,495	184,123	13,751	10,206	70
Providence	4,374	2,069	1,811	30	464
New Haven	15,344	926	121	14,297	-
New York	8,095,300	3,640,445	1,350,786	731,254	1,056,716
Delaware R.	890,114	643,157	166,093	15,124	7,144
Baltimore	744,960	272,381	188,330	19,906	121,502
Hampton Roads	613,690	322,635	206,175	1,338	6,364
Jacksonville	534,868	138,424	16,764	139,303	238,491

NON-CONTAINERIZED CARGO

Port	Total*	FOREIGN		COASTWISE	
		Import	Export	Receipt	Shipment
Portland	41,485	8,176	19	12,855	160
Boston	488,409	386,466	59,731	18,316	695
Providence	93,605	85,817	271	7,428	-
New Haven	391,993	123,754	450	253,126	13,426
New York	10,835,022	5,027,900	2,531,033	1,080,967	674,517
Delaware R.	3,987,718	1,611,354	915,380	616,977	118,376
Baltimore	4,933,095	1,385,796	2,176,431	187,559	906,771
Hampton Roads	1,407,220	356,224	790,202	34,085	48,057
Jacksonville	916,085	360,506	262,108	45,740	107,864

SPECIAL HANDLING

Port	Total*	FOREIGN		COASTWISE	
		Import	Export	Receipt	Shipment
Portland	32	-	32	-	-
Boston	682,348	640,674	265	41,409	-
Providence	139,021	139,021	-	-	-
New Haven	391,993	123,754	450	253,126	-
New York	2,632,809	1,640,445	344,201	383,778	86,459
Delaware R.	1,010,065	804,162	61,055	78,326	33
Baltimore	1,343,539	1,077,883	77,906	157,020	1,139
Hampton Roads	448,309	43,215	8,553	141,839	401
Jacksonville	147,787	83,668	1,921	54,390	7,806

*Total includes internal and local.

CHAPTER II

CODING AND PREDICTING COMMODITY FLOWS

A recent study has developed the Department of Transportation Transoceanic classification code (DOTTO) to improve the compilation of trade data and prediction of U.S. commerce.[1] The study performed forecasts for 1970, 1975, and 1980 of the shipping weights of the approximately 200 commodities specified in the DOTTO code, and for the 54 top-ranking U.S. trading partners. These 54 countries account for more than 95% of U.S. trade. The shipping weights are also predicted for 21 broad groups of commodities having roughly similar transport characteristics.

Data Base on Foreign Trade Statistics

There are essentially two data sources that can provide foreign trade statistics on U.S. imports and exports on a detailed commodity basis. The first source is the U.S. Census Bureau which compiles U.S. trade data from reports furnished to it by the U.S. Customs Bureau. These statistics are designed to serve the needs of a wide range of users. They therefore include a variety of data presented in many different arrangements and are released in the form of reports, machine tabulations, and magnetic tapes. The second source is the International Trade Statistics Center of the Statistical Office of the United Nations. This office, on special order, supplies magnetic tapes, starting with the year 1962, that contain the trade flows of most of the world's countries. The trade flows are given in the SITC code at the four-digit level in terms of value and quantity shipped. The basic United Nations sources for these data are the countries themselves. Thus, the U.S. trade flows are provided to the United Nations by the U.S. Census Bureau. The United Nations then converts these data into the SITC code. In the creation of the DOTTO code, Census Bureau data were selected as the basic data source. One reason for this choice was that, unlike the Census Bureau data, United Nations magnetic tapes did not contain shipping weight information for all commodities but instead dealt in units of quantity, such as barrels, yards, hogsheads, etc.

Basic Commodity Codes

Basically, there are four commodity classification systems with which the DOTTO code is concerned. Several commodity codes are derived from one or another of these. The first system is the Tariff Schedules of the United States, Annotated (TSUSA), which is used to describe imports into the United

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1. Transoceanic Cargo Study, by Planning Research Corporation, Los Angeles, California, for the U.S. Department of Transportation, Asst. Secretary for Policy and International Affairs, Office of Systems Analysis and Information, Washington, D.C., March 1971.

States in reports to the Customs Bureau. The Customs Bureau transmits its data to the Census Bureau, which then processes them and converts them to other codes. At present, and in recent years, the Census reports have used the Schedule A (Revised) code, which is an aggregation of the 10,000 TSUSA items into 2,200 items. Both codes use seven digits per item.

The second system, a seven-digit code, is that used in preparing Shipper's Export Declarations for submission to Customs, and is called Schedule B. These data are also transmitted to the Census Bureau, which reports them in the Schedule B code.

The third system is the Standard International Trade Classification, Revised (SITC) code used by the United Nations to report international trade statistics. It is a five-digit code, based on the classification scheme of the Brussels Tariff Nomenclature (BTN).

The SIC industry code is the fourth system of interest. Several commodity codes besides the eight-character product code are based on it. Some of them are described below.

Major revisions were published of Schedule A in 1964, and of Schedule B in 1965. The object of the revisions was to create codes that, at least up to three digits, coincided with the SITC code so that U.S. trade statistics could be compared readily with foreign statistics. A concomitant objective of the revision of Schedule B was to make it also compatible with the SIC-based (Standard Industrial Classification) product code used by the Census Bureau for presenting data on domestic output. The latter is not the same as the SIC industry code, which is a four-digit code used to classify industries and industrial establishments. The SIC-based product code is, as its designation implies, a code used to classify commodities derived from the SIC industry code. It is an eight-character code; the fifth and sixth characters may be alphabetic or numeric, the others are numeric.

It is not possible to construct an exact concordance between any pair of the four systems. However, it has been necessary to publish tables of correspondences among all of them. In relating TSUSA classifications to SITC classifications, for example, the Census Bureau committee which did the work found that in many cases a group (of one or more items) in one code did not match exactly any group that it was possible to construct in the other code. Thus, many assignments had to be made on the basis of best judgment, usually taking into account what was the dominant commodity in overlapping groups. Any user of the tables of correspondence between TSUSA and SITC who must determine the exact details of a particular relationship may have to consult the United States Tariff Commission for an authoritative statement. Since the adjustments usually involve only the fourth and fifth digits of SITC and the fourth and higher order digits of the TSUSA and SIC product codes, and since the Census tape files used in connection with the DOTTO code aggregate to three- and four-digit derivative codes (S, T, W, A, B), this report need not be concerned with the reconciliation of differences in the fine detail of the basic codes. However, it is necessary to reconcile precisely the sort of discrepancies just described in converting tonnage and value statistics from one of the derivative codes to another.

Derivative Commodity Codes

There has been a considerable evolution in the commodity codes used since 1963. A brief description of the codes follows.

1. Schedule T, 1963 edition, used for 1963-1964 imports. This three-digit code is an aggregation into 169 items of the 10,000 items of the seven-digit TSUSA code. Schedule T is almost identical to Schedule S, the CCSS, and old Corps of Engineers codes. TSUSA itself was introduced in 1963, replacing the 1960 version of the seven-digit Schedule A code. An earlier (1960) edition of Schedule T was an aggregation into 168 items of the 5,000 items of the old Schedule A, which also listed concordances of Schedule T with the U.S. Import Duties Annotated for Statistical Reporting (USIDA) code.

2. Schedule S, 1962 edition, used for 1963-1964 exports. This three-digit code is an aggregation into 199 items of the 2,500 items of the 1958 edition of Schedule B, a five-digit code.

3. Schedule W, 1965 edition, changes issued in 1966, used for 1965-1966 imports and exports. This three-digit code is an aggregation into 280 items of the revised versions of Schedules A (1964 edition, 2,200 items, 7 digits) and B (1965 edition, 3,600 items, 7 digits). Since the revised Schedule A is based on the TSUSA code, a concordance of Schedule W with TSUSA is provided.

4. Schedule A, 1964 edition, revised 1965, used for 1967-1968 imports. Although the complete code uses seven digits, the taped summary statistics have been aggregated by the Census Bureau to the four-digit level. The code is hierarchal, aggregating at the (n+1) level results in a summary of a related class of commodities at the nth level. For example, 671.2 (pig iron, including cast iron) and 671.4 (ferromanganese) are included in 671 (pig iron, etc., and ferroalloys).

5. Schedule B, 1965 edition, revisions added 1968 and 1969, used for 1967-1968 exports. As in the case of Schedule A, the complete code uses seven digits, but the summary statistics have been aggregated to the four-digit level.

Trends in the Use of Codes

As was noted, statistics disseminated by the Census Bureau are collected originally by the Customs Bureau, and commodities must be reported in codes, like TSUSA and Schedule B, that satisfy the tariff collection and export control functions of the U.S. Government. At the same time, there is a firm wish to make U.S. statistics compatible with international statistics reported in the SITC code. Schedules A and B have been designed to satisfy these constraints, and there is a reasonable presumption that there will not be another major change in the commodity codes used by the Census Bureau for some years. Consequently, procedures have been worked out for converting from Schedules S, T, and W to A, B, and the DOTTO code that were mentioned previously. Subsequent minor changes can be made easily. It will also be possible to convert from A and B to the SIC-based product code, which is something that DOT has expressed some interest in doing. It should be noted, however, that precisely the same problems were encountered in making a concordance between A (through TSUSA) and B to the SIC-based product code as to the SITC code, and the same judgmental procedures were applied.

Other Commodity Codes

1. Standard Transportation Commodity Code (STCC), Association of American Railroads, 1967. This seven-digit code is based on the SIC industry code.

2. Commodity Classification for Transportation Statistics (CCTS). This five-digit code was developed for the Census of Transportation. There is a concordance with the SIC industry code. The code is identical with the STCC up to its five-digit level.

3. Corps of Engineers (Department of the Army) Codes. For some years prior to 1965 the Corps code, with some additions, used the Commodity Classification for Shipping Statistics (CCSS), which is a three-digit code based on the SIC classification. There is a concordance with the (old) 1958 five-digit B code and also with the S and T codes. Beginning with 1965, a new four-digit CCSS code, also based on the SIC, has been used. The old and new codes differ from each other and from the CCTS and the eight-digit, SIC-based product code.

Table II-1 summarizes the characteristics of the principal codes.

Formulation of the DOTTO Commodity Codes

Histories of value and shipping weight of U.S. waterborne foreign trade shipments (imports and exports), both by commodity and by country, are readily available on magnetic tape for the years 1963 through 1968. These tapes are compiled by the Census Bureau as SA 305, for annual U.S. Waterborne Imports (1963 through 1968). The format of these tapes is shown in Table II-2, and it is evident that the tapes contain greater detail than necessary for obtaining values and shipping weights of shipments by country and by commodity. In order to reduce the superfluous

TABLE II-1

Characteristics of Principal Codes

Code Name	Import/ Export	Code Format	No. of Items (Approximate)	Code(s) from which derived
TSUSA	I	XXX.XXXX	10,000	-
SITC	I/E	XXXXX	1,312	-
SIC	-	XXXX	416	-
Schedule T	I	XXX	168	TSUSA,CCSS
Schedule S	E	XXX	199	B(1958 ed.)
Schedule W	I/E	XXX	280	SITC,A(1964), B(1965)
Schedule A(1964)	I	XXX.XXXX	2,200	SITC,TSUSA
Schedule B(1965)	E	XXX.XXXX	3,600	SITC
Sched. A Subgrps. for SA305/305-IT	I	XXX.X	556	Schedule A
Sched. B Subgrps. for SA705/705-IT	E	XXX.X	557	Schedule B
SIC-based prod. code	-	XXXXAA XX	2,000	SIC

TABLE II-2

FORMAT OF ANNUAL WATERBORNE FOREIGN TRADE TAPE

COLUMNS

1	2	3-4	5-6	7-11	12-15	16-18	19-21	21-24	25-36	37-48	49-72	73-96	97-120
Identification (1)	Type (2)	Customs District	Port	Foreign Port	Commodity (3)	Country	In Transit Commodity	Trade Area	Value	Shipping Weight	Blank	Foreign Port Alpha	Commodity Alpha

Notes: (1) Identification Codes:
- 1 = exports
- 2 = exports in transit
- 6 = imports
- 7 = imports in transit

(2) Type Codes:
- 1 = liner
- 4 = tanker
- 5 = tramp

(3) Commodity Codes:
- 1963 and 1964 - schedule S for exports and schedule T for imports
- 1965 and 1966 = schedule W for exports and imports
- 1967 and 1968 = schedule B for exports and schedule A for imports

(4) Country Code:
- All years = schedule C

detail and to reduce the number of tape reels, it was necessary first to sort and edit the tapes by country and by commodity, and then to aggregate the value and shipping weight of tape records pertaining to each country-commodity pair for each year for both imports and exports.

Thus, a tape was created containing, for each year and for both imports and exports, the value and shipping weight for each country-commodity pair. The next step was to merge these tapes to construct the six-year history (1963 to 1968) of values and shipping weights for each country-commodity pair. This required that the commodity codes for each of the years be in a consistent commodity code classification. Unfortunately, this was not the case; the commodity classifications were as follows:

Year	Exports	Imports
1963	Three-digit Schedule S	Three-digit Schedule T
1964	Three-digit Schedule S	Three-digit Schedule T
1965	Three-digit Schedule W	Three-digit Schedule W
1966	Three-digit Schedule W	Three-digit Schedule W
1967	Four-digit Schedule B	Four-digit Schedule A
1968	Four-digit Schedule B	Four-digit Schedule A

Through a variety of methods the data for years 1963-1968 were converted to the DOTTO code. Although some inconsistencies occurred in the conversion to the DOTTO code, these were felt to appear in only a small minority of the cases. In future years the effect of any inconsistencies will gradually disappear with the new data which will be compiled in a standard manner.

The DOTTO code enabled the construction of over 16,000 time series describing U.S. foreign trade. A sample time series is shown in Table II-3. The great majority of the time series were smooth enough to allow trend extrapolation. Modifications of linear extrapolation were devised to handle the small portion accounting for less than 5 percent of the total shipping weight involved which were too irregular to exhibit a clear trend.

The basic trend analysis technique applied was exponential smoothing. This technique has the advantage that it is readily computerized. It is quite efficient in its computer storage requirements enabling forecasts to be made by medium power computers, such as the IBM 360/40. In addition, this technique allows weighting of the later years in the time series. Thus, older years in the time series are discounted in favor of more recent years. This has an advantage since older data in the time series are more likely to contain errors due to imperfect commodity classification. An additional advantage is that, as

TABLE II-3

History of U.S. Exports

351 Brazil	Year	Value	Shipweight	%	Alpha	Temp.	Mean	AAGR
643 Standard Newsprint Paper	1963	255212.	5018707.					
	1964	187284.	3148779.					
	1965	105992.	1865303.					
	1966	82964.	1186807.					
	1967	292987.	5452927.					
	1968	1005772.	17120256.					
	1970	0.	18958992.					
	1975	0.	33720208.					
	1980	0.	48481440.	74.31	0.40	1	4632124.	0.10058039
644 Papr PFrbc Not Cut, Nec	1963	15331.	43217.					
	1964	115830.	591574.					
	1965	1778168.	8286886.					
	1966	2437026.	10420508.					
	1967	1801549.	5908005.					
	1968	4182728.	14732545.					
	1970	0.	18495952.					
	1975	0.	31689696.					
	1980	0.	44883440.	64.44	0.40	1	6663787.	0.14138937
651 Yarn, Textile Fibers Nec	1963	26890.	146288.					
	1964	32644.	188768.					
	1965	114901.	111260.					
	1966	251760.	437179.					
	1967	546172.	516574.					
	1968	1043199.	1424466.					
	1970	0.	1726669.					
	1975	0.	3120044.					
	1980	0.	4513419.	48.56	0.40	1	470755.	0.12741661
652 Fab Cot Wov Unc 10 Yd lg	1963	110146.	59738.					
	1964	120210.	81465.					
	1965	11640.	11754.					
	1966	11500.	7598.					
	1967	15478.	25251.					
	1968	94814.	91597.					
	1970	0.	76757.					
	1975	0.	110488.					
	1980	0.	144241.	86.61	0.40	1	46234.	-0.00502627
653 Wov Fab- Txtl EPr, Etc Nec	1964	29448.	121566.					
	1965	104278.	27415.					
	1966	69792.	77896.					
	1967	143381.	52291.					
	1968	233461.	138211.					
	1970	0.	132967.					
	1975	0.	191237.					
	1980	0.	249507.	53.99	0.40	1	83476.	0.04374477

TABLE II-3

History of U.S. Exports

351 Brazil	Year	Value	Shipweight	%	Alpha	Temp.	Mean	AAGR
Total	1963	347343156.	7025163730.					
	1964	362795922.	8394337845.					
	1965	299495179.	6170290886.					
	1966	506369458.	9180168053.					
	1967	478307325.	9316160038.					
	1968	583300674.	10310210410.					
	1970	0.	11447625258.		Sum of individual commodity forecasts			
	1975	0.	14711071605.					
	1980	0.	17974517951.					
	Forecast from Country History							
	1970	0.	11574951936.					
	1975	0.	15092596736.		Forecast of total shipping weight time series			
	1980	0.	18610245632.					

For Country 351 there were 195 Time Series

0.574 were stable	0.968 of shipweight of 1968
0.246 not stable	0.023 (same)
0.179 insufficient data	0.009 (same)

data on subsequent years develop, the forecasts can be updated and will be more responsive to changes in trend.

Transport Homogeneous Groups

DOTTO commodity classifications were further aggregated into Transport Homogeneous Groups (THGs). THGs represent an attempt to bring together DOTTO commodities which have roughly similar transportation characteristics. From the viewpoint of transoceanic transportation planning and programming, this grouping should prove more useful than the underlying detail. The aggregation carries with it the additional benefit of increasing the probability of forecast accuracy through the operation of the "law of large numbers" or through adding offsetting errors.

The 19 Transport Homogeneous Groups are set forth in Table II-4 along with mean densities and mean value per pound for both exports and imports. The grouping process involved three steps. First, the commodities in the DOTTO group were mapped into one of four major sets: bulk liquid, bulk dry, break-bulk, and container. The selection of container commodities was guided by a Port of New York Authority observation and analysis which identifies "prime" containerization commodities as well as "suitable." In this study, only the "prime" DOTTO commodities were identified for container. Thus, many of the break-bulk commodities may move by container in selected trades.

The second step consisted in grouping the commodities within each major set into subsets displaying roughly similar densities and value per shipping weight pound. This was done by graphical clustering.

The third step consisted in a qualitative analysis of the resulting clusters. The individual commodities were compared to ascertain if vastly different materials-handling techniques or packaging requirements were grouped in the same subset. This process resulted in additions to the density-specific value determined subgroups. The results, as seen in Table II-4, are six container, one bulk liquid, five dry bulk and seven break-bulk groups.

Forecasts of the Transport Homogeneous Groups

Because of the greatly reduced bulk resulting from the aggregation of the DOTTO commodities into Transport Homogeneous Groups (THG), it was possible to incorporate these forecasts into the report. Figures II-1 and II-2 show stack diagrams of the forecasts of the THG groups when aggregated into the major categories consisting of bulk, break-bulk, liquid bulk, and container. In interpreting these diagrams, it should be remembered that the "container" group contains the "prime" container commodities. Commodities that were considered "suitable" for container were left in the break-bulk group. It is thus quite possible that, over the forecast years, the commodity group marked "container" will be significantly augmented by commodities switching over from the break-bulk group.

TABLE II-4

Transport Homogeneous Commodity Groups

Group Number	Description	Density (lbs/ft^3)	Value Per Pound (in dollars) Exports	Imports
1	Container, Reefer	40	0.11	0.228
2	Container	40	0.25	0.219
3	Container	75	1.25	0.446
4	Container	20	1.07	0.793
5	Container	150	0.62	0.522
6	Container	15	7.02	1.989
8	Bulk Liquid	50	0.007	0.007
10	Dry Bulk	250	0.010	0.005
11	Dry Bulk	50	0.005	0.005
12	Dry Bulk, Perishable	50	0.024	0.027
14	Dry Bulk	200	0.087	0.007
16	Dry Bulk, Perishable	40	0.046	0.098
20	Break Bulk (Live Animals)	5	1.345	5.004
21	Break Bulk	200	0.078	0.049
22	Break Bulk	30	0.021	0.025
23	Break Bulk	30	0.086	0.059
24	Break Bulk	80	0.228	0.073
25	Break Bulk	30	0.097	0.220
26	Break Bulk	30	1.033	0.705

Fig. II-1: Forecasts of Major Commodity Group Exports

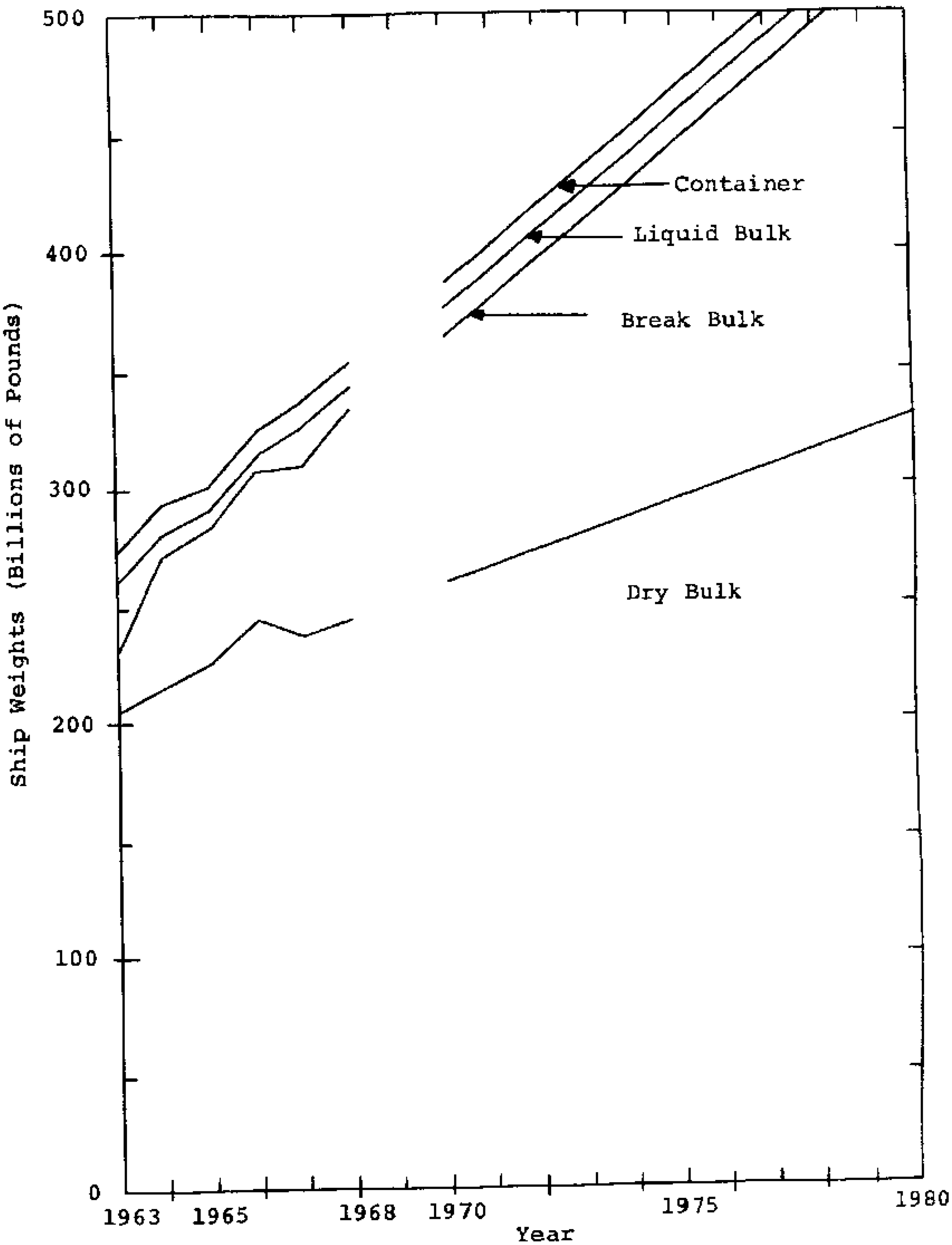
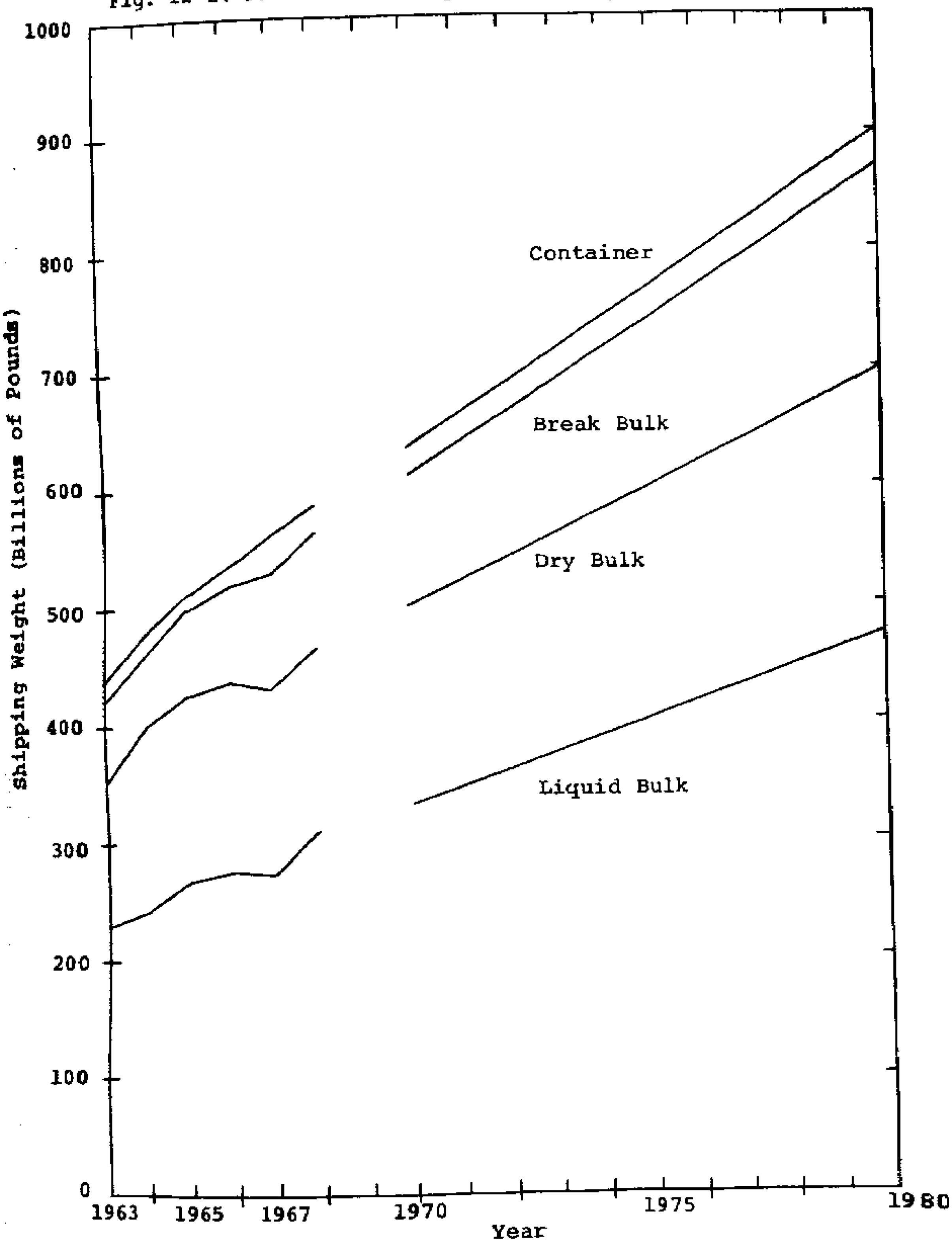


Fig. II-2: Forecasts of Major Commodity Group Imports



CHAPTER III

A SHIPPER SURVEY OF ORIGINS AND DESTINATIONS OF COMMODITY FLOW[1]

BACKGROUND

The material in the first two chapters was concerned with the movement of goods between a U.S. port and a foreign port, between a U.S. port and another U.S. port, or between the country of the United States and a foreign country. Research is currently underway to determine the inland origins and destination in the United States of certain international cargo movements. The Department of Transportation and the Department of the Army, Corps of Engineers, are jointly sponsoring a survey which is being undertaken by the Bureau of the Census. A smaller but similar survey of waterborne exports and imports during 1956 was sponsored jointly by the Corps of Engineers and Traffic Executive Association--Eastern Railroads and undertaken by the Bureau of the Census.

PURPOSE

This survey is being undertaken primarily to obtain new data on the domestic leg of U.S. foreign trade and to link those new facts with already available information on the international segment of "liner-type" commodity flows. The new data alone are expected to shed substantial light into a very dark statistical area--the origins, destinations, means of transport and distances involved in foreign trade movements within this country. The coupling of the domestic and the international legs of each shipment in the sample will create a new set of data for use in the systematic analysis of commodity flows between the interior of the United States and foreign countries.

A variety of analyses and applications for these data were discussed with the sponsors and other data users during the initial planning phase. Two illustrations may be helpful to indicate, at least partially, the range of applications. At one extreme, at least partially, the range of applications. At one extreme is a macroeconomic application involving the geographic location of the U.S. interior sources for exports and markets for imports, without regard to transportation, spatial relationship to ports or foreign areas. Near the other extreme would be the use of the sample as a basis for developing realistic input factors for computer models for estimating and analyzing selected commodity flows from (or to) selected interior areas, moving through specific customs districts (or ports) by desig-

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1. Information presented in this section was derived from the report, *Domestic and International Transportation of U.S. Foreign Trade: 1970*, sponsored by the U.S. Department of Transportation and the Department of the Army, October 1971.

nated foreign trade routes, by means of transport.

A substantial number of intermediate applications have been discussed, such as the size, location and characteristics of the "hinterland" of selected customs districts or coastal ranges; the differences between the "hinterlands" for some commodity groups as compared with others; the intermodal shares of traffic on the domestic segment of the international movement; the volume of domestic intermodal shares of traffic moving in international cargo containers compared with traffic not in containers; and the extent to which exporters acquire products at substantial distances from the point of production in the United States. The last-mentioned information would be useful as an indicator of potential change in the flows if the situation should change toward (or away from) exporting directly from the point of production, etc.

SCOPE OF SURVEY

The survey is designed to obtain data on "liner-type" commodities moving through ports within the 48 contiguous states, and transported on the international leg by vessel or air during 1970.

The term "liner-type" is rather vague, but seems to describe the general class of commodities better than possible alternative terms such as "non-bulk," "general cargo" or "merchandise" traffic. Actually the commodity scope is defined as including all items in U.S. foreign trade, except specified commodities. The major exceptions are wheat, corn, other unmilled grains, cotton, oilseeds and oil nuts, iron ores, nonferrous metal scrap, stone, sand and gravel, coal, coke and petroleum, and items "not classified by kind."

With respect to the geographic scope, all U.S. customs districts in the 48 contiguous states and and District of Columbia are included. Customs districts in Alaska, Hawaii, Puerto Rico and the Virgin Islands are not included.

With respect to means of transportation on the international leg, the specific inclusion of waterborne and airborne commerce has the net result of excluding land transport which is mainly rail and highway between the United States, Canada and Mexico. However, "liner-type" commodity flows by vessel and air to and from those two countries, as well as all others, remain within the scope of the survey.

SURVEY METHOD

The general concept of the survey method is relatively simple. It starts with a complete "universe" which consists of a listing of all in-scope exports and imports contained in the Census Bureau's base tapes used to tabulate and publish data on foreign trade. A probability sample of individual shipments is selected from that base tape, and a questionnaire is prepared for each shipment selected in the sample. Each questionnaire is then mailed (or delivered) to the exporter or importer, who is requested to supply the new facts that are not obtainable from information already on hand for that specific shipment.

The new facts supplied by the questionnaire are then coupled with the sampled data already obtained from the foreign trade base tape, plus some additional items derived from other sources to create a new computer record that contains the complete statistical detail (within the scope of the survey) for the specified shipment between the foreign area and the U.S. interior.

Since the probability of selection of each shipment is known (and is greater than zero), each of the new computer records is then expanded to its approximate "universe equivalent" level. Those expanded records then are used for tabulations that approximate the data that would have been obtained by a complete enumeration.

Further details regarding the survey method are interwoven in the discussion of the sample size and design in the next section and in the following sections concerning principal items of information.

SAMPLE SIZE AND DESIGN

A. General

The main function of a probability sample is to provide a basis for estimating the "universe" at substantially lower cost and reporting effort than would be involved in a complete enumeration. A secondary, but nevertheless important, function is to provide a basis for estimating the sampling variability[2] involved in using sample estimates in contrast to complete counts. The sample being used in this survey performs both of those functions.

As an indication of the reduction in survey costs and reporting effort by importers and exporters, it is worth noting (Tables III-1 and III-2) that the waterborne sample for the year consists of about 15,700 exports and about the same number of import shipments.[3] The airborne sample for the year consists of

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2. A total estimated from a sample would be expected to vary from the total that would be found by a complete count. That variance is due to the use of a sample, and is called "sampling variability."

3. A "shipment" for this purpose is defined as a "line" on an export declaration or an import entry document submitted by the exporter or importer and used for compiling foreign trade statistics.

6,800 exports and a similar number of imports to represent a universe of 1,370,000 and 720,000 exports and imports respectively. The samples contain less than one percent of the total number of shipments.

However, the objective of the survey is to obtain data on the weight and value of foreign trade--not the number of shipments. Since weight was considered to be more important than value as a measure of the waterborne volume, the shipments by vessel were selected proportionate to their weight, as discussed more fully below. Since the heavy shipments had a greater chance of being selected than smaller shipments, the sample contains a larger proportion of the "universe" weight than value--specifically, the sample contains 45 percent of the total weight of "liner-type" imports and 64 percent of the weight of exports, respectively.

On the other hand, the value of products was considered to be the primary measure of the volume by air. Consequently, the air shipments for the sample were selected proportionate to value, and the proportion of the "universe" value contained in the sample is larger than its counterpart in terms of weight. The air sample contains about 13 percent of the total value of both air imports and exports, but about 3 or 4 percent of the weight of air imports and exports.

Since the probability or chance of selecting each shipment in the sample is known, both the weight and value of vessel and air shipments can be expanded to their "universe equivalents" for tabulations. Estimates and sampling variability for both weight and value data also may be derived from the sample records.

B. "Target" Size of the Sample

The total sample "target" was set at about 42,000 shipments. That total was divided between waterborne and airborne traffic--about 30,000 shipments for vessel and 12,000 for air and then split equally between exports and imports. In brief, the "targets" were 15,000 shipments for waterborne exports, the same for waterborne imports, and 6,000 shipments for airborne exports and also for imports.

The actual rates used for drawing the sample were based on the 1969 foreign trade volume, coupled with a detailed analysis of the composition of the first quarter 1970 foreign trade documents. The actual sample for calendar 1970 quite closely approximated the "targets" as shown by Tables III-1 and III-2.

C. Stratification

Four primary strata are used, based on international transport and direction of flow:

Table III-1

Export "Universe"[1/] and Sample (Calendar Year 1970)

(Preliminary data subject to revision)

	Exports					
	Vessel			Air		
	Dollars (millions)	Pounds (millions)	Record Count	Dollars (millions)	Pounds (millions)	Record Count
Universe:						
1st Quarter	4,546	40,806	572,676	1,332	187	349,123
2nd Quarter	4,942	47,062	597,099	1,483	198	377,105
3rd Quarter	4,649	47,818	553,053	1,400	188	335,976
4th Quarter	4,775	43,204	521,834	1,499	191	310,841
Total 1970	18,912	178,890	2,244,662	5,714	764	1,373,045
Sample:						
1st Quarter	654	25,638	3,675	140	5.3	1,580
2nd Quarter	799	31,034	4,128	177	6.4	1,768
3rd Quarter	757	30,832	4,041	188	5.7	1,664
4th Quarter	683	27,655	3,825	221	7.2	1,813
Total 1970	2,893	115,159	15,669	726	24.6	6,825
Unexpanded Sample as % of Universe:						
1st Quarter	14.4	62.7	0.6	10.3	2.9	0.5
2nd Quarter	16.2	65.9	0.7	11.9	3.2	0.5
3rd Quarter	16.3	64.5	0.7	13.4	3.0	0.5
4th Quarter	14.3	64.0	0.7	14.7	3.8	0.6
Total 1970	15.3	64.4	0.7	12.7	3.2	0.5

1/ "Universe" is total within the commodity and area definition of the survey; not the total of all U.S. exports.

TABLE III-2

Import "Universe" * and Sample (Calendar Year 1970)

(Preliminary data subject to revision)

	Imports					
	Dollars (millions)	Vessel Pounds (millions)	Record Count	Dollars (millions)	Air Pounds (millions)	Record Count
Universe:						
1st Quarter	4,655	24,105	496,048	708	119	167,074
2nd Quarter	4,994	26,852	529,114	727	128	173,530
3rd Quarter	5,162	28,359	564,085	753	124	180,786
4th Quarter	5,345	30,726	540,464	822	142	198,939
Total 1970	20,156	110,042	2,129,753	3,010	513	720,329
Sample:						
1st Quarter	409	10,382	3,368	92	5.2	1,583
2nd Quarter	478	11,886	3,778	81	4.9	1,625
3rd Quarter	460	13,157	3,915	96	5.5	1,661
4th Quarter	542	14,283	4,320	118	5.9	1,776
Total 1970	1,889	49,708	15,381	387	21.5	6,645
Unexpanded Sample as % of Universe:						
1st Quarter	8.8	43.2	0.7	13.1	4.4	0.9
2nd Quarter	9.6	44.3	0.7	11.1	3.8	0.9
3rd Quarter	8.9	46.4	0.7	12.7	4.4	0.9
4th Quarter	10.1	46.5	0.8	14.4	4.2	0.9
Total 1970	9.4	45.2	0.7	12.9	4.2	0.9

* "Universe" is the total within the commodity and area definition of the survey--not the total of all U.S. imports.

(1) Waterborne--imports
(2) " --exports
(3) Airborne --imports
(4) " --exports

Each of those strata are treated as a separate and independent sample for most purposes, although the "universe estimates" for each can be combined with the others to estimate aggregates involving both air and vessel or exports and imports.

In addition to those four primary strata, the sample selection procedure involved additional stratification for the purpose of minimizing sampling variability, insofar as feasible. This additional stratification took the form of sequencing or "ordering" the universe file, but did not involve differential sampling rates as occurred in the four primary strata. The supplemental stratification within each of those four primary strata included the following sequencing: (a) month, (b) size of shipment, (c) commodity, (d) foreign country and (e) customs district.

Sampling Rates and "Universe Equivalents"

As mentioned earlier, the probability of selection of shipments by vessel is proportionate to the weight of the shipment. Every waterborne import weighing 4,000,000 pounds or more was retained in the sample. The 4-million-pound figure is called the "certainty level" in the table at the end of this section. The probability of selection of smaller imports is the ratio of the weight of the specific shipment to 6,000,000 pounds, known as the "sampling interval." For example, a shipment of 3 million pounds has a 3 million/6million probability of being selected or 1 chance in 2. Similarly, a 1,000 pound shipment has a chance of 1,000/6,000,000 or 1 in 6,000 of being selected.

With respect to "universe equivalents," all waterborne imports weighing over 4 million have a 1 in 1 chance and therefore are already at their "universe level" without expansion. The 3 million pound shipment illustrated above has a 1 in 2 chance of being drawn. Its "universe equivalent weight" is twice its actual weight, or 6 million pounds. Its "universe equivalent" value also is twice its actual value. Similarly, the 1,000-pound shipment's "universe equivalents" would be 6,000 times its actual weight and value.

The probability of selection of air shipments is proportionate to the value (rather than weight) of the shipment. Every air import valued at $250,000 or more is retained in the sample, and its probability of selection is 1 in 1 or "certainty." Lower-valued imports are selected proportionate to an interval of $450,000. For example, an import valued at $4,500 would have a 4,500/450,000 or 1 in 100 chance of being selected. Its "universe equivalents" would be 100 times its actual value and weight.

The following table presents the sampling rates for each of the four primary strata:

Primary Stratum	Certainty Level[1]	Sampling Interval[1]
Waterborne:		
Exports	6,000,000 pounds	8,000,000 pounds
Imports	4,000,000 pounds	6,000,000 pounds
Airborne:		
Exports	$250,000	$900,000
Imports	$250,000	$450,000

1. See text for explanation of use of these sampling parameters.

QUARTERLY TREND ANALYSIS OF UNIVERSE AND SAMPLE

A. Exports

The volume of exports behaved much as expected. Record counts (number of shipment lines) as well as universe value and weights generally peaked in the 2nd quarter for both air and vessel, as shown by Table III-1. When the "peak" 2nd quarter is omitted from consideration, the number of shipment lines declines for both air and vessel as the year progresses. The 4th quarter had 9 percent fewer vessel shipments and 11 percent fewer air shipment than the 1st quarter. However, the value and weight generally increased for all exports from the 1st to the 4th quarter, indicating the intra-year trend toward fewer but larger shipments in 1970 (both in terms of dollars and pounds).

Since the sample design employed fixed certainty cutoffs and sampling intervals in terms of weights and values, the larger shipment sizes in the later quarters resulted in more sampled lines even though the universe record or line count decreased. This was particularly true for air exports whose sample size in the 4th quarter was 15 percent larger than in the 1st quarter, although the universe number of shipment lines decreased 11 percent as indicated earlier. Larger shipment in the later quarters also resulted in more dollars and pounds in the sample (both in absolutes and in percent of the universe). The resulting gross total export sample size of 15,669 vessel and 6,825 air shipments very closely approximated the target sample size of 15,000 vessel and 6,000 air shipments.

B. Imports

Unlike exports, imports did not experience a 2nd quarter peak but increased in each successive quarter during 1970, as shown by Table III-2. This total increase amounted to 9 percent for the number of vessel and 19 percent for the number of air shipments when measuring the 1st quarter with the final quarter. Weight of vessel imports and value of air imports increased 28 percent and 16 percent respectively from the 1st to the 4th quarters. As with exports, the sample as a percent of the universe increased as the year progressed. Similarly, the record counts in the sample increased 28 percent and 12 percent for the number of vessel and air shipments in the sample. However, where in the case of exports the increasing quarterly sample sizes were the result of larger average shipments, the larger 4th quarter sample sizes for imports were the result of an increasing universe number of similar shipments. Although the sampling parameters were different for imports, they also were fixed. These parameters, as was the case with the export sample, yielded a slightly larger-than-target total sample (15,381 vessel and 6,645 air versus a target of 15,000 vessel and 6,000 air shipment lines).

C. Imports and Exports Compared

It is also interesting to note that air exports exceed air imports in total number, value and weight. Vessel exports similarly exceeded vessel imports in number and weight, but the reverse was found for value--the total value of vessel imports exceeded the total value of vessel exports. The average vessel export shipment was heavier (81,314 pounds) than the average vessel import (52,400 pounds) but valued less ($8,596 to $9,598). Although there were 52 percent fewer air import shipments as compared to air exports, the average air import slightly exceeded the average air export both in terms of value ($4,181 to $4,170) and pounds (712 to 588).

PROFILE OF UNIVERSE

A brief description of the anatomy of the foreign trade flows covered by this survey is useful as background information. These "profiles" (Tables III-3 to III-6) are based on special tabulations of the Bureau's basic foreign trade tapes which are complete counts of the "universe" represented by this survey. Although the underlying data are not new, the classifications and organization of items are unusual, and consequently the "profiles" shed new light on several aspects not previously covered by available data. Much of this "new light" doubtless confirms the impressions or "working knowledge" of experts in the foreign trade field. Perhaps some unexpected relationships have been found, but the major contribution probably is the development of specific data to replace nonquantifiable impressions.

The most striking differences--as expected--are between vessel and air movements, with generally moderate differences between export and import flows within each of the two international modes of transport. For example, large shipments generate the major portion of the tonnage moved internationally by water. In contrast, relatively small shipments are the primary tonnage-generators for air. However, it is worth noting that the aggregate of small shipments constitute more than half of the total value of commodity flows both by vessel and air as well as for imports and exports within each mode.

To illustrate that point, Table III-3 shows that 56.4 percent of the total tonnage of waterborne trade was accounted for by less than 6,000 large shipments, while the 2.2 million smaller shipments contributed only 43.6 percent of the total weight. However, on a value basis, the relative shares are reversed. The smallest shipment strata (under 100,000 pounds) accounted for 58.1 percent of the total value as compared with 10.6 percent by the largest shipment-size strata. A similar profile is shown by Table III-4 for waterborne imports.

In contrast, the air profiles (Tables III-5 and III-6) show that the bulk of air traffic is generated by shipments on the low end of the weight and value scale.

Another striking difference in the profiles is the value (per pound) of products transported by vessel as compared with air. Commodities shipped by vessel averaged 11 cents per pound for exports, and 18 cents per pound for imports. Those figures compared with $7.48 and $5.87 per pound for air exports and imports, respectively.

The progressions between shipment size-classes in the four profiles are affected to some extent by the fact that the classification of vessel shipments was based on weight in contrast to value for air shipments. However, there is a general progression from large to small shipments in all of the tables, as indicated by "average shipment size" in terms of weight and value in each of the tables.

With that background, it is interesting to note in Tables III-3 and III-4 that the value per pound of waterborne cargo--both exports and imports--is about 2 cents per pound for exceptionally large shipments (6,000,000 pounds or over) and the value-per-pound increases progressively with the decrease in size of shipment, ending with 65 cents per pound for export shipments of less than 100,000 pounds each and 53 cents per pound for imports in the same weight-size class. Clearly, the weight of the shipment is not the causal factor, but the progressions doubtless reflect differences in "commodity mixes" in the various weight strata. Those inverse progressions suggest that the lower value-per-pound commodities tend to be imported and exported in larger consignments than the higher value-per-pound commodities.

The reverse situation exists for air shipments, as shown by Tables III-5 and III-6, in which the size classification is based on total value of shipment. The value-per-pound of air exports was $44.45 for the largest shipment ($250,000 and over) and declined with a decrease in shipment size to $4.34 per pound for the smallest size class (under $10,000). A similar but steeper decline was found for air imports--from $79.17 per pound for the largest shipments to $4.03 for the smallest class shown in the tables. This direct correlation for air cargo between prod-

Table III-3

Profile of Waterborne Export Universe Annual 1970

Size of Shipments (thousand pounds)	Number of Shipments (actual)	Total Value ($ mil)	Total Weight (mil pounds)	Percent Distribution Value	Percent Distribution Weight	Average Shipment Size Value ($ thous)	Average Shipment Size Weight (thous lbs)	Value cents/lbs
6,000 lbs. and over	5,925	2,008	100,895	10.6	56.4	339	17,029	2
4,000 - 5,999 lbs	2,504	417	12,167	2.2	6.8	167	4,859	3
2,000 - 3,999 lbs	5,477	783	14,771	4.1	8.3	143	2,697	5
1,000 - 1,999 lbs	8,069	893	10,794	4.7	6.0	111	1,338	8
500 - 999 lbs	11,884	991	8,258	5.2	4.6	83	695	12
100 - 499 lbs	73,758	2,846	15,113	15.1	8.4	39	205	19
Under 100 lbs	2,137,045	10,974	16,892	58.1	9.5	5	8	65
TOTAL	2,244,662	18,912	178,890	100.0	100.0	8	80	11

Table III-4

Profile of Waterborne Import Universe Annual 1970

Size of Shipments (thousand pounds)	Number of Shipments (actual)	Total Value ($ mil)	Total Weight (mil pounds)	Percent Distribution		Average Shipment Size		Value cents/lbs
				Value	Weight	Value ($ thous)	Weight (thous lbs)	
6,000 lbs and over	2,408	648	33,775	3.2	30.7	269	13,860	2
4,000 - 5,999 lbs	1,390	280	6,740	1.4	6.1	201	4,849	4
2,000 - 3,999 lbs	3,870	698	10,682	3.5	9.7	180	2,760	7
1,000 - 1,999 lbs	6,713	1,158	8,975	5.7	8.2	173	1,337	13
500 - 999 lbs	12,205	1,406	8,434	7.0	7.7	115	691	17
100 - 499 lbs	97,229	4,170	19,181	20.7	17.4	43	197	22
Under 100 lbs	2,005,978	11,796	22,255	58.5	20.2	6	11	53
TOTAL	2,129,753	20,156	110,042	100.0	100.0	9	52	18

Table III-5

Profile of Airborne Export Universe Annual 1970

Value of Shipment (thousand dollars)	Number of Shipments (actual)	Total Value ($ mil)	Total Weight (mil pounds)	Percent Distribution		Average Shipment Size		
				Value	Weight	Value ($ thous)	Weight (thous lbs)	Value ($ per lb)
$250 and over	1,067	529	11.9	9.3	1.6	496	11.1	44.45
$100 - $249	3,695	540	23.0	9.5	3.0	146	6.2	23.48
$50 - $99	8,504	584	30.3	10.2	4.0	69	3.5	19.27
$25 - $49	20,578	705	51.8	12.3	6.8	34	2.5	13.61
$10 - $24	70,967	1,075	122.4	18.8	16.0	15	1.7	8.78
Under $10	1,268,234	2,281	525.0	39.9	68.8	2	.4	4.34
TOTAL	1,373,045	5,714	764.0	100.0	100.0	4	.5	7.48

Table III-6

Profile of Airborne Import Universe Annual 1970

Value of Shipment (thousand dollars)	Number of Shipments (actual)	Total Value ($ mil)	Total Weight (mil pounds)	Percent Distribution		Average Shipment Size		
				Value	Weight	Value ($ thous)	Weight (thous lbs)	Value ($ per lb)
$250 and over	389	190	2.4	6.3	.5	488	6.2	79.17
$100 - $249	1,697	248	12.4	8.2	2.4	146	7.3	20.00
$50 - $99	4,232	289	27.8	9.6	5.4	68	6.5	10.40
$25 - $49	11,218	381	47.2	12.8	9.2	34	4.2	8.07
$10 - $24	41,102	626	108.7	20.9	21.2	15	2.6	5.76
Under $10	661,691	1,268	314.7	42.2	61.3	2	.4	4.03
TOTAL	720,329	3,010	513.2	100.0	100.0	4	.4	5.87

uct value and size of shipment reflects differences in "commodity mix" in the various size classes. It seems to indicate a tendency for higher-valued products to be shipped in larger consignments than lower-valued commodities.

FIRST SIX MONTHS--1970

The broad outlines of the distribution of the "universe" by customs regions and commodity for the first six months of 1970 are shown in Table III-7.

The New York region handles roughly half of the total air exports and imports (both value and weight), and nearly 40 percent of the total value of waterborne trade. However, on a weight basis, the New York region handles only 7.5 percent and 18.3 percent of waterborne exports and imports, respectively. The San Francisco region presents a striking contrast. Its relative share of air traffic on a value basis is about twice its share on a weight basis, as compared with rough equality in the New York region. San Francisco's relative shares of value and weight of waterborne trade are the reverse of the New York situation. San Francisco has a larger share of weight than value in waterborne trade. In fact, it is the leading region in the United States for vessel exports on a weight basis.

These observations point up two aspects that should be emphasized. First, the total trade covered by the survey consists of "liner-type" commodities as specifically defined in an earlier section under the general subject of "Universe." Second, variations in "commodity mix" need to be taken into consideration when comparing one port or region with another.

QUESTIONNAIRES

All of the new information requested from exporters and importers is being obtained by Forms TS-501, Export Questionnaire, and TS-502, Import Questionnaire, as shown in Exhibits III-1 and III-2. This new information will be combined with other facts obtained from already available records--including the foreign trade base data tapes--to create a "combined shipment record" covering the movement between the interior origin or destination in the United States and the foreign area.

An "Export Questionnaire" (Form TS-501) is prepared for each export shipment in the sample. A photocopy of the export declaration submitted by the exporter at the time of exportation is attached to the questionnaire to clearly identify the precise transaction and to help the exporter find the records or recall the situation to answer the questions with respect to that shipment.

Item 1 of the questionnaire is designed to locate the interior point at which the exporter acquired the merchandise or assumed responsibility for it, and how it was moved within the

Table III-7

Distribution of Weight and Value by Customs Region and Commodity

First Six Months - 1970 - Gross Sample Expanded to Universe -- Preliminary 1/

Customs Region	Imports				Exports			
	Vessel		Air		Vessel		Air	
	Value	Weight	Value	Weight	Value	Weight	Value	Weight
Boston	4.9	6.5	7.8	15.3	1.0	1.9	3.4	3.4
New York	39.2	18.3	47.5	46.0	38.6	7.5	57.1	51.2
Baltimore	14.1	15.5	5.0	2.5	17.1	9.5	2.6	1.3
Miami	7.1	12.1	5.6	12.2	5.8	6.7	6.1	15.1
New Orleans	6.0	10.5	1.0	1.5	11.3	19.1	.5	1.3
Houston	4.4	7.1	3.2	1.2	8.4	14.2	1.6	1.9
Los Angeles	9.5	8.0	8.9	6.4	4.2	11.4	11.4	7.1
San Francisco	9.3	14.3	7.1	3.0	11.6	25.5	7.6	4.7
Chicago	5.5	7.7	13.9	11.9	2.0	4.2	9.7	14.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Commodities								
Food and animals	17.2	15.1	1.1	9.2	6.5	10.8	.6	4.8
Beverages and tobacco..	3.2	1.7	.3	.4	2.7	.4	.1	.5
Crude materials-ined...	5.7	21.1	2.7	1.2	11.4	38.1	1.7	1.9
Mineral fuels, lub.....	.1	2.4	--	--	1.6	10.0	--	.8
Oils & fats-animals,veg	.7	.9	--	--	2.1	2.3	--	--
Chemicals	5.2	11.0	4.0	1.5	15.7	16.8	5.9	6.3
Mfg. goods-by materials	26.6	38.9	13.8	10.4	18.7	18.4	6.6	20.5
Machinery & equipment..	26.3	6.5	34.9	36.8	35.4	2.9	68.2	47.8
Misc. mfg. articles....	15.0	2.4	43.2	40.5	5.9	.3	16.9	17.4
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1/ Includes data for returns received as of August 15, 1971. See Table 8 for Response Analysis of first 6-months returns.

EXHIBIT III-1

EXPORT QUESTIONNAIRE

O.M.B. No. 41-S70051, Approval Expires December 31, 19[illegible]

FORM TS-501
(7-21-70)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
ACTING AS COLLECTING AGENT FOR THE
OFFICE OF THE SECRETARY
U.S. DEPARTMENT OF TRANSPORTATION
AND CORPS OF ENGINEERS,
DEPARTMENT OF THE ARMY

SURVEY OF DOMESTIC MOVEMENT OF U.S. IMPORTS AND EXPORTS

EXPORT QUESTIONNAIRE

NOTICE – All information which would permit identification of the individual will be held in strict confidence, will be used only by persons engaged in and for the purposes of the survey, and will not be disclosed or released to others for any purposes. The law also provides that copies retained in your files are immune from legal process.

In correspondence pertaining to this report please refer to this number

Please return this form within 20 days in the enclosed preaddressed, postage-paid envelope to:
Bureau of the Census
Washington, D.C. 20233

Gentlemen:

The Bureau of the Census is conducting a survey periodically to gather statistical information on the 1970 domestic movement of imports and exports. This information is being collected for the U.S. Department of Transportation and the Corps of Engineers, Department of the Army. The questionnaire on the reverse side of this letter is designed to obtain data on goods leaving the country – origin within the United States, domestic means of transport, and containerization.

Because the survey involves a scientific sample of items selected from export documents filed with the Collector of Customs, **some companies will have items selected each period and will receive one or more of these forms each period while others may be requested to report less often.** It is important that we receive a complete and prompt response from each exporter. Please complete the questionnaire for the item on the enclosed copy of Form 7525-V, Shipper's Export Declaration. If more than one item is on the document, the specific item referred to is circled.

Please return the questionnaire within 20 days in the enclosed envelope, which does not require postage. A file copy is enclosed for your records should you wish to have it.

All information will be held in strict confidence, will be used for statistical purposes only, and will not be disclosed or released to others for any purposes. Your cooperation will be greatly appreciated.

Sincerely,

George H. Brown

GEORGE H. BROWN
Director
Bureau of the Census

3 Enclosures

IF YOU RECEIVE MORE THAN ONE QUESTIONNAIRE, PLEASE COMPLETE EACH QUESTIONNAIRE RECEIVED

USCOMM-DC

Please continue on reverse

EXHIBIT III-1 (Continued)

EXPORT QUESTIONNAIRE

All questions refer to the item on the attached copy of Form 7525-V Shipper's Export Declaration. If more than one item is on the document, please complete the questions only for the item circled on the copy.

Item 1 WHERE MERCHANDISE WAS ACQUIRED

Where did your firm acquire the merchandise (or assume responsibility for it) in the form in which it was exported? How did it move to the Port of Export?

If the merchandise was acquired in more than one city, enter in columns (a) and (b) the city and State where each portion was acquired.

Complete one line for that part of the merchandise, if any, that was acquired in the Port of Export.

If acquired at more than one location, enter in column (c) the percentage (by value) of the total acquired at each location.

If more than one means of transport was used – Check the means for the longest haul.

If "freight forwarder" was used – Check the major means of transport if known. If you do not know the means of transport used by the freight forwarder – Check "Other."

Check "Other" for parcel post, railway express, messenger service, etc.

Line No.	Where acquired or responsibility assumed: City (a)	State (b)	Percent of total value (c)	Major means of transport in the U.S. *CHECK ONLY ONE MEANS*: Rail (d)	Truck (e)	Air (f)	Inland water including Great Lakes (g)	Other (h)	CENSUS USE ONLY
1				1	2	3	4	5	
2				1	2	3	4	5	
3				1	2	3	4	5	
4				1	2	3	4	5	
5				1	2	3	4	5	
6				1	2	3	4	5	
7				1	2	3	4	5	

Item 2 CONTAINER – INTERNATIONAL MOVEMENT

Did the merchandise move in a REUSABLE CARGO container(s) from the U.S. Port of Export to the foreign port of unloading?

Check ONE box →

1 ☐ Yes – *Go to item 3*
2 ☐ No – *Skip to item 4 for water shipments. For air shipments skip to item 5*
3 ☐ Don't know – *Skip to item 5*

Item 3 CONTAINER – DOMESTIC MOVEMENT
Answer only if "Yes" checked in item 2

Did the merchandise move in the SAME container(s) as in item 2 from where the merchandise was acquired to the U.S. Port of Export?

Check ONE box →

1 ☐ Yes
2 ☐ No
3 ☐ Don't know
} *Skip to item 5*

Item 4 PACKAGING OTHER THAN CONTAINER
For international water shipments only

For merchandise not shipped in a REUSABLE CARGO container, how was the shipment packaged for the ocean voyage?

Check ONE box →

1 ☐ Palletized
2 ☐ Individual lots and cases or barrels
3 ☐ Ship's tank
4 ☐ Bulk
5 ☐ Don't know

Item 5 WHERE MERCHANDISE WAS PRODUCED

Where was the merchandise produced (grown, mined, manufactured, or assembled)?

If more than one location, enter city where the major portion was produced.

City

State

☐ Don't know

CENSUS USE ONLY

FORM TS-901 (7-31-70)

U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 461-217

USCOMM-DC

EXHIBIT III-2

IMPORT QUESTIONNAIRE

O.M.B. No. 041-S70051, Approval Expires December 31, 197[illegible]

FORM TS-502

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
ACTING AS COLLECTING AGENT FOR THE
OFFICE OF THE SECRETARY
U.S. DEPARTMENT OF TRANSPORTATION
AND CORPS OF ENGINEERS,
DEPARTMENT OF THE ARMY

SURVEY OF DOMESTIC MOVEMENT OF U.S. IMPORTS AND EXPORTS

IMPORT QUESTIONNAIRE

NOTICE – All information which would permit identification of the individual will [illegible] ... will be used only by persons engaged in [illegible] for the purposes of the survey, and will not be disclosed or released to others for any purposes. The law also provides that copies retained in your files are immune from legal process.

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The Bureau of the Census is conducting a survey periodically to gather statistical information on the 1970 domestic movement of imports and exports. This information is being collected for the U.S. Department of Transportation and the Corps of Engineers, Department of the Army. The questionnaire on the reverse side of this letter is designed to obtain data on goods entering the country – destinations within the United States, domestic means of transport, and containerization.

Because the survey involves a scientific sample of items selected from import documents filed with the Collector of Customs, **some companies will have items selected each period and will receive one or more of these forms each period while others may be requested to report less often.** It is important that we receive a complete and prompt response from each importer. Please complete the questionnaire for the item on the enclosed copy of Form 7501, Consumption Entry, or Form 7502, Warehouse or Rewarehouse Entry. If more than one item is on the document, the specific item referred to is circled.

Please return the questionnaire within 20 days in the enclosed return envelope, which does not require postage. A file copy is enclosed for your records should you wish to have it.

All information will be held in strict confidence, will be used for statistical purposes only, and will not be disclosed or released to others for any purposes. Your cooperation will be greatly appreciated.

Sincerely,

George H Brown

GEORGE H. BROWN
Director
Bureau of the Census

3 Enclosures

IF YOU RECEIVE MORE THAN ONE QUESTIONNAIRE, PLEASE COMPLETE EACH QUESTIONNAIRE RECEIVED

Please continue on reverse

EXHIBIT III-2 (Continued)

IMPORT QUESTIONNAIRE

All questions refer to the item on the attached copy of Form 7501, Consumption Entry (or Form 7502, Warehouse or Rewarehouse Entry). If more than one item is on the document, please complete the questions only for the item circled on the copy.

Item 1 **DESTINATIONS**

To what destinations did you ship this merchandise? How did it move from the Port of Entry?

The destination is the city or town in which you further processed or used the merchandise, or shipped it to customer(s), or was the last known place to which it was shipped.

If the merchandise was destined to more than one city enter in columns (a) and (b) the city and State where each portion of the merchandise was shipped.

Complete one line for that part of the merchandise, if any, that remained in the Port of Entry, showing this port as the destination.

If shipped to more than one destination, enter in column (c) the percentage (by value) of the total shipped to each destination.

If more than one means of transport was used – Check the means for the longest haul.

If "freight forwarder" was used – Check the major means of transport if known. If you do not know the means of transport used by the freight forwarder – Check "Other."

Check "Other" for parcel post, railway express, messenger service, etc.

Line No.	Destination: City (a)	Destination: State (b)	Percent of total value (c)	Major means of transport in the U.S. *CHECK ONLY ONE MEANS*: Rail (d)	Truck (e)	Air (f)	Inland water, including Great Lakes (g)	Other (h)	CENSUS USE ONLY
1				1	2	3	4	5	
2				1	2	3	4	5	
3				1	2	3	4	5	
4				1	2	3	4	5	
5				1	2	3	4	5	
6				1	2	3	4	5	
7				1	2	3	4	5	

Item 2 **CONTAINER – INTERNATIONAL MOVEMENT**

Did the merchandise move in a REUSABLE CARGO container(s) from the foreign port of loading to the U.S. Port of Entry?

Check ONE box →

1 ☐ Yes – *Go to item 3*
2 ☐ No – *Skip to item 4 for water shipments*
For air shipments stop here
3 ☐ Don't know – *Stop here*

Item 3 **CONTAINER – DOMESTIC MOVEMENT**

Answer only if "Yes" checked in item 2.

Did the merchandise move in the SAME container(s) as in item 2 from the U.S. Port of Entry to where you shipped it in the United States?

Check ONE box →

1 ☐ Yes
2 ☐ No
3 ☐ Don't know

Item 4 **PACKAGING OTHER THAN CONTAINER**

For international water shipments only

For merchandise not shipped in a REUSABLE CARGO container, how was the shipment packaged for the ocean voyage?

Check ONE box →

1 ☐ Palletized
2 ☐ Individual lots and cases or barrels
3 ☐ Ship's tank
4 ☐ Bulk
5 ☐ Don't know

FORM TS-902 (7-21-70)

U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 401-218

United States to the port of export. Item 5 also is concerned with an interior point in the United States, but in this instance the question is the place where the merchandise was produced. Frequently, the exporter acquires control at the point of production, but the two places often are different. Each location should provide useful information--the former for questions involving the "transportation origin" of exports, and the latter the "production origin." Analyses of the differences between the two should provide useful clues regarding potential transportation diversion.

Items 2 and 3 are concerned principally with through movements in reusable containers from the U.S. interior to foreign destinations. The question on packaging other than in containers applies only to international water shipments.

Corresponding information on imports is being obtained by Form TS-502 sent to importers of record.

"CENSUS BASE FILE"

A new computer record is being created by combining data from each questionnaire with other information from the document for that shipment filed at the time of shipment with the Collector of Customs. Those "raw data" are supplemented by an extensive series of recodes and computer-generated items to obtain such information as multiple commodity classifications (e.g., schedule A, schedule B, approximate SIC, STCC, etc.), trade routes, world areas, geographic areas and distances within the United States, etc.

The complete file of these new composite records will be known as the "Survey Base File," which will be used for tabulations and to create the "Public Use Tape" and other special tapes.

PRIMARY DATA ELEMENTS IN THE "SURVEY BASE TAPE"

The primary data elements in each shipment record in the "Survey Base Tape" are:

1. Transport--international segment

   Vessel or air and U.S. or foreign "flag" or "registry."

2. Direction of flow

   Export or import.

3. Time--month

4. Commodity

   Each record has a multiple commodity code. The basic codes will be the standard codes used for foreign trade--schedule A, schedule B, TSUSA and SITC. Recodes also will be written into the record that approximate SIC (used mainly for U.S. domestic commodity production data), TCC or STCC (used for domestic commodity flow data in the Census of Transportation, by the Interstate Commerce Commission and rail and motor carriers), and the commodity-related "Input/Output Sectors."

5. Weight of shipment

Shipping weight in pounds reported on the export or import document.

6. Value of shipment

Value in dollars reported on the export or import document.

7. Foreign area

Foreign country of origin or destination; also foreign port of lading or unlading.

8. U.S. Customs District and port (Schedule D)

U.S. customs district and port of export, or district and port of entry and of unloading. The port of unloading, as its name implies, is the port at which the merchandise is unloaded from the international carrier. The port of entry is the port at which the customs papers are filed. While the port of entry and port of unloading usually are identical, they are sometimes different.

9. Interior transport origin of export or destination of import

This is the point or area where the exporter acquired control of the shipment or the destination of the import. It will be used as the transport origin or destination. The "PICADAD" computer program will be used which identifies the point or small area and provides geographic codes for county, Standard Metropolitan Statistical Area (SMSA), "Production Area," State, Census Division, and coordinates for computing distances between each possible pair of points. The PICADAD detail also can be used for other area recodes, if needed.

10. Interior point or area of production

This is initially coded to PICADAD, which will be used to assign the balance of geographic information and distance computations. In many instances, this will be identical to the "transport" origin or destination; in some instances, it will not be known to the importer or exporter and will not be answered.

11. Computed distances within U.S.

The following distances will be computed in terms of straight-line miles by the PICADAD computer program:

(a) Miles from production in United States (if reported) to point acquired by exporter.

(b) Miles from point acquired by exporter ("transport origin") to port of export.

(c) Miles from production (if reported) to port of export. This may be shorter or longer than the sum of the distances in (a) and (b) above.

(d) Miles from port of entry to destination in United States.

(e) Miles from port of unlading to destination in United States.

(f) Miles between port of unlading and port of entry in United States.

12. Transport--domestic segment

Major means of transport used between U.S. origin and port of export, or from port of entry to interior destination. To the extent available from administrative records, the means of transport between the port of unloading and port of entry (if different) also will be contained in the survey base record.

13. Use of containers

The code will show whether a reusable cargo container was used on the international segment, and (if so) whether the same container also was used for the domestic segment of the movement.

14. Packaging

Type of packing used for international water shipments in instances where the answer to item 13 shows that a container was not used.

15. Universe equivalents

The weight and value of the shipment in items 5 and 6 will be raised to their "universe equivalents" as described in the text. In general, if the probability of selection of this shipment were 1 in 4, the "universe equivalent" would be 4 times the actual values shown in items 5 and 6. If the probability of selection were 1 in 1 (as is the case for exceptionally large shipments), the "universe equivalents" would be identical to items 5 and 6.

16. Serial identification of shipment

This is used principally for processing purposes, but also for creating random groups for use in estimating sampling variability.

REPORTS AND RELEASE OF DATA

The information developed by this survey will be released in three forms:

(a) Published reports
(b) Special tabulations
(c) Computer tapes

A. Published Report

The general purpose report is tentatively scheduled for release in March 1972. That report will present the major findings of general interest. This will be supplemented by a technical report dealing with such aspects as survey methodology, sampling procedures, estimation of sampling variability, glossary of terms, and other technical aspects.

B. Special Tabulations

The sponsors have provided for the creation of a "public use" tape to be made available to other government agencies and the public at cost of reproduction. This is expected to be the primary mechanism for data users to undertake an almost unlimited variety of special tabulations with their own computer facilities or other services.

However, there are some applications that require access to details in the Census "Survey Base Tape" that cannot be shown in the public use tape without possible disclosure. In these instances--as well as others--the Bureau of the Census will undertake special tabulations or analyses.

B. Computer Tapes

The complete basic file of data will be contained in the "Survey Base Tape" which contains confidential information and will be used only by the Bureau of the Census. A "Government Administrative Tape" will contain essentially all of the details in the base tape, except specific items or codes which--singly or in combination with other information on the tape record--may lead to disclosures. The use of this tape is restricted to government administrative use.

The primary tape for special tabulations and analyses beyond those available from the published reports will be the "Public Use Tape" that will be released (at cost of reproduction) to other government agencies and the public. The "Public Use Tape" will contain details for each shipment line in the sample. Potential disclosures will be avoided mainly by generalizing the codes. For example, the high degree of commodity detail in the base tape (7-digit level) will be generalized to a commodity class (4-digit level), which still provides a very substantial degree of commodity detail. The specific ports identified in the base tape are coded in terms of customs districts in the public use tape. The specific interior origins, destinations, or other places are coded in terms of a system of about 5,700 reference (or "key") points in the "base," but are classified into States and "Production Areas" in the public use tape. The foreign ports and countries in the "base" are generalized to "world areas" and maritime trade routes.

PART 4

SHIPBUILDING COSTS

by

E. G. Frankel

Chapter I
SHIPBUILDING COST ELEMENTS

There is no standard method by which various cost elements in the construction of ships in the major shipbuilding countries of the world can be estimated and compared with any degree of authenticity. No two shipyards, even within the same country, account for all labor productivity and cost data in the same manner, and as a result those with a need to know have found it virtually impossible to use one cost estimating system which would effectively highlight significant differences in costs between countries. One of the major factors contributing to this problem is that no two shipyards categorize material costs as well as labor productivity and cost data in the same manner, i.e., there is wide diversity of definitions of what comprises items of propulsion and what comprises items of outfit. Such diverging methods of accounting also make it difficult to analyze the effectiveness of labor application resulting from different ship erection approaches, ship unit handling methods, degrees of automation, and other modern shipyard innovations. This difficulty, on the other hand, has not been found to exist with regards to the hull steel and coating categories.

A major problem in providing reasonably good manpower factors for the hull outfit and propulsion subsystems is the large difference among shipyards, even within individual countries, of:

a) Degree of preassembly of outfit or propulsion components into subassembly or outfit blocks.

b) Degree of preoutfitting in the subassembly, stiffened panel assembly or block erection stage.

c) Degree of open sky (double botton) erection of major machinery elements and related systems.

d) Design-production integration and resulting inclusions of production requirements into working plans.

e) Percentage of and approach to post launch outfitting.

f) Ability of electrical, pipe, ducting, machinery and other shops to provide effective outfit and propulsion system preassembly.

g) Degree of outfitting subcontracting.

h) Methods of procurement and delivery (including transport) of propulsion subsystem components.

i) Definition and accounting of subcontractor labor, particularly form -- in subcontractor labor.

It is the purpose of this chapter to present a system of unit manpower utilization factors (MUF) for the hull, propulsion, and outfit subsystems as a function of size and country of construction, based upon a grouping of the cost factors common to all the shipyards and countries, in order that the shipowner, or shipyard for that matter, can estimate with reasonably good accuracy the labor productivity and cost of any new ship construction, given the estimated quantities of material involved in the hull, propulsion and outfitting subsystem are known within reasonable accuracy. As it would be difficult to define the explicit effects of combinations of conditions such as listed above on manpower utilization factors, a simplifying set of assumptions was made, which nevertheless maintains proper consideration of the vast differences in approach to ship production practiced among various yards and different countries.

The purpose of this report is to provide a means whereby a ship operator can estimate the labor manhours for items comprising the hull, outfit, and propulsion systems of a ship being built or to be built. The system can be used to calculate the manhours for any size ship built at any shipyard in the countries under consideration. By estimating hull, outfit and propulsion manhours for several yards and then projecting the labor rates for the countries in which the yards are located, a ship owner can choose the yard which will build his ship for the minimum cost at the time of its construction, as opposed to choosing a yard which may have minimum costs at present but whose costs will not be minimum at the time of construction. It should be noted, though, that this analysis is concerned with costs and not prices of ships. Since ships are usually placed on order several years before completion, the owner may desire to seek a rationale of placing an order with a yard which can build his ship at minimum costs at the time of its construction as opposed to minimum costs at the time the order is placed.

As a result, the problem includes consideration not only of productivity factors as indexes, but also the rate of change of productivity and resulting manpower costs with time. Basically, two types of manpower utilization factors (MUF) are needed. The first will deal with manhours for total systems as defined by such units as hull cargo system, accommodation spaces, electric power, main propulsion, cargo heating, steering, etc., while the second will deal with specific items on the product level, where quantities are determined from material lists. While the first MUFs are defined as manhours per SHP, ton of cargo system capacity, number of crew, etc., the second MUF is defined as manhours per foot of cable or pipe, square feet of accommodation, barrels per minute of pump capacity, etc. While the proposal suggests inclusion of manpower cost of transportation within the yard as direct labor, we find that this labor component is more appropriately considered on overhead or indirect labor items, since it does not represent added value and it is found practically impossible to assign realistic manhours because of the vast differences in yard layout and approach to materials handling.

A system of unit manpower utilization factors (MUFs) for the hull propulsion and outfit subsystem has been developed. These MUFs are a function of ship size and country of construction, based upon a grouping of the cost factors common to all the shipyards and countries, which permit estimates with reasonably good accuracy of the labor productivity and cost of any new ship construction, given the estimated quantities of material involved in the propulsion and outfitting subsystem.* Similar approaches are difficult to derive for other ship types due to the significant differences in design of dry cargo and containerships, for example. As a result, we present only functional cost relations for dry cargo ships of various types.

The propulsion and outfit systems are for our purposes defined as all production activities not related to steel fabrication and ship erection, internal cargo tank coating and painting, launch and trials, ship design, and engineering and administration. The propulsion system comprises all main propulsion and related auxiliary machinery including required engine room piping, ducting, cabling, shafting, etc. The outfit system includes accommodations, steering and hull engineering (mooring, anchor, windlasses, davits, etc.), cargo system, tank cleaning system, service and distributive systems, navigational and control systems (excluding propulsion system controls in machinery spaces), etc.

A detailed definition of major system and material components was developed in our approach. The rationale adapted to the solution of the stated problem was to define MUFs by product levels which, in turn, were related to system definitions. In this manner the degree of accuracy in the estimate was varied as required and the sensitivity of total manhours determined to changes in 1) system design or performance specifications and/or 2) quantity or type of product or material used. This approach permits the effects of changes in tanker or ship design, such as degree of subdivision, sluiced versus piped cargo system, etc., to be introduced and their effects on manhour and material costs evaluated. This, combined with considerations of shipyard production approach as it affects propulsion and outfit system manpower utilization or productivity, provides a reliable methodology for estimating ship costs.

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*The basic study concentrated on tanker manhour requirements.

Reviews of the different manhour and materials costing procedures now in use by the world's shipbuilders were made. Information was solicited from many of the world's leading shipyards and sufficient information was obtained to arrive at reasonable estimates of the manhours being used and the material costs involved in the construction of a number of tankers in sizes ranging from about 30,000 DWT to 300,000 DWT. Less complete information was obtained for bulk and break-bulk dry cargo ships.

The shipbuilding costs derived by the methodology described above and elsewhere in this report have been checked against the actual estimated cost of ships by methods now in use for estimating the costs of ships in various countries, and manhour and materials costs obtained by the system have been found to be within the normal limits of such estimates or within a standard deviation of plus or minus 7% for the period of 1971-1976.

In the determination of the shipbuilding direct labor rates to be utilized in costing, historical data was consulted for eleven major shipbuilding countries.

Based upon escalation indexes and other factors, projected direct material and labor rates were developed. Both the historical and projected rates reflect the steady and substantial increases which are anticipated worldwide in the shipbuilding markets.

Shipyard overhead costs were established for the various shipbuilding countries from shipyard information obtained directly from a number of leading shipyards.

Using the various references listed at the end of this section as well as the results of our own analysis, a comparison of world shipbuilding costs as of 1969 was performed. These results are summarized in Table I-1 in which we present general indices of shipbuilding costs. It should be noted that these were derived on the basis of total cost for all ocean-going shipbuilding, independent of the type and size of ships constructed. Larger differences in the various cost elements exist if particular segments of the shipbuilding industry are compared country by country. For example, it would be found that Denmark and Japan have probably the lowest tanker shipbuilding cost index, while Spain has a general cargo ship index as low as that of Japan.

Cost indices are divided into labor cost, overhead cost, and material cost indices. Direct labor cost indices are functions of relative productivity and unit labor costs. Relative productivity indices in tanker propulsion and outfit labor are presented in Figure I-1. Similarly, relative tanker steel (hull) productivity indices are shown in Figure I-2. It should be noted that labor productivity varies widely among shipbuilding countries.

Material costs, on the other hand, have much smaller deviations with the exception of shipbuilding material costs in the U.S. Most other shipbuilding countries permit basically free and unhindered import of shipbuilding materials, although import duty is charged for such imports in many countries (Spain, United Kingdom, etc.). Part or all of this duty is reimbursed in most shipbuilding countries for ships to be exported.

Overhead costs include the costs of non-production labor and all indirect costs (including financial charges). These obviously vary with management, required depreciation, administrative procedures, cost of services, etc. As a result, countries with major and recent shipyard investments pay an overhead premium.

COUNTRY / YEAR	DIRECT LABOR COSTS	OVERHEAD	DIRECT LABOR COSTS PLUS OVERHEAD	MATERIAL COSTS	TOTAL SHIP COST	% COST DIRECT LABOR	% COST DIRECT LABOR + OVERHEAD
Japan	6.137	2.569	8.706	18.04	26.74	24.8	37.3
U.K.	7.190	5.033	12.223	19.73	31.95	22.5	38.3
Sweden	8.079	2.666	10.745	19.29	30.04	26.9	35.7
Norway	6.340	2.409	8.749	19.54	28.29	22.4	30.9
Denmark	6.046	1.995	8.041	18.98	27.02	22.4	29.8
Germany	6.563	2.725	9.288	19.50	28.79	22.5	32.0
Italy	8.415	3.376	11.791	19.73	31.52	25.9	36.2
Spain	5.028	3.638	8.666	19.57	29.24	17.3	29.5
Holland	6.846	4.168	11.014	19.27	30.28	22.5	36.4
U.S.A.	16.685	9.343	26.028	29.96	55.98	30.3	46.7
Taiwan	4.253	3.701	7.954	20.54	28.634	14.9	27.8

GENERAL INDICES OF WORLD SHIPBUILDING COSTS, 1969

Table I-1

Fig. I-1
Relative Tanker Propulsion and Outfit Labor Productivity Index

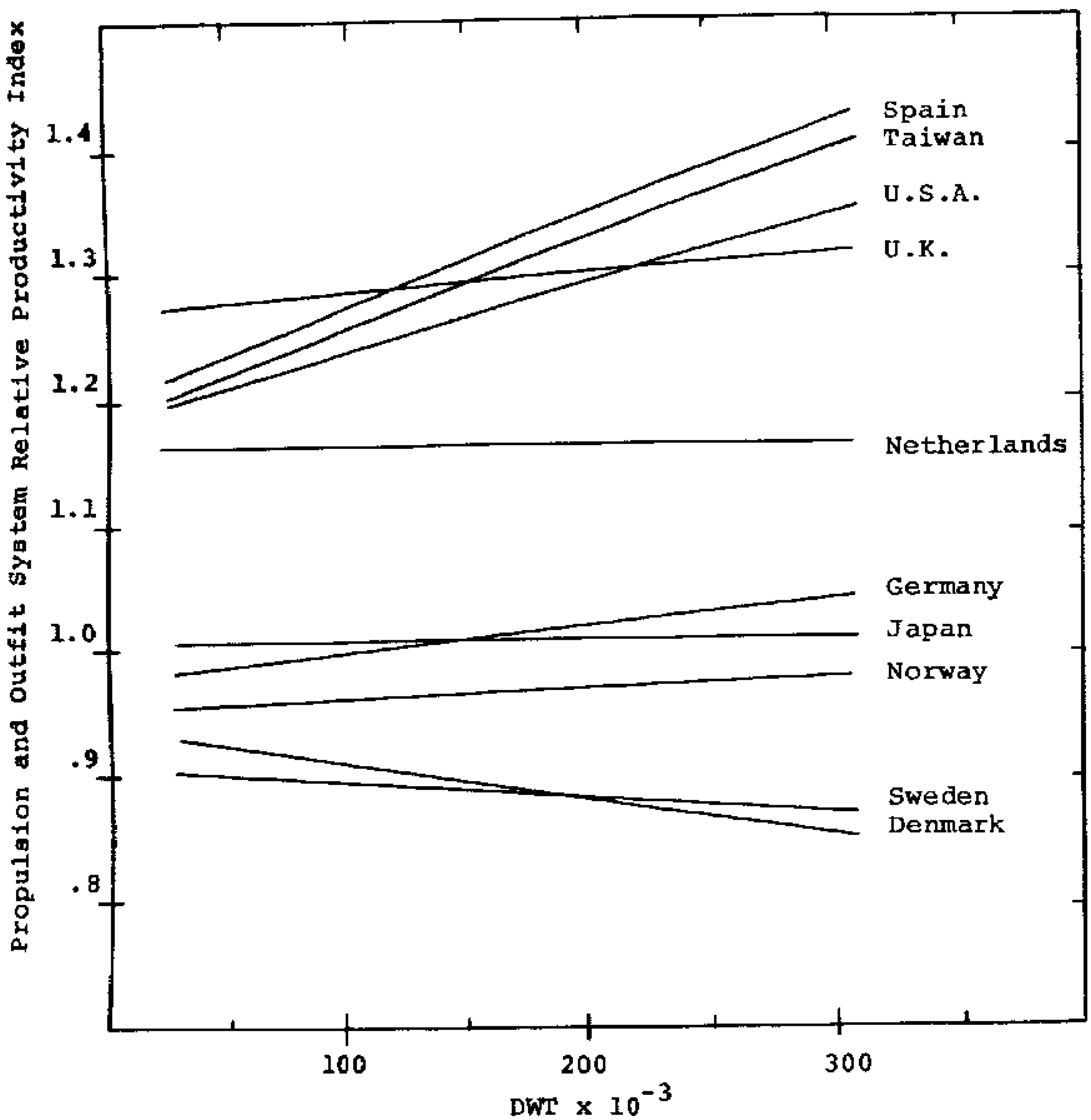
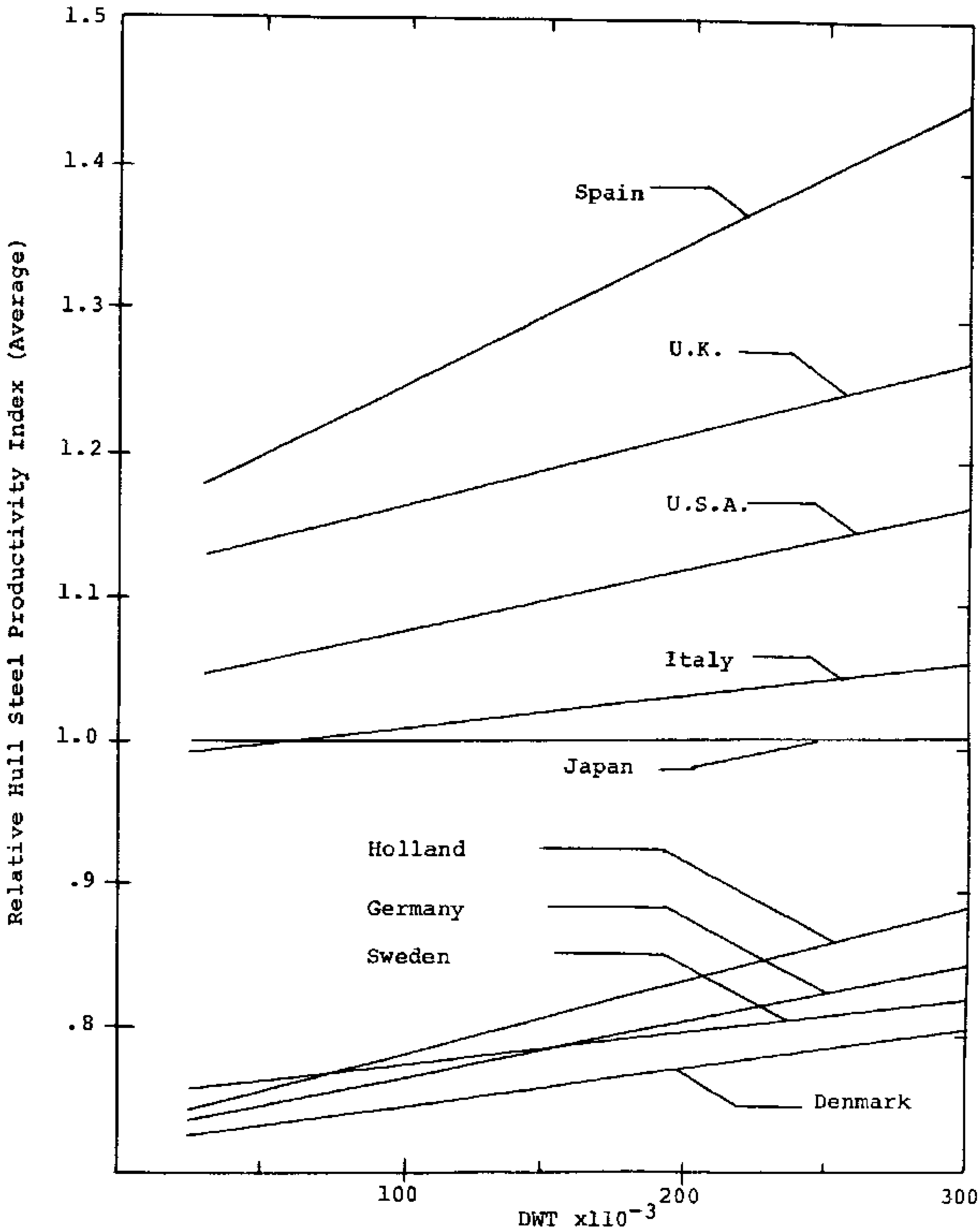


Fig. I-2

Relative Hull Steel Productivity Index



Labor Costs

There is a paucity of published labor productivity and cost data in the shipbuilding industry, both domestic and foreign, yet there is no periodically published set of detailed unit productivity factors of the shipbuilding industry similar to those, for example, which are found in the public construction industry. The reason for this appears to be the highly competitive and proprietary nature of the shipbuilding industry, which affects publication of cost and/or productivity data. This competition exists between shipyards within a country and between countries themselves.

The most reliable sources of information on shipbuilding productivity and cost data are believed to be contained in the records of the shipyards engaged in tanker construction, followed by data amassed by the shipbuilding professional associations and to some extent by the International Labor Organization.

In order to achieve as much standardization as possible in the data received from the many shipyards and nations involved, a common questionnaire was sent to each. As will be noted, manpower utilization data was requested in terms of manhours per unit of system component output or product. The questionnaire was accompanied by amplifying information as to the items considered to comprise each of the system or equipment categories listed in the questionnaire as an aid to standardization.

However, though many of the shipyards found it feasible to adhere to the format of the questionnaire, others, apparently for time and/or economic reasons, submitted requested data in the format of their individual cost classification systems. It became necessary for us then, exercising best judgment and expertise, to reclassify this data into a format approaching our requirements in order to obtain consistency of data base between countries.

One major difference in shipyard approach to labor utilization is in the method and degree of subcontracting. While some shipyards only subcontract complete and definable jobs (often performed outside the yard or in subcontractor controlled facilities) other shipyards use a large amount of farm-in labor. The latter method may involve suppliers of complete teams of subcontractor labor or individuals who then work under supervision of shipyard staff. In general farm-in subcontractor labor is integrated into shipyard personnel. Because of the large number of differences in approach to subcontracting the labor requirements are developed in this study for all labor that could be performed by the shipyard. This means that only manufacturing labor provided by suppliers is not included.

Weighting factors were derived to establish the effect of differences in shipyard production approach, equipment, on unit manhours for similar ships built in basically identical shipyards in which only one of the eight major shipyard variables differed. This type of analysis was performed for all sets of combinations of shipyards. The assumption was made that the particular weighting factor established by comparing yards of one country will be valid for any other country once multiplied by the relative productivity for the particular skills involved.

In a similar fashion manpower utilization was compared for the construction of ships such as tankers which differed substantially in design, when built in basically identical yards of a country.

The results of the manpower analysis are presented as MUF (manpower utilization factors) for individual ship types in subsequent sections.

The data accumulated, analyzed and presented can also be used to develop basic manpower utilization factors by product if desired. The scope of this project, while permitting the development of manhour data per applicable unit measure, does not permit detailed manpower utilization factors by product. The numerical work in such an effort would probably be best performed by a simple computer program. The degree of detail of data obtained varied widely. Therefore while reliable information was obtained on such statistically tractable work functions such as piping and wiring, less complete information became available for accommodation outfit, machinery installation, etc. Similarly, while it can be assumed that pipe, wiring or similar outfit products are basically identical no matter where or how they are installed, this is not true for such factors as accommodation outfitting, for example. Here standards and approach vary widely among owner, shipbuilder, flag of registry or a combination of the above. As a result the manpower utilization factors for accommodation are based, for reasons for comparison on good, present standard Japanese practice. A weighting factor must be included over and above other factors previously discussed to account for deviations from this standard.* Similar adjustments must be made for deviations in propulsion machinery type or arrangement and for changes in hull equipment and/or hull outfit systems.

The MUFs by product and system were derived from

*The standard deckhouse for example consists of a single consolidated, stern-located, rectangular box type deckhouse with practically identical deck plans.

shipyard data on ships within a DWT size range and averaged. While this average will give reasonably accurate estimates of manhours for the propulsion and outfit system, we derived DWT correction factors which can be used when the DWT of a tanker under consideration for example, varies substantially from the average DWT within the size range. These corrections coefficients are applied universally to system or product level MUFs and will assure more accurate results. No account was taken of support service manhours or MUFs as the accounting for this item varies widely. A majority of yards consider support services direct costs while about one-third lump it under indirect costs.

Another problem arises in allocating painting manhours. While painting of superstructure interiors was included in superstructure outfit manhours count, painting of the hull and the superstructure exterior, as well as machinery and pump room painting, was excluded. The MUFs can easily be added to this analysis, though many shipyards tend to lump all painting under one category. Generally, the manhours expended on painting machinery spaces vary from 0.05 to 0.1 per deadweight ton for tankers between 300,000 and 25,000 DWT, as one example.

The relative labor productivity indices were derived from the accumulated hull, outfit, and propulsion system expended by an average yard in subject countries for the various sizes of ships under consideration. More detailed productivity indices by major skills were not obtained. This information was largely derived from data accumulated by the International Labor Office or from various national labor studies. The data was then superimposed on the relative productivity indices derived from actual shipyard data to obtain relative productivity by skills. The information on productivity by skills obtained from the above-named sources was usually not specifically for shipyard labor but for industrial labor in general or for specific, not necessarily shipyard related, activities. Therefore, while we are confident that our cumulative relative productivity index averaged over all skills used in the hull propulsion and outfit systems is valid, the relative productivity by individual skills of interest is subject to correction as more detailed shipyard information is obtained.

The productivity of labor varies widely among the various shipbuilding countries and among the shipyards within a country as well. Based upon relative manhour requirements for similar ships, the productivity of the various countries illustrated in Figure I-1 and Figure I-2 is the ratio of manhours required in the outfitting of standard tankers to compensate for the differences in productivity relative to the productivity of the Japanese workers taken as a standard.

It is noted that the northern European yards and Japan have in general dedicated workmen resulting in excellent productivity. The United States, Spain, and the United Kingdom are, in general, saddled with work rules or union practices which decrease the productivity of their shipbuilding labor.

The productivity of Spanish workers, for example, is low, due largely to labor practices in vogue in that country. Also, the retention of workers in industry is required by governmental policies, hence labor is less productive and much work is subcontracted at high cost to avoid taking on additional personnel. The productivity in Spain is on the increase, however.

The productivity of Taiwan has been estimated, however; thus the index assigned has the lowest validity as the data available is scarce.

With regard to the supply of shipbuilding labor the following comments appear to be in order:

a) Japan is having trouble recruiting workers for shipbuilding. This is true in the upper echelons of engineering talent as well as the production workers themselves. This will result in a continued escalation of Japanese shipbuilding costs.

b) The northern European yards are importing southern European workers, primarily Spanish and Greek nationals, to meet their personnel requirements.

c) Spain has an excess of shipyard workers, due largely to the consolidation of several of their shipbuilding yards.

d) The United States has an excess of shipyard personnel.

Summarizing, it is evident that the primary factors in determining who is going to build the ships of the future will be the labor rate and the labor productivity of the countries and shipyards in competition for a share of the world's shipbuilding market.

Various sources of information were used in the generation of the above data. These include:

a) Swedish Employers Confederation wage cost listings;

b) Publications by the U.S. Shipbuilding Council;

c) "Improving the Prospects for U.S. Shipbuilding" by the Center for Maritime Studies;

d) U.S. Department of Commerce, Bureau of Census;

e) Bureau of Labor Statistics, U.S. Department of Labor;

f) Department of Labor, Office of Foreign Labor and Trade;

g) International Labor Organizations, U.S., Geneva;

h) Maritime Administration, Office of Ship Construction;

i) Private information on building construction codes; various shipyards in Sweden, Denmark, Germany, Spain, Holland, and Japan; and

j) Verbal verifications with representatives of Danish, Spanish, Swedish and Japanese shipyards.

Like any forecasts, the projected percentage increases of labor rates are subject to a multitude of effects, largely unpredictable. We feel confident that the projections are reliable within 5% for the time period 1971-1976 and within 10% between 1977-1982.

The cost of shipbuilding is generally considered in the two main categories of material and labor. While the costs of material do vary from country to country, the differences are not major and material costs are relatively stable compared with the cost of labor. Escalation of material costs can therefore be much more readily estimated.

The major exception is the United States for the reason that her shipbuilding has not been internationally competitive for some time and most of it has been for her own account and with materials of her own manufacture.

The principal variant in determining the cost of a ship is the total cost of labor and overhead charged to the construction of the ship.

The cost of labor required for the production of a ship is basically a function of the wage scale of the shipyard employees and their relative productivity as workers.

The total hourly wages for the various shipbuilding countries are contained in Table I-2 and I-3. The historical and projected total hourly wage scales are plotted on semi-log scale in Figure I-3. (Constant escalation is a straight line.)

The primary sources for the historic information are tables published of direct and total wage costs for workers 1957-1964 by the Swedish Employers Confederation and the International Labor Organization Yearbook of Labor Statistics - 1970.

Year / Country	1960	1961	1962	1963	1964	1965	1966	1967	1968	Average Annual Increase
U.K.	$ .97	$1.04	$1.07	$1.09	$1.17	$1.27	$1.34	$1.41	$	4.8%
SWEDEN	1.39	1.49	1.62	1.73	1.88	2.06	2.24			8.3%
NORWAY	1.12	1.18	1.31	1.39	1.53	1.62	1.76	1.89		8.1%
DENMARK	1.09	1.18	1.33	1.44	1.54	1.75	1.94	1.99		9.0%
GERMANY	0.98	1.10	1.28	1.34	1.50	1.63	1.74	1.81		11.2%
ITALY*	0.89	0.95	1.10	1.29	1.42	1.60	1.80	2.02		12.5%
HOLLAND	0.86	1.02	1.12	1.20	1.32	1.45	1.61	1.70		11.2%
U.S.A.	3.17	3.37	3.48	3.62	3.69	3.87	4.10	4.33		3.75%
BELGIUM	1.39	1.48	1.62	1.68	1.86	----	----	----		7.3%
JAPAN	0.48	0.51	0.57	0.61	0.67	0.73	0.79	0.88		6.4%
SPAIN	0.36	0.39	0.40	0.46	0.50	0.52	0.57	0.61		5.5%
CHINA (Taiwan)	0.098	0.105	0.111	0.113	0.115	0.122	0.128	0.148	0.168	15.0%
CANADA	2.09	2.16	2.24	2.35	2.44	2.59	2.67	2.81	2.97	5.3%

*Men and Women

TOTAL HOURLY WAGES+ IN WORLD SHIPYARD INDUSTRIES
(Historical)

Table I-2

+Hourly wages before deductions. Includes bonuses, incentives, family allowances, overtime, vacation pay, sick pay, insurance.

Source: Direct and total wage costs for workers 1957-1964, Swedish Employers Confederation.

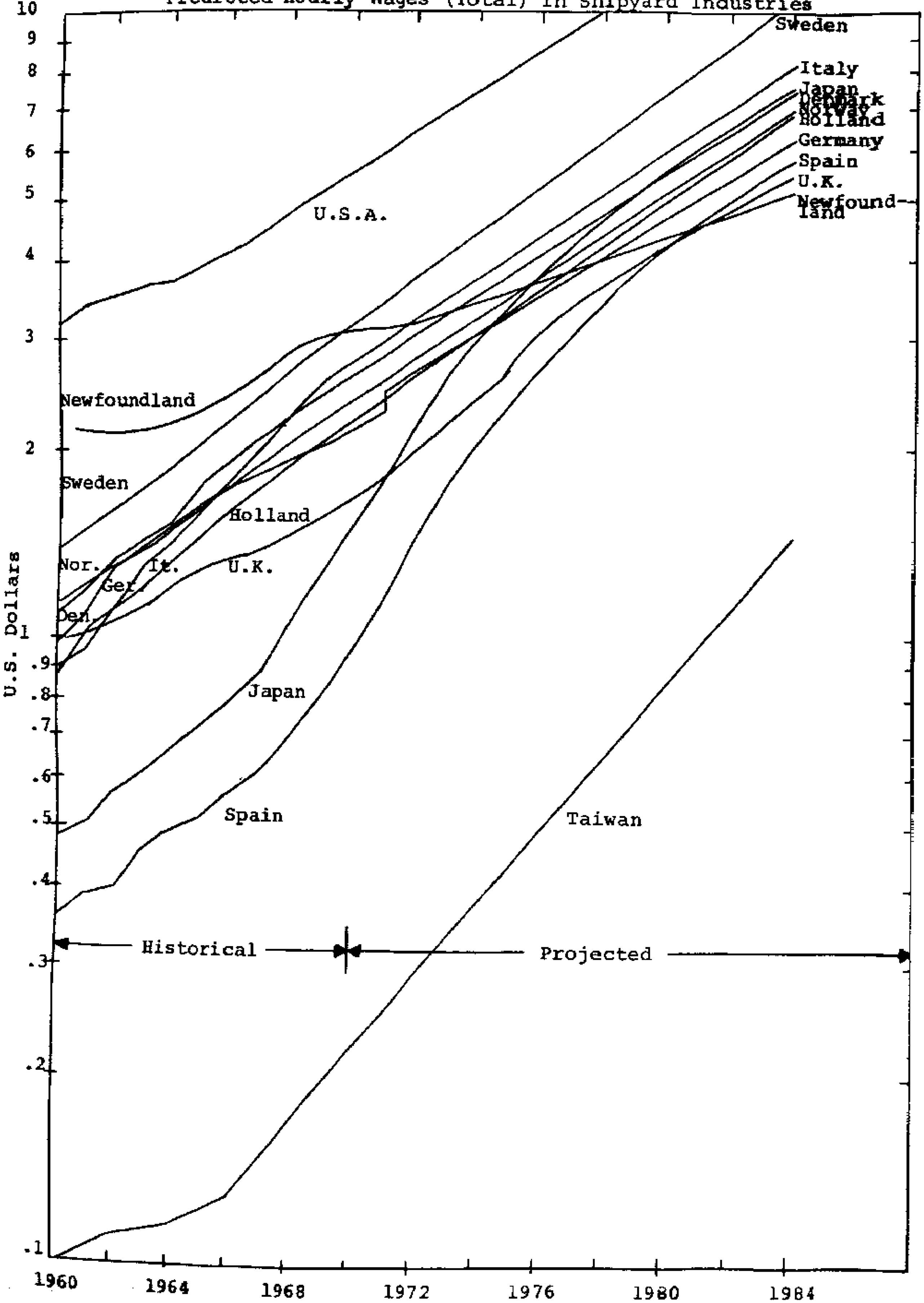
Country \ Year	1970	1972	1974	1976	1978	1980	1982	1984
Japan	$ 1.50	$ 2.18	$ 2.98	$ 3.81	$ 4.68	$ 5.55	$ 6.49	$ 7.54
U.K.	1.70	1.95	2.35	3.08	3.67	4.18	4.79	5.45
Sweden	3.13	3.71	4.41	5.24	6.21	7.40	8.77	10.50
Norway	2.37	2.77	3.22	3.77	4.40	5.11	5.99	6.97
Denmark	2.60	3.02	3.50	4.07	4.72	5.48	6.36	7.36
Germany	2.14	2.64	3.07	3.51	4.04	4.68	5.39	6.19
Italy	2.77	3.22	3.77	4.40	5.10	5.95	6.96	8.11
Spain	0.95	1.43	2.05	2.70	3.44	4.20	4.98	5.79
Holland	2.21	2.60	3.05	3.59	4.21	4.94	5.82	6.82
U.S.A.	5.44	6.35	7.39	8.62	10.10	11.75	13.75	16.00
Taiwan	0.22	0.29	0.38	0.49	0.64	0.84	1.10	1.44

TOTAL HOURLY WAGES* IN WORLD SHIPYARD INDUSTRIES
(Projected)

Table I-3

*Hourly wages before deductions. Includes bonuses, incentives family allowances, overtime, vacation pay, sick pay, insurance.

Fig. I-3
Predicted Hourly Wages (Total) in Shipyard Industries



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    e) British Trade Development Office
    f) Swedish Information Service
    g) French Cultural Counselor
    h) Netherlands Information Office
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9. Japanese Shipbuilders Association
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Material Costs

The material costs in shipbuilding construction are usually broken down into hull steel, propulsion and outfit and coating costs. These material cost elements in turn can be broken down into a very large number of subgroups right down to the piece and/or component level. In this section material costs are reviewed as total groups as defined as the particular distribution of material requirements differs in detail among shiptypes. Hull steel for example, for large tankers or bulk carriers, consists of a vastly different proportion among rolled shapes, fabricated shapes, and plates than hull steel for general cargo ships. Similarly, the unit size distribution of plates and shapes as well as the percentage of scrap will differ markedly. Similar comments apply to propulsion outfit and coating.

Steel Costs

A study or world steel prices was made as a part of a determination of steel costs and resulting effects on the competitive position of shipyards in various countries. The price of steel in domestic markets of the world, as well as the export price of steel by the major producing nations was determined. These prices are different because generally a two-price policy is used by some of the major steel producing nations.

It is extremely difficult to meaningfully project the rise and fall in prices in the world steel market because of the extreme complexity of the world steel pricing systems. This complexity arises from the multitude of factors which influence steel costs. These factors include raw material costs and prices, labor costs, transportation costs, and governmental policies. Steel prices are highly transient and sensitive to domestic and world supply and consumption. Several of the major producing nations follow a two-price policy which provides different prices for domestic and export markets. These prices are often highly dependent on governmental policies on the regulation of trade, the balance of payments, and the steel industry itself.

Table I-4 shows the historic developments in the domestic base prices for heavy steel plate ex mill. These prices do not include any extras for chemistry and quantity, size, transportation charges, or rebates and other alignment factors. More current information than reported was only available for a more limited number of nations.

Table I-5 gives prices ex mill in the world export market. These are base prices for heavy steel plate and again do not include extras for long and wide plates normally used by shipyards, transportation, or alignment factors. These prices are not indicative of specific shipyard purchase prices as the major producers frequently align their export prices in relation with the consumers' domestic market price.

DATE	WEST GERMANY[1]	BELGIUM[1]	FRANCE[1]	U.K.[1]	JAPAN[2]	U.S.A.[1]	CANADA[1]
Jan. 1, 1966	111.84	92.00	109.64	117.48	94.40	122.36	110.20
Apr. 1, 1966	111.84	102.00	109.64	122.30	106.95	122.36	110.20
Jul. 1, 1966	111.84	102.00	109.64	122.30	116.65	122.36	110.20
Oct. 1, 1966	111.84	102.00	109.64	122.30	133.35	122.36	110.20
Jan. 1, 1967	111.84	102.00	109.64	122.30	144.45	122.36	111.38
Apr. 1, 1967	103.44	102.00	109.64	122.30	119.45	122.36	111.38
Jul. 1, 1967	103.44	102.00	109.64	122.30	105.55	122.36	111.38
Oct. 1, 1967	97.44	102.00	109.64	122.30	91.65	126.76	111.38
Jan. 1, 1968	93.50	102.00	99.48	104.82	88.90	126.76	111.51
Apr. 1, 1968	93.50	99.00	99.48	104.82	84.70	126.76	111.51
Jul. 1, 1968	94.75	99.00	99.48	104.82	90.25	126.76	111.51
Oct. 1, 1968	100.38	99.00	99.76	104.82	100.00	134.48	111.51
Jan. 1, 1969	106.00	108.00	106.68	104.82	94.45	134.48	111.51
Apr. 1, 1969	117.30	124.00	106.68	104.82	116.65	134.48	111.51
Jul. 1, 1969	122.30	147.00	114.57	112.91	119.45	134.48	115.33
Oct. 1, 1969	124.90	157.50	109.91	112.91	--	142.20	115.33
Jan. 1, 1970	143.40	164.00	132.97	112.67	--	142.20	119.00
Jul. 1, 1971	--	--	--	--	150.00	165.80	--

Source[1]: The Iron and Steel Industry, OECD Annual Reports
Source[2]: The Steel Market in 1968, U.N. Economic Commission for Europe

BASIC HOME PRICES HEAVY STEEL PLATE
(U.S. Dollars per Metric Ton, Ex Mill)

Table I-4

Date	West Germany[1]	Belgium[1]	France[1]	U.K.	Japan	U.S.A.[1]
Jan. 1, 1966	84	84	84	---	---	122.36
Apr. 1, 1966	88	88	88	---	---	122.36
Jul. 1, 1966	85	85	85	---	---	122.36
Oct. 1, 1966	89	89	89	---	---	122.36
Jan. 1, 1967	87	87	87	---	---	122.36
Apr. 1, 1967	91	91	91	---	---	122.36
Jul. 1, 1967	89	89	89	---	---	122.36
Oct. 1, 1967	82	82	82	---	---	126.76
Jan. 1, 1968	78	78	78	---	---	126.76
Apr. 1, 1968	81	81	81	---	---	126.76
Jul. 1, 1968	83	83	83	---	---	126.76
Oct. 1, 1968	87	87	87	---	---	134.48
Jan. 1, 1969	100	100	100	---	---	134.48
Apr. 1, 1969	120	120	120	---	---	134.48
Jul. 1, 1969	145	145	145	---	---	134.48
Oct. 1, 1969	160	160	160	---	---	142.20
Jan. 1, 1970	158	158	158	---	---	142.20
Apr. 1, 1970	155	155	155	---	---	----
Jul. 1, 1970	133	133	133	---	---	--
Jul. 1, 1971					120	165.80

[1] Source: The Iron and Steel Industry, OECD Annual Reports.

Table I-5

<u>Base Export Price for Heavy Steel Plate</u>
(U.S. Dollars per Metric Ton, Ex Mill)

The ship steel market presents a very complex picture and fluctuates quite rapidly. The reasons for its sinuous curve, oscillating about the normal escalation curve, are several in number.

For example, Japan is a major steel producing and exporting country. By government policy and/or economic necessity it maintains her steel plants at a fairly steady predetermined output capacity. To permit this approach, Japan maintains a dual pricing system and varies the domestic and export steel prices to assure her share of the market. To export the desired quantity of steel, Japan is able to price her product just barely under potential competition to receive her desired export quota. To a certain degree several other countries follow the same practice. The natural laws of supply and demand are therefore artificially influenced by government policies, export-import balances and labor requirements. The net result is that steel prices are often predicted well into the future except in terms of general escalation. The average escalation of the cost of basic steel during the 1960's was about 3-1/2% per year. However, a rate of 5-7% appears to be justified for the period 1972-1980.

Steel prices increase at varying rates in the different countries under consideration and while the rate increase varies appreciably, depending on country (since in some countries steel prices have advanced more rapidly than in others), the average escalation of the cost of basic steel during the 1960's has been about 3-1/2% per year.

Rapidly increasing world demand, production and transportation costs and varying supply all contribute to the increase of steel prices at an annual rate well in excess of the historic 3-1/2% per year.

Equating the total cost of ship steel to the unit price of ship steel, multiplied by the tons of steel in a ship, does not produce a cost which looks like the cost of steel on a pound-per-pound basis. This stems from the fact that steel wastage will run from about 5% to 10% depending upon the size and type of ship. Smaller ships usually have greater wastage. In addition, a factor of from 5% to 10% must be added to required steel weight to reflect the cost and weight of welding materials.

Propulsion and Outfit Costs

Economic analysis of ship construction is usually made more difficult as a result of the diversity of definitions of what comprises propulsion and what comprises outfit. These discrepancies in definition occur not only among countries but also among shipyards of individual countries.

It is therefore necessary to establish simple and comprehensible guidelines to define those items considered under propulsion and outfit, respectively. The problem is particularly relevant now when many new propulsion plants, whose bounds are equally ill-defined among themselves, enter the market. This fact has been noted from shipyard estimates and reports in which ships with various propulsion plants are compared. It is curious to note that most shipyards have no basic consistent definition of items comprised by propulsion and outfit, respectively, and therefore often resort to adopting the propulsion plant manufacturer's own definition. This, in turn, may introduce penalties of various sorts, such as:

a) Unrealistic propulsion plant weight;
b) Unrealistic propulsion plant procurement costs;
c) Unrealistic propulsion plant installation costs;
d) Unrealistic economic analysis of tankship operational performance.

The gray areas in the definition of items are not confined to the divisions of propulsion and outfit but include overlap of these categories with hull structure steel in such areas as foundations, casings, etc.

A meaningful definition is primarily important because most cost items in shipbuilding are compared on the basis of cost per unit weight. Any skewing of weight content of categories may, therefore, introduce erroneous assumptions and wrong conclusions. Such weight manipulations have, in the past, formed the basis for attractive accounting tricks for many shipyards and prevented owners from taking advantage of the most effective cost-saving changes which often only marginally affect the performance of the tanker.

In the United States, there are two primary cost classification systems used -- those of the Maritime Administration (MARAD) and the U.S. Navy. MARAD uses three main categories: hull, outfit, and machinery. The Navy uses seven cost groups: hull, propulsion, electrical, communications and navigation, auxiliary systems, outfit and furnishings, and armament. Of the foreign yards analyzed, some have systems quite similar to the MARAD classification while others use systems of their own which involve many more (20-25) rather specific categories, without the larger, more general, grouping of the aforementioned systems

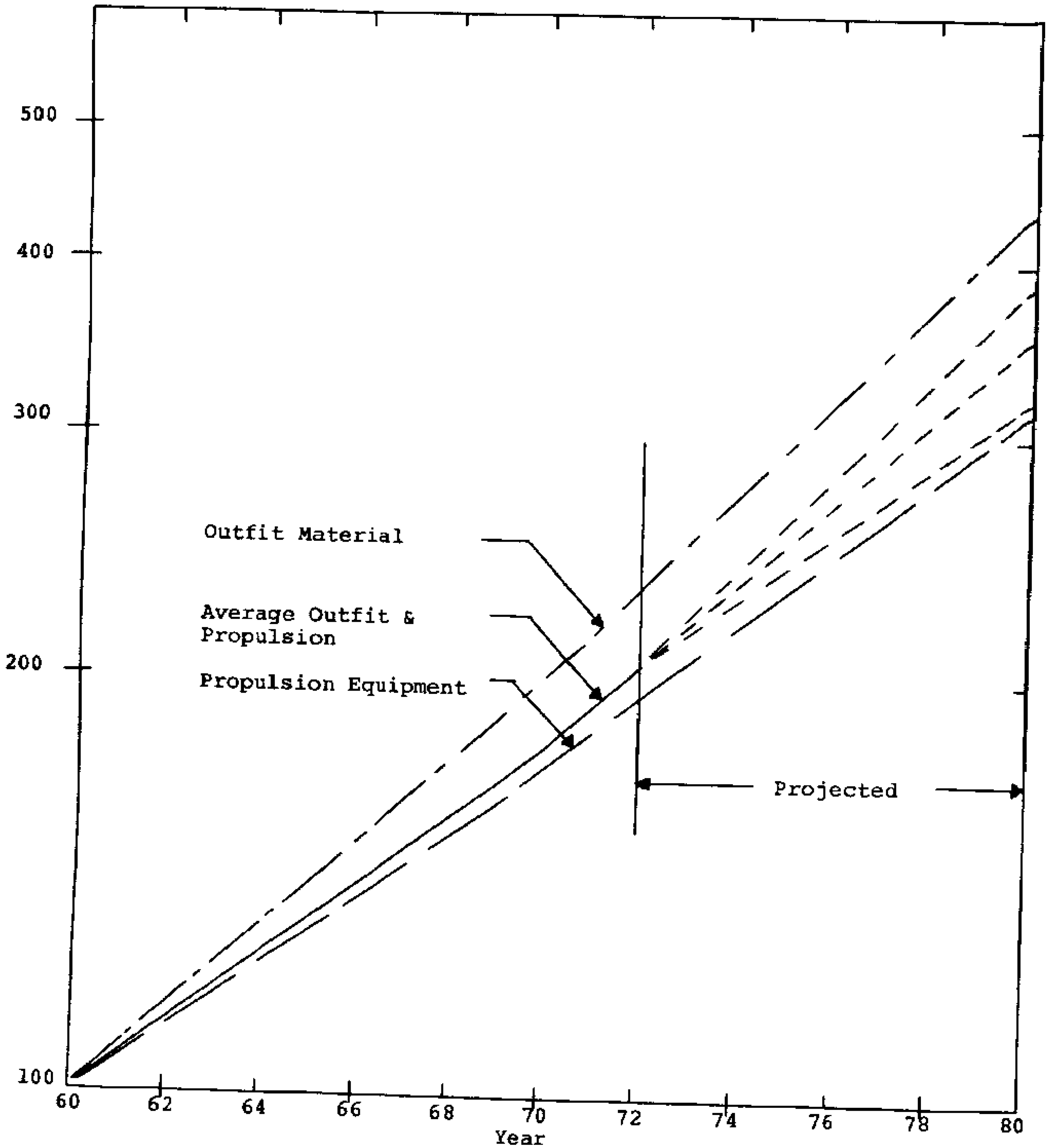
The problem with the existing systems is that some or all of the many auxiliary systems are grouped with machinery, with the rest going to outfit. This makes it difficult to separate the main propulsion machinery from the total ship cost. The more detailed grouping gives the ability to separate specific systems but in an unnecessarily complicated manner.

Effective and consistent cost classification is not only required to estimate material costs, but also to develop associated labor and overhead costs. This is more difficult as a meaningful material classification does often result in inaccurate or meaningless labor classification.

Propulsion and outfit material costs vary widely among countries. Recent revaluations of the currencies of major shipbuilding material supplying countries introduce additional difficulties which hamper effective estimate of material costs. From 1960 to 1970 most propulsion and outfit material costs escalated at an annual average of 6.2%. From 1970 to 1972 though annual escalation was generally in excess of 8%. While for many materials comparative costs can be derived on a year by year basis, other materials change form or are affected by technological advances which make national comparison on a unit cost basis rather difficult. Average world cost escalations since 1960 for propulsion system and outfit components and material are shown in Figure I-4. Table I-6 gives typical U.S. and foreign costs for major propulsion and outfit system components.

Fig. I-4

Propulsion and Outfit Component Cost Growth



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Ship Costs

A large number of different methods exist to derive ship costs. In fact, practically every individual yard and owner has his "own" method for estimating ship costs. Many shipyards, particularly in the U.S., still resort to cost estimating on an item-by-item basis. This approach requires generally that detailed design drawings and/or material lists be available. The amount of work spent on an item-by-item ship cost estimate may vary from a few hundred to many thousands of manhours. As a result, time and cost of such an estimating approach is high and usually not justified. It has been shown that the accuracy of a detailed estimate is on the average not better than cost estimates obtained by effective agregation of work packages or tasks by major parameters (such as subsystem weight, dimension, or output) and the application of empirical cost relationships.

In fact, a large number of experiments have shown that item-by-item cost estimating is more prone to error than well-defined empirical methods. In addition, it must be recognized that detailed drawings and/or material lists are generally not available when cost estimates are requested or desired. The result is usually the development of hypothetical material lists by people not completely familiar with the design and consequent error in an item-by-item cost estimate. The penalty cost of time and manhours in an item-by-item cost estimate may also seriously effect bidding schedules and the ability to bid a sufficient number of potential contracts. For these and other reasons the empirical approach presented in this study is recommended. The results have been tested against those obtained by item-by-item estimates of a number of non-U.S. shipyards and compared with the actual cost of construction. They have been found to be consistently accurate well within the standard deviation of item-by-item or other empirical estimates.

The results of the application of the developed relationships to dry bulk and tanker construction in the U.S. and low cost non-U.S. (Japan) are shown in Figure I-5. The tanker and dry bulk carrier dimensions used were for consistency with the results of Lloyd's computer analysis results of dimensional relations of liquid and dry bulk carriers. The cost relations plotted are construction costs and do not include profit, taxes, etc. Construction costs of general cargo liners, containerships and LNG carriers are presented in Figure I-6.

The bulk carrier dimensional relationships used are shown in Table I-7.

Group	Section		200,000DWT-35,000SHP Tanker (Steam Turbine)		20,000DWT-25,000SHP Cargo Liner (Steam Turbine)	
			U.S.	Foreign	U.S.	Foreign
1	3000	Hull and Deck Fittings	500,000	387,000	290,000	210,000
2	3000	Steel Door - Cargo Ports	60,000	42,000	52,000	40,000
3	3000	Cargo Hatch Covers, etc.	-	-	600,000	480,000
4	3000	Air Ports + Windows	16,000	9,000	26,000	20,000
5	3000	Carpenter Work	16,000	10,000	15,000	10,000
6	3000	Joiner Work	420,000	280,000	280,000	200,000
7	3000	Painting + Cleaning	1,300,000	920,000	480,000	300,000
1	4000	Deck Machinery	1,280,000	900,000	1,220,000	1,000,000
2	4000	Ventilation Heating	120,000	100,000	160,000	142,000
1	5000	Main + Aux. Boilers	1,450,000	1,100,000	1,080,000	820,000
2	5000	Main Propulsion	2,600,000	2,220,000	1,860,000	1,620,000
3	5000	Main Condensers	550,000	420,000	400,000	310,000
4	5000	Machinery Controls	500,000	400,000	280,000	220,000
5	5000	Electric Generators	480,000	370,000	290,000	220,000
6	5000	Auxiliary Condensers	-	-	-	-
7	5000	Misc. Auxiliaries	1,380,000	1,120,000	620,000	460,000
8	5000	Misc. Items Mach.	280,000	190,000	160,000	100,000

TYPICAL MAJOR PROPULSION EQUIPMENT AND OUTFIT MATERIAL AND COMPONENT COSTS

(Dollars--1972)

Table I-6

Group	Section		200,000DWT-35,000SHP Tanker (Steam Turbine)		20,000DWT-25,000SHP Cargo Liner (Steam Turbine)	
			U.S.	Foreign	U.S.	Foreign
1	6000	Steam + Exh. Piping	220,000	180,000	162,000	143,000
2	6000	Feed, Cond., FW, Piping	100,000	80,000	82,000	68,000
3	6000	Sea Water Piping	350,000	270,000	200,000	162,000
4	6000	L.O., F.O., etc., Piping	100,000	85,000	68,000	54,000
5	6000	Air Piping	-	-	-	-
6	6000	Cargo + Service Piping	528,000	420,000	20,000	16,000
1	7000	Switchboard, etc.	160,000	142,000	110,000	82,000
2	7000	Power Wiring	150,000	132,000	90,000	70,000
3	7000	Electric Lighting	55,000	40,000	40,000	30,000
4	7000	Communication	85,000	70,000	60,000	42,000
5	7000	Nav. Equipment	78,000	62,000	65,000	52,000

Table I-6 (continued)

Table I-7

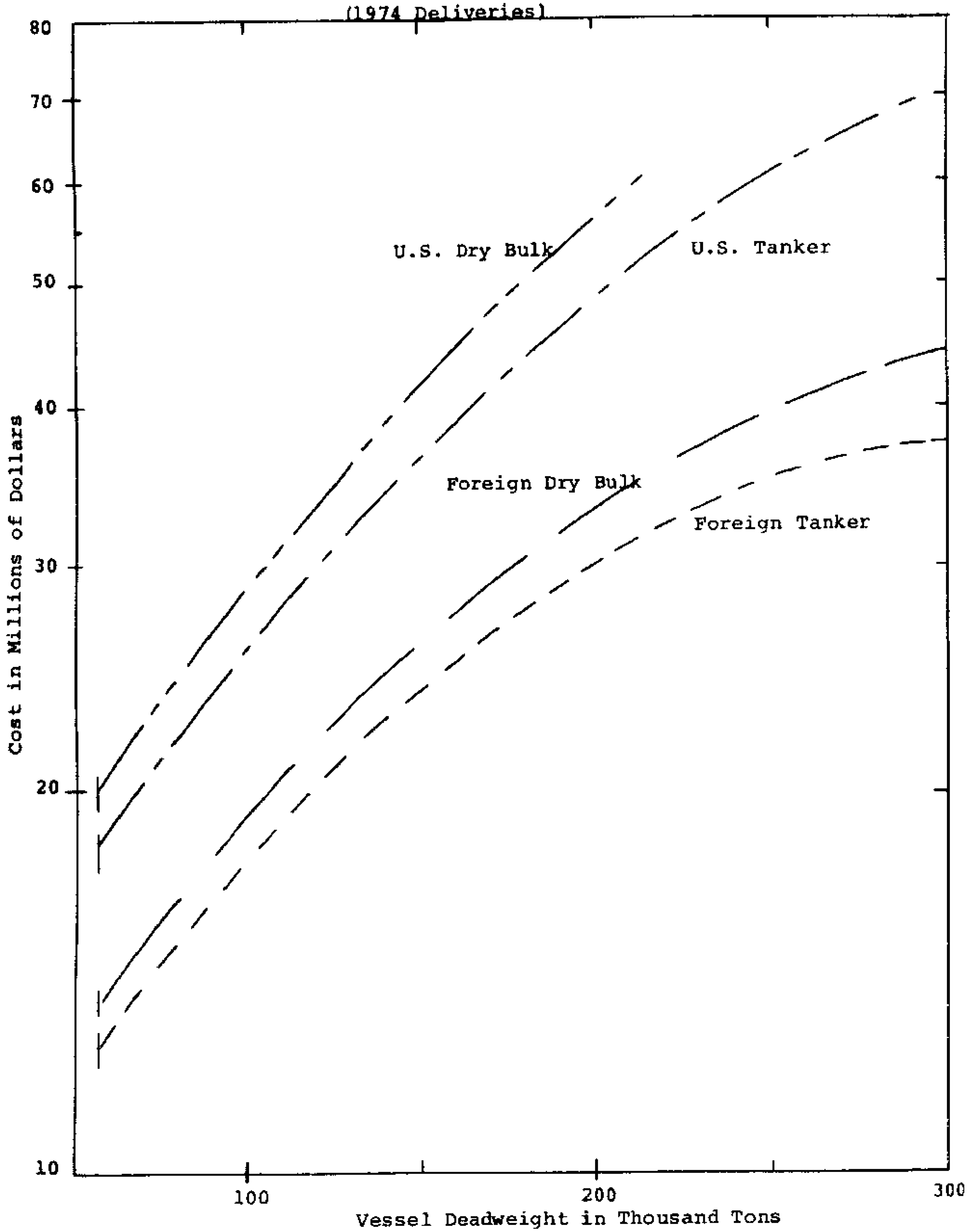
Bulk Carrier Dimensions

Bulk Carrier	Tanker
$DWT = 60364 - 279L + 0.3697L^2$	$DWT = 98044 - 453L + 0.528L^2$
$DWT = -1964 - 312B + 8.626B^2$	$DWT = 150033 - 3349B + 23.2B^2$
$DWT = 4501 - 1703.4H + 74.1H^2$	$DWT = 76819 + 1289.7H + 52.8H^2$

D = DWT tons
L = Length Between Perpendiculars (ft)
B = Beam (ft)
H = Draft (ft)

1) Lloyd's Computer Analysis

Fig. I-5
Relationship Between Vessel Size and Construction
Cost of Bulk Carriers
(1974 Deliveries)



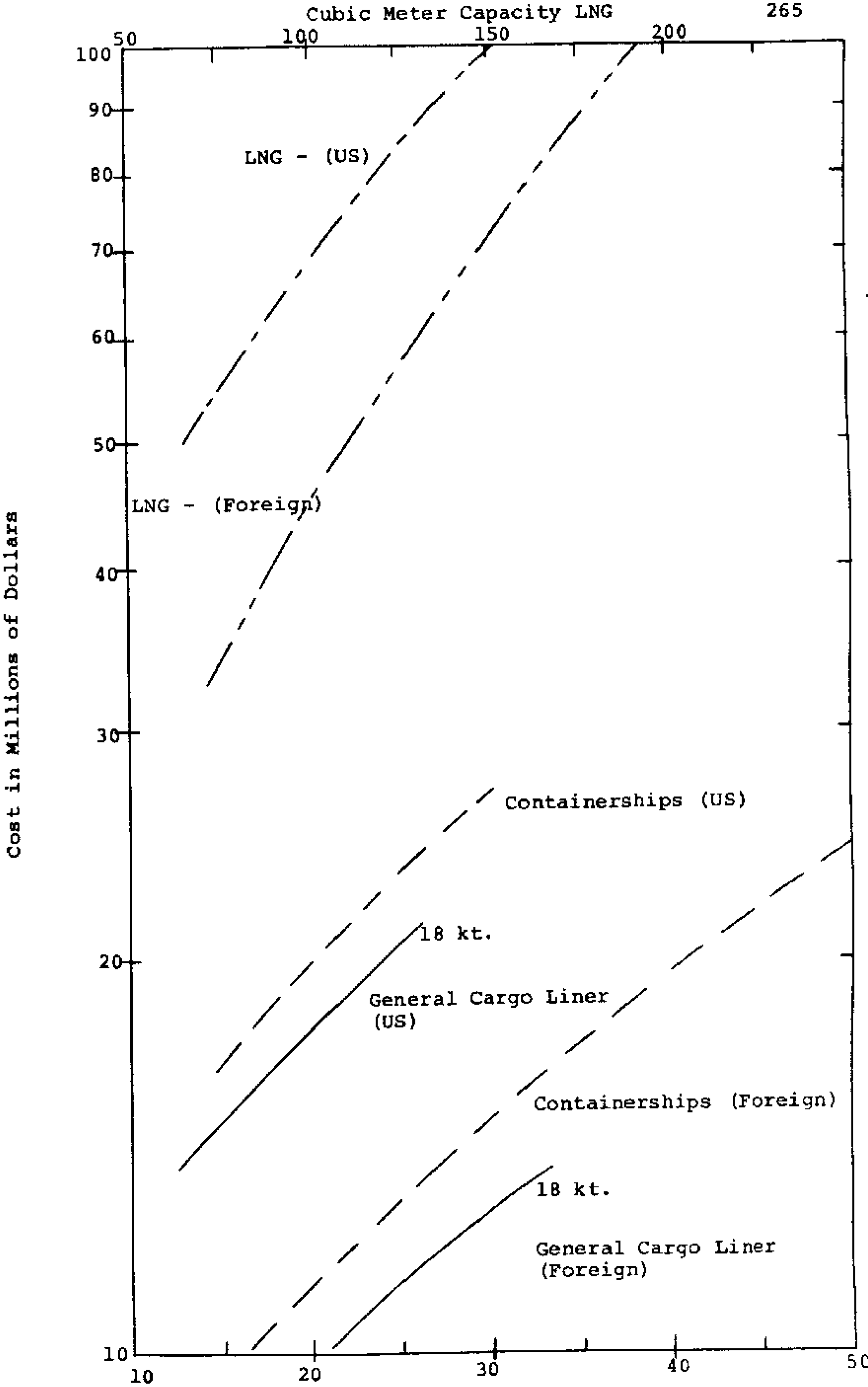


Fig. I-6: Construction Cost of GC Liners, Containerships and LNG Carriers
(1972-73 Delivery)

Chapter II

TANKER COSTS

Tanker costs have increased greatly during recent years and are expected to continue to grow. These cost increases are not only affected by the escalations in material and labor costs worldwide, but also by the financial costs of the large investments made into new and larger tanker building facilities. Direct production manhours vary with the size of the tanker, the type of propulsion and cargo system and various aspects of structural design and arrangement. They are furthermore affected by the ship production methodology, production facility, labor productivity, work rules and other factors. As a result we find that costs are most effectively divided into labor, material, and overhead cost categories. In this report labor and material are furthermore reviewed under hull and "propulsion and outfit" as these major subsystems are affected in different ways by various cost and productivity factors. To account for differences in facilities and methodology, various coefficients were derived by which standard manpower utilization factors (MUF) are modified. These are presented in Figures II-1--II-11. Only some of these coefficients apply to particular categories of MUFs as noted in Table II-1. In addition manpower productivity factors or indices as presented in Figure II-1 and II-2 for each major shipbuilding country are applied.

In computing the required manhours for a particular subsystem the product of all the relevant correction factors is then multiplied by the established MUF (as given in subsequent tables, II-8 to II-22). In this manner the direct manhours for the construction of tankers of various types built in differing facilities and countries can be established.

Hull Steel Labor Costs

Reference material, assembled through work with various shipyards and in association with owners' ship contract negotiations with shipyards, was used to develop estimates of steel manhours per ton or steel productivity per ton for shipbuilding countries capable of constructing tankers in the size range of 25,000-250,000 tons.

The manhours per long ton of steel corresponding to the productivity of the various countries considered for tankers are tabulated in Table II-2. These are average values for standard tankers.

The anticipated productivity improvement percentage per year is also included in this Table.

Using available design data for various types of tankers in the range under consideration, an analysis was performed to establish the manpower intensity in steel manhours for major components of tankers of various sizes, such as bow, midbody, stern, and superstructure. This work was performed by evaluating the percentage of flat versus curved steel in each of these major components and, furthermore, dividing curved steel into the average of doubly and singly curved steel by weight. We then evaluated the percentage of shapes and stiffeners in relation to total steel in each of these major components. These figures were used to estimate the manhours required, based on available statistics of curved, flat panel, and internal structure steel work. Table II-3 presents our findings.

Hull steel labor standards include all direct labor employed in

1) Steel preprocessing
2) Prefabrication (Cutting, etc.)
3) Forming
4) Subassembly
5) Assembly
6) Erection
7) Major Foundations

and other steel work such as clips and brackets required. They do not include services and other overhead labor costs.

The resulting hull steel manhours are multiplied by total averaged hourly shipyard wages (Table II-2-II-3) to determine direct hull steel labor costs for a particular application.

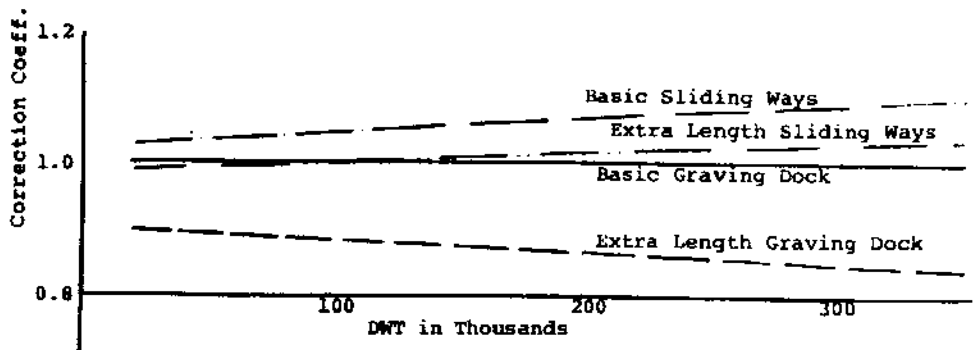


Figure II-1 Effects of Building Platform

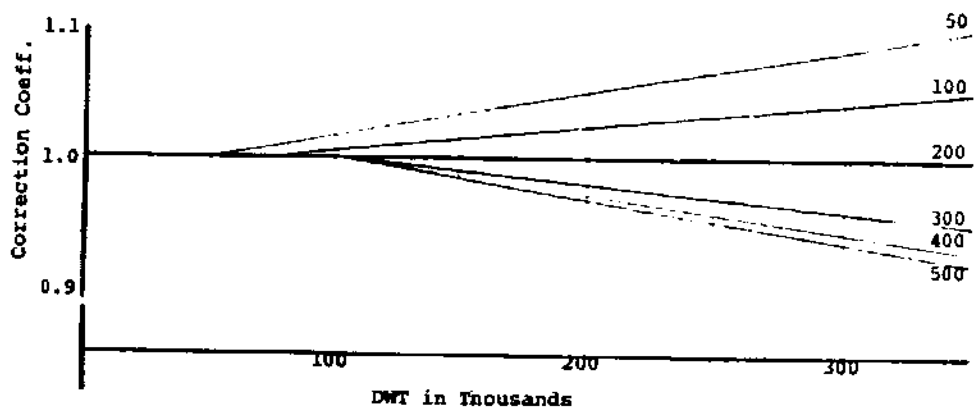


Figure II-2 Crane Lift Capacity Effects (tons)

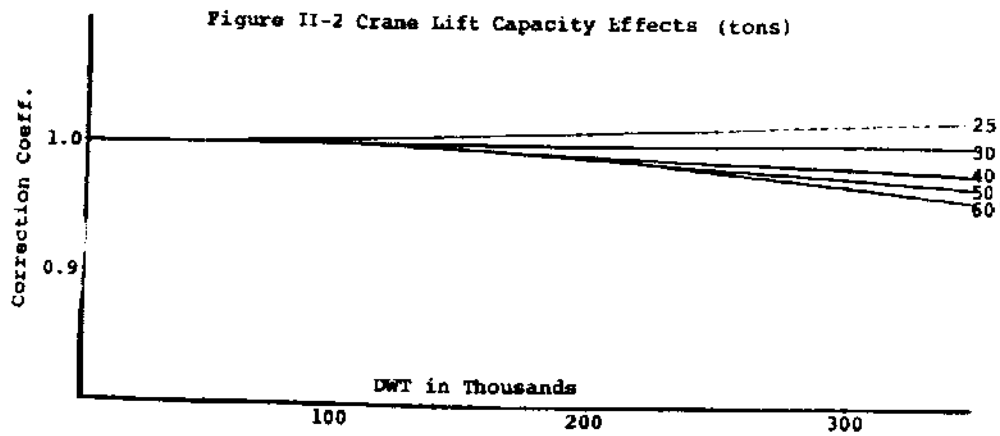


Figure II-3 Length of Fabricated Section

Fig. II-4

Flat Panel Line Effect

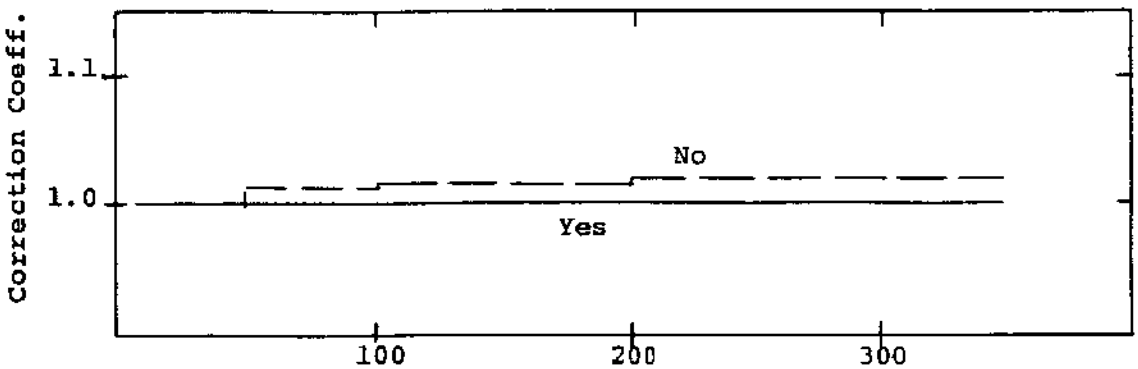
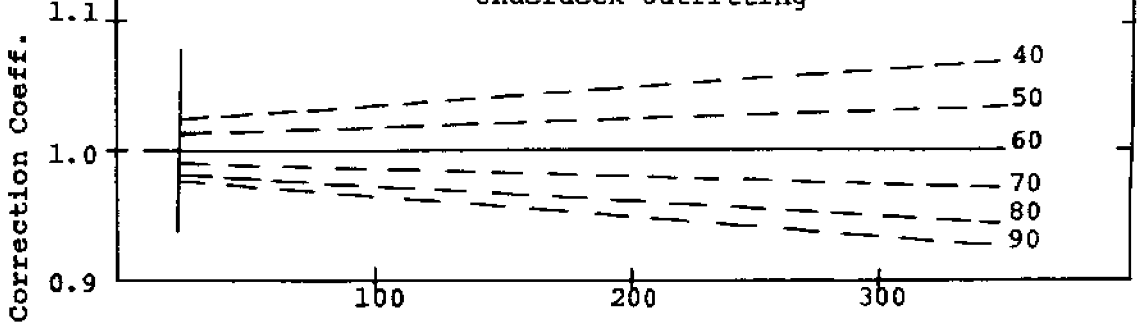


Fig. II-5: Effect of Preoutfitting % of Completion of Underdeck Outfitting



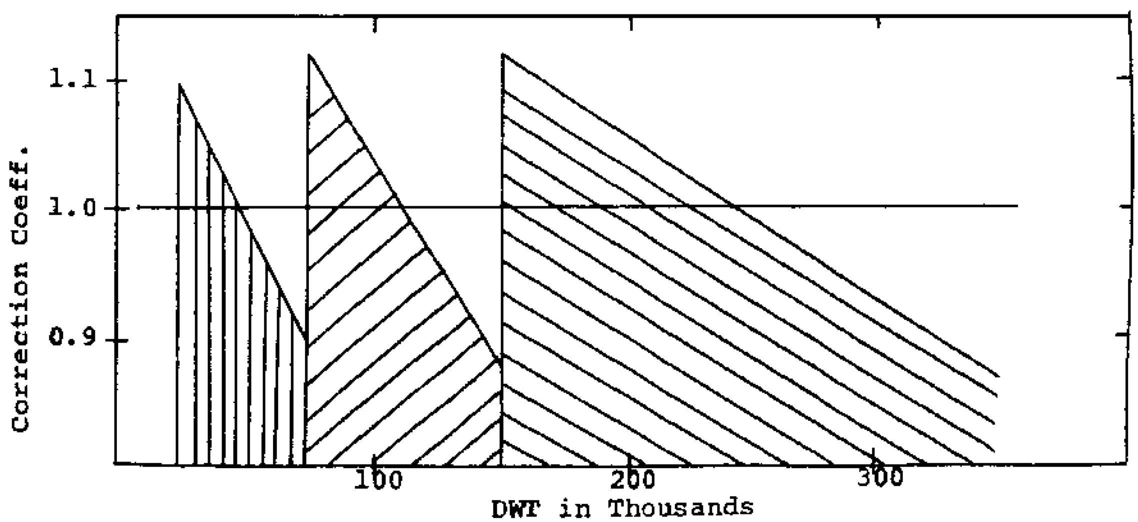
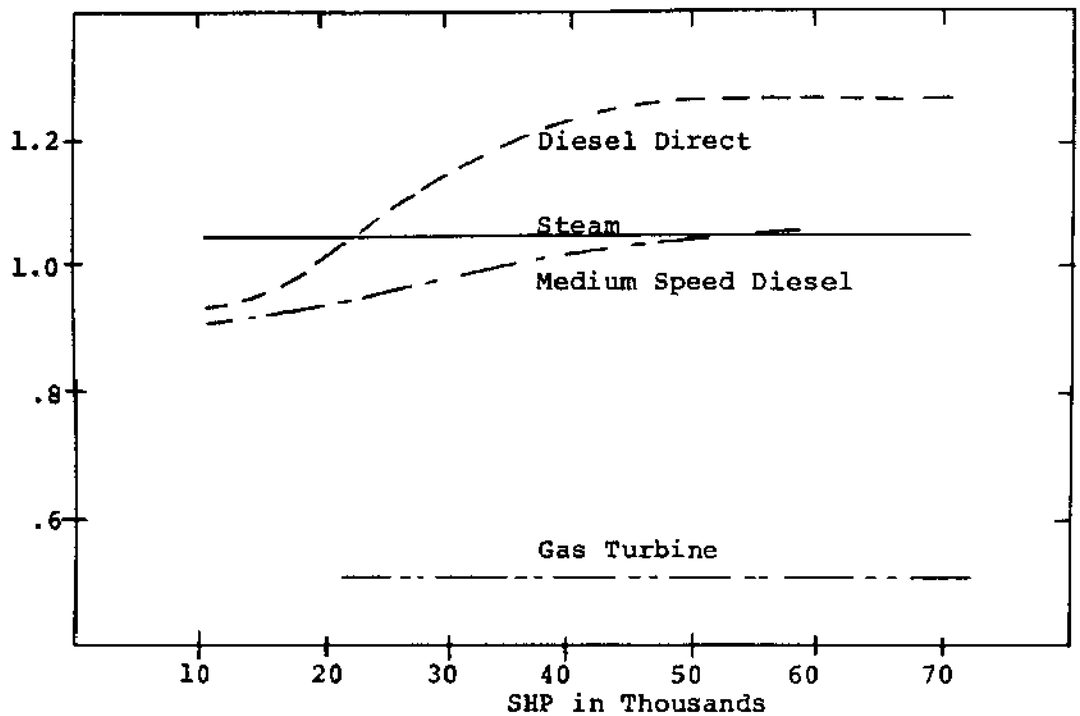


Fig. II-6: Correction Factor for DWT Ranges

Fig. II-7

Effects of Machinery Type



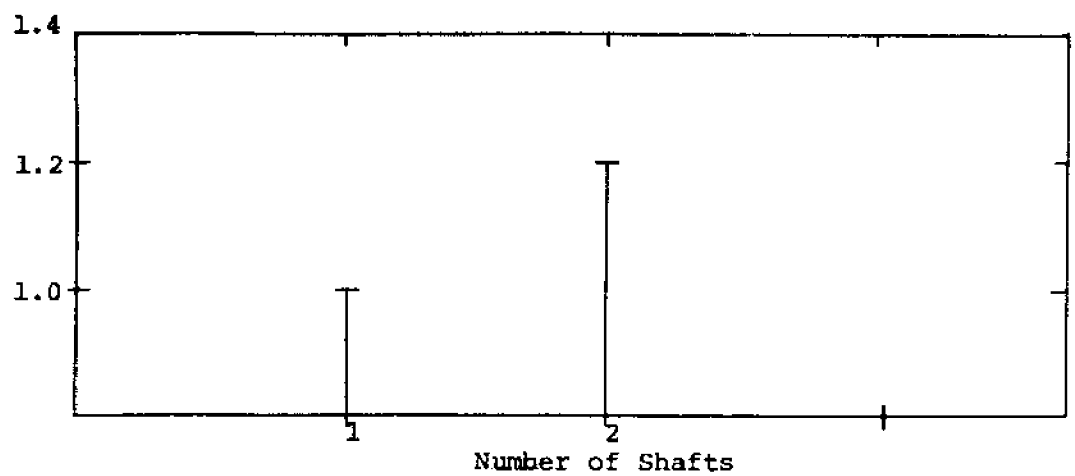


Fig. II-8

Effects of Number of Shafts

Fig. II-9

Effects of Number of Boilers

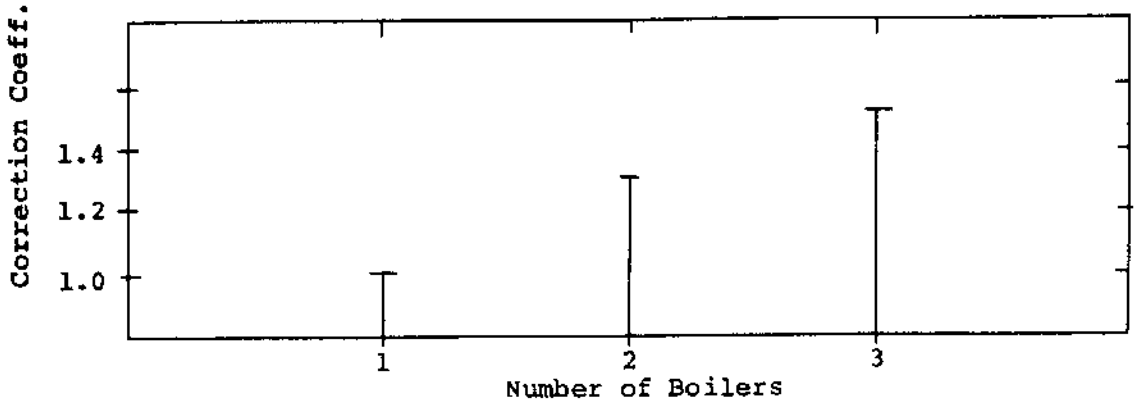
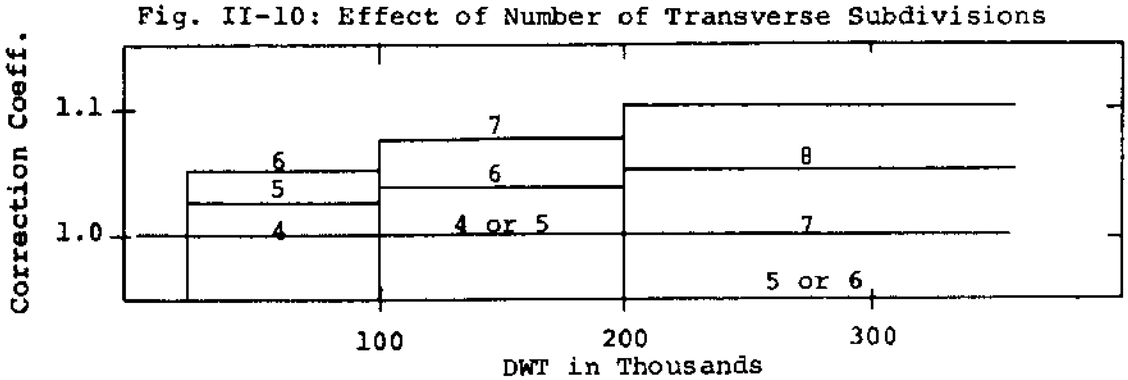


Fig. II-10: Effect of Number of Transverse Subdivisions



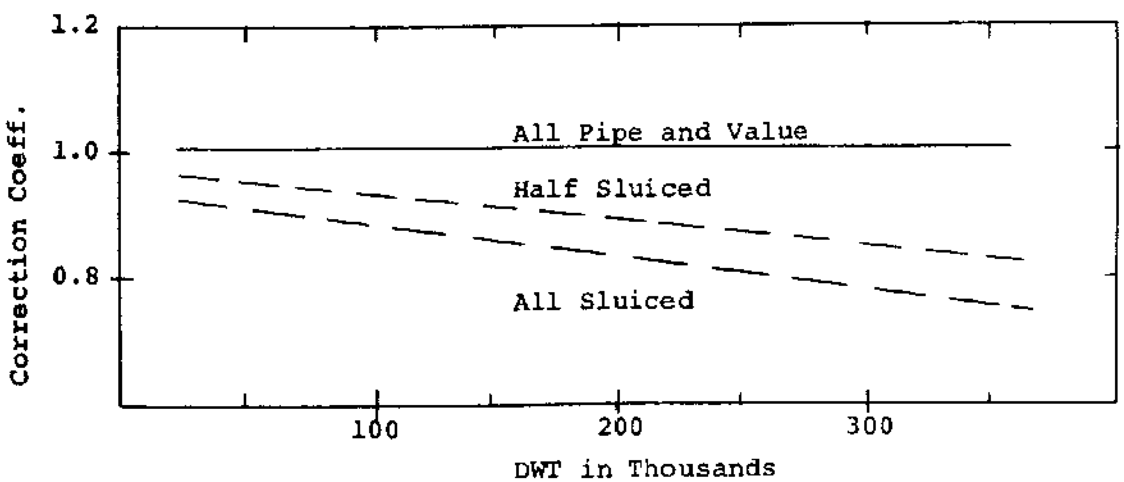


Fig. II-11

Effect of Cargo System

Table II-1

Manhour Correction Coefficients

Effects on Subsystem Manhours

Figure	Coefficient Designation	Affected Subsystems
I-1	Relative Propulsion and Outfit Labor Productivity	All propulsion and Outfit Sub-systems
I-2	Relative Hull Steel Productivity Index	Hull Steel
II-1	Effects of Building Plat-form	Hull Steel All Propulsion and Outfit Subsystems except Superstructure and Hull Equipment
II-2	Crane Lift Capacity Effects	Hull Steel - Main Machinery - Aux. Machinery - Superstructure Cargo/Machinery Piping
II-2	Length of Fabricated Section Effect	Hull Steel - Cargo Piping - Hull Outfit
II-4	Flat Panel Line Effect	Hull Steel
II-5	Effect of Preoutfitting	All propulsion and outfit sub-systems except superstructure and Hull Equipment
II-6	Correction for DWT Ranges	All subsystems
II-7	Effect of Machinery Type	Main Machinery - Aux. Machinery Machinery Piping
II-8	Effect of Number of Shafts	Main Machinery - Aux. Machinery Machinery Piping
II-9	Effect of Number of Boilers	Steam Main Propulsion (other propulsion 1.0)
II-10	Effect of Cargo System	Cargo Piping

Table II-2

HULL STEEL MANHOURS
(normalized to 1971 figures)
(Steel MH/LT)

Country	DWT				Comments
	25,000	87,000	125,000	250,000	
Denmark	55.0	47.2	34.0	24.0	1% Improvement per Annum
Germany	57.5	49.0	37.0	26.0	1% " " "
Holland	57.0	*50.0	*37.5	27.5	1% " " "
Sweden	59.0	50.0	37.0	25.0	1% " " "
Norway	57.0	48.2	*36.0	25.0	1.5% " " "
Italy	75.0	*62.5	*46.5	33.2	2% " " "
Spain	91.0	*78.0	*57.5	42.5	2% " " "
France	84.0	74.0	*53.0	35.0	2% " " "
Japan	76.0	63.0	45.0	31.0	2% " " "
U.K.	88.0	74.0	54.0	39.0	2% " " "
U.S.A.	79.5	68.0	49.2	35.0	

The above Steel MH/LT were derived from data obtained from:

1) Shipyard Reports and Quotes
2) Technical Papers
3) Verbal Discussions with Owners and Shipyard Reps.

Where data was not consistent with particular ship size units, available data was plotted as in Fig. 1-2 to derive estimate. The steel MH improvement % as noted was applied to normalize information to a 1970 base. (Data was spread over 1964-1969 period)

*Estimates, only two points available.

Tanker DWT	Forebody [1] Steel MH/LT / Avg. MH/LT	%Steel	Parallel Midbody [2] Steel MH/LT / Avg. MH/LT	%Steel	Aftbody [3] Steel MH/LT / Avg. MH/LT	%Steel	Superstructure [4] Steel MH/LT / Avg. MH/LT	%Steel
25,000	1.20	.150	.780	.468	.121	.304	.110	.78
67,000	1.22	.142	.790	.511	.1233	.288	.112	.59
87,000	1.32	.139	.804	.540	.1247	.2728	.115	.482
125,000	1.24.1	.134	.819	.564	.126	.2695	.116	.325
205,000	1.28	.124	.830	.636	.1298	.2139	.119	.261
250,000	1.29	.1178	.840	.662	.1318	.195	.121	.252

1) Forebody including bulb and pumproom if any
2) Midbody including all cargo and midship ballast tanks
3) Aftbody including pumprooms to forward pp. room bulkhead
4) Superstructure including stacks, etc.

Table II-3

STEEL MH FOR VARIOUS TANKER COMPONENTS

To assure versatility of results, these are presented in the form of component Steel MH/Average Steel MH for each tanker size. The results can be used to compute the component steel MH for various tanker sizes built in the subject countries by multiplying the above ratio by the (LT steel (net) x % of steel in component x Average MH's/ST).

Outfitting and Propulsion System Labor Costs

Propulsion and outfit manhours are a function of three groups of variables: tanker size and configuration, the equipment and production techniques of the shipyard in which the vessel is being built, and the manhour productivity of the yard workers.

A system which can effectively evaluate propulsion and outfit manhours must be flexible enough to allow for all the permutations and combinations of the above three groups of variables without becoming unwieldy to use.

In keeping with this strategy, manpower indices for propulsion and outfitting systems were developed for different tanker size ranges. These indices apply to what we refer to as tankers with a "standard" configuration built in a "standard" manner. A tanker with a "standard" configuration is defined as having steam turbine main propulsion, a single screw, one boiler, pipe and valve type cargo system, minimal automation and reasonably standard transverse bulkhead spacing. Building in a "standard" manner assumes a shipyard which uses a graving dock for erection, has a maximum crane lift capacity at the centre line of 200 tons, a flat panel line, no ability to build separate stern sections while a full size tanker is being erected, and does a median amount of pre-outfitting.

These standard sets of manpower indices act as a base which can then be adjusted to arrive at propulsion and outfitting system manhours for tankers with other than standard configurations and/or being built in yards using other building techniques and/or facilities. In selecting our "standard", however, we attempted to choose the most commonly encountered ship configuration and building technique in order to minimize the frequency and extent of any adjustments that may be required.

The initial step in setting up the manpower indices for the ranges of tanker deadweights required was the selection of a set of components which would be all-inclusive of propulsion and outfitting systems for all tankers to be investigated. From this group the components with appropriate manpower factors were selected for a series of "standard" ships. The base manpower requirements for the "standard" ships were based upon medium Japanese manpower productivity by appropriate skills.

In calculating propulsion and outfitting manhours for a tanker which differs from the standard tankers in tanker configuration and/or building technique, we select the manhour per unit for the respective vessel deadweight range and apply the manhour factors to all the vessel materials and equipment to obtain the manhours for each item or system (i.e., the hours which would result if the vessel was of the standard configuration and built in the standard manner).

These hours then are adjusted by applying correction coefficients to the manhours for items which are affected by deviations from the standard tanker configuration and/or building technique.

Once manhours are calculated for each tanker product based on the actual tanker configuration and construction methods used, the hours are consolidated into groups or systems according to the labor skills involved. These manhours for each skill are adjusted according to the labor productivity index for the country in which the ship is to be built. The final result reflects the estimated manhours required, in a specific shipyard, to install the propulsion and outfitting systems for a given tanker.

The basic system for determining the propulsion and outfit manhours is described diagramatically in Figure II-12. Table II-4 gives typical results of estimated propulsion and outfit manhours requirements (using the above system) in the construction of a standard 220,000 DWT tanker steam propulsion and a 135,000 DWT diesel driven tanker in each of the selected shipyards.

In using this method of calculating outfitting and propulsion system manhours a tanker owner, for example, would initially specify his tanker deadweight, propulsion system type and shaft-horsepower, number of shafts, number of boilers (if any), spacing between transverse bulkheads, degree of automation, cargo system type, number of crew, etc. Following this would be a list of the quantities of each of the major tanker materials and equipments as found in Table I-6. Then one would specify, for the shipyard to be investigated, building dock type, crane capacity, maximum dimension of size of sections, whether or not the yard has a flat panel line and/or the ability to build separate stern sections, and the degree of pre-outfitting practiced. Taking all these values and using the tables and charts provided, he can arrive at the estimated required manhours.

If the product level of detail in estimating manpower costs is not desired or if material and equipment lists are not available, the method permits derivation of manpower utilization factors and/or costs for complete systems such as propulsion, accommodation, etc.

Propulsion and outfit were first divided in major groupings as shown in Table II-5 and each group defined by a list of products. These products were then broken into work items.

COUNTRY (SHIPYARD)	PROPULSION AND OUTFIT MANHOURS			
	220,000 DWT TANKER	RANK	135,000 DWT TANKER	RANK
1. United Kingdom (Harland and Wolff)	604,000	7	504,000	7
2. Japan (Standard Yard)	607,000	5	490,000	5
(IHI)	475,000	-	396,000	2
3. Spain (ASTANO)	763,000	9	612,000	8
4. Denmark (Odense)	412,000	1	357,000	1
5. Sweden (Gotaverken)	521,000	3	425,000	3
6. Norway (Aker)	612,000	6	485,000	4
7. Taiwan	820,000	8	632,000	9
8. U.S.A. (Seatrain) (estimated)	842,000	10	672,000	10

PROPULSION AND OUTFIT MANHOURS FOR 220,000 DWT AND 135,000 DWT TANKERS IN SELECTED COUNTRIES AND SHIPYARDS (1970)

Table II-4

Tanker configuration variables used are listed in Table II-6 which also lists the affected component or work items. The standard unit manhours for the affected work item are then multiplied by the corresponding tanker configuration coefficients. These coefficients were derived from an analysis of manhour requirements by the same yard building different tankers. It was found that the resulting coefficients were hardly affected by the relative productivity of a shipyard. As a result, it is suggested to use the same coefficients for all yards in all countries.

The effect of shipyard facilities on outfit and propulsion labor productivity is quite pronounced and realized in many different ways. The ability to pre-outfit larger blocks is provided by bigger crane capacity. This introduces increases in productivity of block versus on berth outfitting. Block provides better access, lower labor density, open spaces or volumes, better material flow and schedule, etc., all of which contribute to improved productivity. A longer building dock with a separate stern position for open sky or similar outfitting and propulsion system installation provides improvements over closed stern installation and outfit.

Various important shipyard facility variables are defined and the affected components or work tasks listed in Table II-7. These are used later to derive correction coefficients for the effect of shipyard facility variables on outfit and propulsion system labor productivity.

The manhour standards derived in a recent study[1)] are presented in Tables II-8 to II-21. These standards are based on the relevant units of each particular product.

Product manhour standards were subsequently used to derive group manhour standards for various countries and tanker sizes as presented in Table II-22. These manhour standards can be used to compute the manhour requirements for the construction of a specific type of tanker, in a particular country, by a selected shipyard. Multiplying the resulting manhour requirements by unit manhour costs (Table I-3) will then provide the direct propulsion and outfit labor costs.

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1) This study was in part funded by Esso International.

Figure II-12

METHOD FOR DERIVING MUF's FOR PROPULSION AND OUTFIT

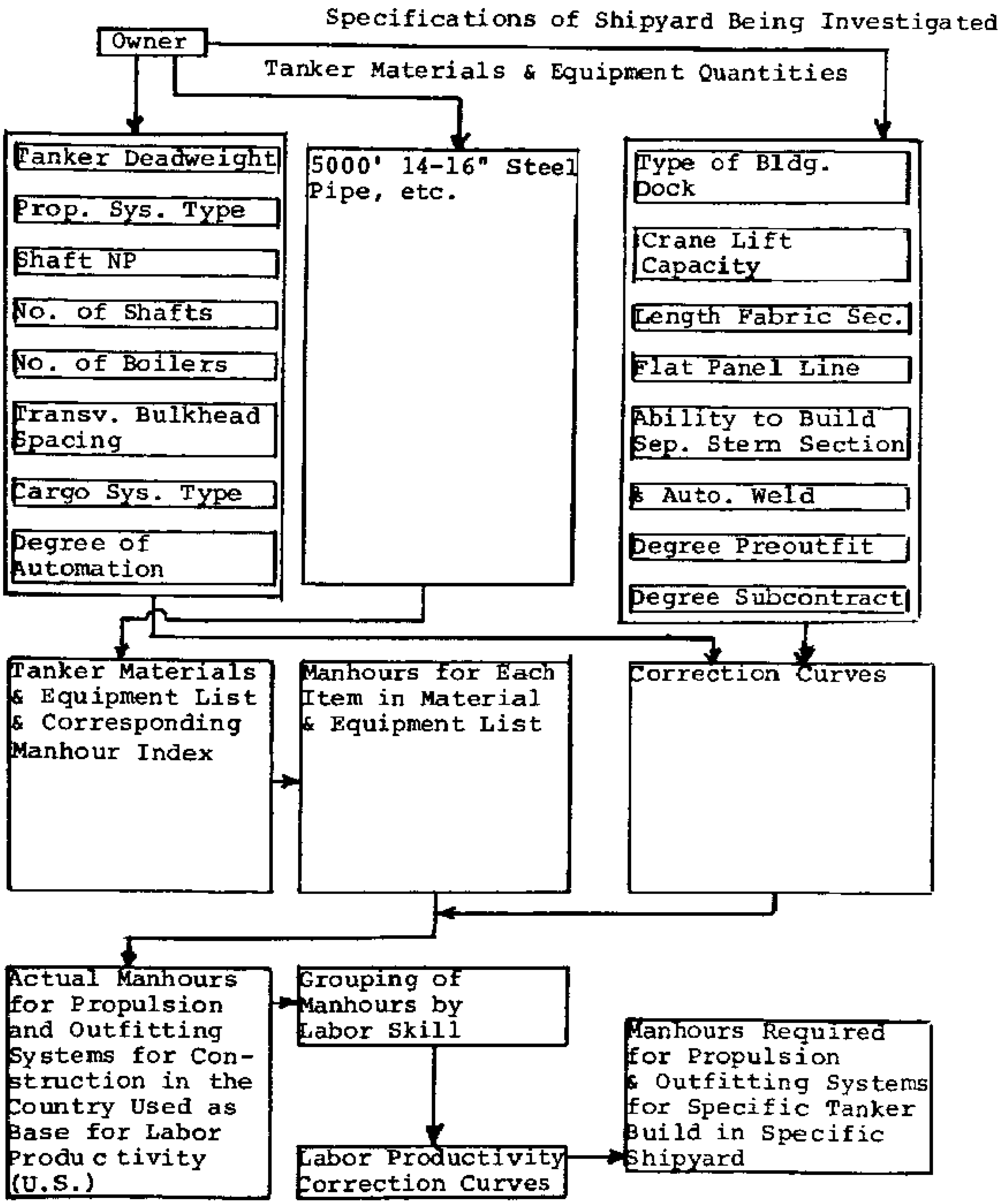


Table II-5

Product Listing

GROUP	LIST OF PRODUCTS
Structure	Flat Panels, Curved Panels, Built-up Sections, Medium Weldments, Ladders, Rails, Guards and Gratings, Miscellaneous Structures.
Piping	Welded Ferrous Pipe, Mechanically Joined Pipe, Non-Mechanically Joined Non-Ferrous Pipe, Plastic Pipe, Tubing
Electrical	Cable up to 1-1/4" diameter, cable from 1-5/16" diameter, cable over 2" diameter, Fixtures and Equipment, self-mounted, Fixtures and Equipment, bedplate mounted, Fixtures and Equipment, built-up foundations.
Sheet Metal	Rectangular Ventilation Ducting, Round or Oval Ventilation Ducting, Bins and Stowages, Compartment Sheathing, Metal Joiner Bulkheads, Metal Furniture--permanently mounted.
Machinery	Heat Exchangers, Units assembled and aligned on integral foundations (Turbines, Gears, Main Diesels, Main Shafting), Package Units mounted on bedplate-type foundations, (Winches, Pumps, Compressors, Blowers). Hydraulic Units assembled in place.
Joiner	Joiner Bulkheads, Joiner Furniture and Trim.
Support Services	Blocking, Shoring and Alignment, Material Handling and Shipyard Rigging, Temporary Utilities, Scaffolding, Cleanup and Housekeeping, Lofting and Dimensional Control.
Miscellaneous	Surface Preparation and Painting, Ship Rigging, Canvas and Cloth Work, Surface Coverings (Deck Covering, Wall Covering, Mouldings).

The "total products" identified can be accumulated into larger identifiable units to the group or systems level and then continued further to the complete ship divided into major systems which are the sum of all total products and groups, or systems.

TANKER CONFIGURATION VARIABLES	AFFECTED COMPONENTS
Deadweight	As stated in MUF System or Component Data
Main Machinery Type (Diesel, Steam or Gas)	Main and Auxiliary Machinery Installation. Piping and Electric System in Machinery Space.
Number of Shafts (1 or 2)	Main and Auxiliary Machinery Installation. Piping Electric System in Machinery Space.
Number of Boilers (0, 1 or 2)	Main and Auxiliary Machinery Installation. Piping and Electric System in Machinery Space.
Spacing Between Transverse Bulkheads	Cargo System and Related Piping.
Cargo System (Conventional or Sluicing)	Cargo System and Related Piping.
Number of Crew	Superstructure Outfit and Lighting System.
Other, such as Multi-Product Capability, Special Safety Maneuvering, Endurance, etc. Requirements	Various

Tanker Configuration Variables and

Affected Tanker Components

Table II-6

Shipyard Variables	Affected Components
Type of building and/or platform (graving dock, sliding ways, lock, marine railway, etc.	Propulsion components piping and electrical systems throughout ship
Maximum Crane Lift Capacity	Piping, machinery components accommodation, other distributed and service system components
Maximum dimension or size of section, assemble or block	Piping, grating, railing, other distributed systems
Flat Panel Line (Yes or No)	Piping, grating, railing, other distributed systems
Ability to build separate stern section(s) (Yes or No)	Machinery components and machinery outfit system components
Percent or auto or semi-automatic welding used	Piping, ducting
Degree of Preoutfitting	All propulsion and outfit components
Degree of subcontracting in machinery accommodation, etc.	Same system components

Shipyard Variables and
Affected Tanker Components

Table II-7

ITEM	UNIT	25-75,000 DWT Tanker	75-150,000 DWT Tanker	150-300,000 DWT Tanker	COMMENTS
Main & auxiliary boilers	SHP	0.802	0.551	0.465	Main boilers, aux. boilers Fuel oil service Forced draft, feed pipes
Main propulsion machinery	SHP	1.124	0.882	0.736	Main engine, gears Lub oil pp., coolers; Heaters, filters, purifiers Prop, shafting, stern tube Bearings
Main condenser & accessories	SHP	0.260	0.180	0.156	Main condensers Accessories - main Circulating- air ejecting
Centralized machinery controls	SHP	0.936	0.736	0.615	Propulsion controls Mach./Pilot house Cargo system-reefer-deck Machinery
Electric generators	SHP (KW)	0.131 (1.52)	0.107 (1.3)	0.089 (1.22)	Generators-emergency Generators
Auxiliary condensers & access.	SHP	0.069	0.054	0.045	Aux. condensers Aux. circulating pumps
Misc. Auxiliaries	SHP	1.988	1.598	1.338	Evaporators & access. FW and SW pumps Air compr.-F.O. transfer Pumps - reefer- fire pps. Cargo pumps Sanitary pps. - sewage plant Butterworth or equivalent Oily water separating, etc.
Misc. items in machinery spaces	SHP	1.185	0.838	0.698	Mech. communication Instruments - insulation Floor plates - pans Name plates - oper. gear, etc.
TOTAL		6.495	4.946	4.142	

TANKER MATERIALS AND EQUIPMENT LIST AND CORRESPONDING MANHOUR STANDARDS
Table II-8

Category: Machinery* Installation in Manhours/Unit Stated (Steam Turbine 650/900)
(*Including: shafting, propellers, bearings, gears, heaters, pumps, etc.)

	MANHOURS/UNIT FACTOR					
	25-75,000 DWT Tankers		75-150,000 DWT Tankers		150-300,000 DWT Tankers	
	SHP	DWT	SHP	DWT	SHP	DWT
Piping System						
Steam and Exhaust	0.60		0.48		0.40	
Feed, Condensate, Vacuum	0.08		0.07		0.06	
Fresh Water and Sanitary Wash Water		0.020		0.018		0.012
Chilled Water		0.016		0.012		0.010
Steam Drain	0.02		0.02		0.015	
Sea Water Cooling	0.40		0.35		0.30	
Bilge, Ballast in Mach.		0.040		0.035		0.030
Fire main		0.120		0.100		0.070
Sea Water Sanitary		0.010		0.008		0.005
Lub. Oil	0.20		0.18		0.16	
Fuel Oil Service	0.06		0.05		0.04	
Fuel Oil Filling, Transfer Oily Water Ballast in Mach.		0.050		0.030		0.020
Heating Coils Cargo Tks.		0.100		0.070		0.050
Air Piping	0.02		0.02		0.015	
Reefer Piping		0.010		0.008		0.005
Hydraulic		0.010		0.008		0.005
Cargo Piping Tanks incl. Valves		0.320		0.250		0.180
Cargo Piping Mach. incl. Valves		0.300		0.225		0.150
Butterworth-Jet Cleaning		0.100		0.080		0.060
Vents, Overflows, Sounding Tubes, etc.		0.140		0.110		0.080
Level Indicators		0.008		0.006		0.004
Drain and Scuppers		0.008		0.006		0.004
Bilge, Ballast, Outside Machinery		0.100		0.090		0.080
Totals	1.38	1.232	1.17	0.945	0.985	0.705

Example: 200,000 DWT and 30,000 SHP, Total Piping System MH are 0.985 x 30,000 + 0.765 x 200,000 or 182,850 MH

	Unit Factor	Electrical System		
Switchboards	KW	1.48	1.35	1.20
Power Wiring incl. Wireways	KW	13.20	11.80	10.20
Communication Sys.	None	6,600	8,000	10,000
Navigation Sys.	None	3,200	4,000	5,000
Elec. Lighting Accommodation	Ft^2	0.36	0.30	0.26
Elec. Lighting Mach., Deck	DWT	0.13	0.10	0.08

Example: Elec. System MH; Tanker 200,000 DWT, 3000 KW, 30,000 ft^2; MH = 16,000+7800+15,000+34,200 = 73,000

Tanker 50,000 DWT, 1800 KW, 20,000 ft^2
MH = 6500+7200+9800+26,500 = 50,000

Table II-9
Category: Piping and Electrical System

ITEM	MANHOURS PER TON DISPLACEMENT 25-75,000 DWT Tanker	75-150,000 DWT Tanker	150-300,000 DWT Tanker
Hull Equipment			
Windlass, chain stopper	0.026	0.022	0.020
Capstan, mooring & towing winches	0.041	0.036	0.032
Cargo winches	0.014	0.010	0.008
Elevators	0.009	0.007	0.006
Steering gear	0.019	0.015	0.012
TOTAL/ton displacement	0.109	0.090	0.078
Ventilation and Airconditioning			
Machinery ventilation MH per SHP	0.39	0.32	0.30
Accommodation ventilation, MH per ft^2	0.32	0.28	0.25

Table II-10

Tanker Materials and Equipment List and Corresponding Manhour Standards

Category: Hull Equipment and Ventilation

ITEM	MANHOURS/FT^2 OR BY NUMBER OF CREW 25-75,000 DWT Tanker	75-150,000 DWT Tanker	150-300,000 DWT Tanker
Airports and windows	0.100	0.085	0.078
Carpenter ward	0.108	0.104	0.100
Joiner work	1.579	1.544	1.504
Painting and cleaning interior, superstructure	0.400	0.360	0.320
TOTAL	2.187	2.093	2.002

Table II-11

<u>Tanker Materials and Equipment List</u>
<u>and Corresponding Manhour Standards</u>

Category: Superstructure Outfit

ITEM	MANHOURS PER TON DISPLACEMENT 25-75,000 DWT Tanker	75-150,000 DWT Tanker	150-300,000 DWT Tanker
Bitts, chock cleats, fairleads	0.018	0.016	0.014
Anchors, chains, towline, hawsers	0.012	0.009	0.007
Laddars, stairways, outside machinery	0.092	0.071	0.062
Railing outside machinery	0.060	0.048	0.041
Manholes, hatch covers, a access plat.	0.027	0.019	0.016
Aux. and misc. foundations	0.064	0.048	0.041
Standing rigging	0.005	0.003	0.002
Running rigging	0.009	0.006	0.004
Cargo ports - steel doors	0.015	0.010	0.007
Closures	0.490	0.320	0.280
Misc. hull & deck fittings	0.026	0.019	0.014
TOTAL	0.818	0.569	0.488

Table II-12

Tanker Materials and Equipment List and Corresponding Manhour Standards

Category: Hull Outfit

ITEM	25-75,000 DWT Tanker manhrs/ft^2	75-150,000 DWT Tanker manhrs/ft^2	150-300,000 DWT Tanker manhrs/ft^2
Hull insulation	0.21	0.20	0.19
Division & passage bulkheads	0.185	0.18	0.17
Lining	0.37	0.36	0.35
Ceiling	0.26	0.25	0.24
Toilet partitions-door	0.01	0.01	0.01
Wire mesh bulkheads	0.01	0.01	0.01
Joiner doors & frames	0.08	0.08	0.08
Furniture	0.08	0.08	0.08
Air ports & window panes	0.01	0.01	0.01
Hardware	0.02	0.02	0.02
Name plates	0.02	0.02	0.02
Reefer boxes	0.02	0.02	0.02
Bins & shelving	0.01	0.01	0.01
Misc. joiner work	0.01	0.01	0.01
Galley & pantry equip.	0.05	0.05	0.05
Stewards material	0.01	0.01	0.01
Deck covering-wall tile	0.02	0.02	0.02
Portable grating	0.01	0.01	0.01
Canvas work	0.001	0.001	0.001
Fire-life saving outfit	0.01	0.01	0.01
Nav. instrument outfit	0.05	0.05	0.05
Laundry outfit	0.04	0.04	0.04
Hospital outfit	0.001	0.001	0.001
Deck stores outfit	0.001	0.001	0.001
Hull stowage	0.001	0.001	0.001
Davits, rafts, etc.	0.04	0.04	0.04
Accommodation Ladders, gangways, etc.	0.05	0.05	0.05
TOTAL	1.579/ft^2	1.544/ft^2	1.504/ft^2

Table II-13

Tanker Materials and Equipment List
and Corresponding Manhour Standards

Category: Joiner Work in Manhours/Ft^2 of Total Area (outfitting of accommodations, public spaces, messes, etc., including furnishings)

Wire Size	25-75,000 DWT Tanker manhours/ft	75-150,000 DWT Tanker manhours/ft	150-300,000 DWT Tanker manhours/ft
	Steel Armoured Cable with Vinyl Cover in Lead		
Hasta 16	0.144	0.140	0.140
17 A 26	0.168	0.164	0.164
27 A 35	0.180	0.175	0.174
35 A 60	0.201	0.190	0.188
	Neoprene Covered Cable		
Hasta 16	0.120	0.120	0.120
17 A 26	0.122	0.122	0.122
27 A 39	0.140	0.140	0.140
40 A 58	0.150	0.150	0.150
	Lead Covered Cable		
7	0.250	0.248	0.244

Table II-14

Tanker Materials and Equipment List
and Corresponding Manhour Standards

Category: Electrical Wiring

Material	Dimension	Type of Joint	MANHOUR INDEX 25-75,000 DWT Tanker manhours/ft	75-150,000 DWT Tanker manhours/ft	150-300,000 DWT Tanker manhours/ft
Steel	3/4"-2"	W	1.15	1.11	1.06
		F	1.36	1.31	1.26
Steel	2-1/2"-4"	W	1.49	1.44	1.39
	5"	F	1.69	1.64	1.59
Steel	5"	W	1.65	1.60	1.55
		F	1.85	1.80	1.75
Steel	6"	W	1.81	1.76	1.70
		F	2.01	1.96	1.90
Steel	8"	W	1.95	1.90	1.84
		F	2.15	2.10	2.06
Steel	10"	W	2.24	2.18	2.11
		F	2.45	2.39	2.32
Steel	12"	W	2.52	2.46	2.39
		F	2.74	2.68	2.61
Steel	14"	W	2.82	2.76	2.69
		F	3.06	3.00	2.92
Steel	16"	W	3.22	3.16	3.08
		F	3.38	3.32	3.24
Steel	18"	W	3.39	3.32	3.24
		F	3.68	3.61	3.53
Steel	20"	W	3.69	3.61	3.53
		F	4.00	3.92	3.83
Steel	22"	W	4.04	3.96	3.87
		F	4.31	4.23	4.14
Steel	24"	W	4.34	4.26	4.17
		F	4.58	4.50	4.41

Table II-15

Tanker Materials and Equipment List
and Corresponding Manhour Standards

Category: Piping

Service: Vacuum, low and medium pressure salt water condensate, or steam piping (machinery).

Material	Dimension I.D."	Type of Joint	Service	MANHOUR INDEX 25-75,000 DWT Tanker manhours/ft	75-150,000 DWT Tanker manhours/ft	150-300,000 DWT Tanker manhours/ft
S	3-6"	W	F,B,S	1.6	1.5	1.4
	3-6"	C	F,B,S	1.3	1.2	1.1
S	6-9"	W	F,B,S	2.9	2.7	2.6
	6-9"	C	F,B,S	2.5	2.3	2.2
S	9-12"	W	F,B,S	3.3	3.1	3.0
	9-12"	C	F,B,S	2.8	2.6	2.5
S	12-18"	W	B,S,C	3.8	3.6	3.5
	12-18"	C	B,S,C	3.3	3.1	3.0
S	18-24"	W	B,S,C	4.4	4.2	4.1
	18-24"	C	B,S,C	3.9	3.7	3.6
S	24-30"	W	C	-	4.8	4.7
	24-30"	C	C	-	4.2	4.1

Material: S = Steel

Joint: W = Welded
C = Coupling

Service: F = Fuel Oil
B = Ballast
S = Stripping
C = Cargo

Tanker Materials and Equipment List and Corresponding Manhour Standards

Category: Piping

Table II-16

				MANHOUR INDEX		
Material	Dimension	Type of Joint	Service	25-75,000 DWT Tanker manhours/ft	75-150,000 DWT Tanker manhours/ft	150-300,000 DWT Tanker manhours/ft
GS	1/2"	W	S	0.560	0.530	0.500
GS	1"	F + W	S	0.645	0.595	0.540
GS	1-1/2"	F + W	S	0.760	0.710	0.665
GS	2"	F + W	S	0.890	0.840	0.790
GS	2-1/2"	F + W	S	0.910	0.860	0.810
GS	4"	F	S	1.000	0.950	0.900

Service: S = Sanitary Piping (Accommodations)

Material: GS = Galvanized Welded or Seamless Steel

Joint: F = Flange (Screwed or Welded)
W = Welded

Table II-17

Tanker Materials and Equipment List and Corresponding Manhour Standards

Category: Piping

Material	Dimension	Type of Joint	MANHOUR INDEX 25-75,000 DWT Tanker manhours/ft	75-150,000 DWT Tanker manhours/ft	150-300,000 DWT Tanker manhours/ft
Steel	3/4"-2"	W	1.80	1.80	1.80
		F	2.20	2.20	2.20
Steel	2-1/2"-4"	W	2.10	2.10	2.10
		F	2.60	2.60	2.60
Steel	5"	W	2.50	2.50	2.50
		F	2.92	2.92	2.92
Steel	6"	W	2.92	2.92	2.92
		F	3.42	3.42	3.42
Steel	8"	W	3.56	3.56	3.56
		F	4.16	4.16	4.16
Steel	10"	W	4.26	4.26	4.26
		F	4.96	4.96	4.96
Steel	12"	W	5.38	5.38	5.38
		F	6.18	6.18	6.18

Table II-18

Tanker Materials and Equipment List and Corresponding Manhour Standards

Category: Piping

Service: High Pressure Machinery

Wire Type	Volts	Hz	Dimensions in mm^2	25-75,000 DWT Tanker ft.	75-150,000 DWT Tanker ft.	150-300,000 DWT Tanker ft.
Lead Covered	250	60	2 x 1.5	16,800	21,000	25,000
Neoprene Covered	250	60	2 x 1.5	27,000	31,500	35,000
"	"	"	2 x 2.5	5,800	7,200	8,000
"	"	"	2 x 4.0	1,000	1,200	1,380
"	"	"	2 x 6.0	254	300	350
"	"	"	3 x 1.5	3,800	4,500	5,150
"	"	"	3 x 2.5	400	450	520
"	"	"	3 x 4.0	2,600	3,000	3,400
"	"	"	3 x 6.0	500	600	700
"	"	"	3 x 10	500	600	700
"	"	"	4 x 1.5	650	750	850
"	"	"	6 x 1.5	5,000	6,000	7,000
"	"	"	8 x 1.5	500	600	700
"	"	"	10 x 1.5	650	750	850
"	"	"	10 x 2.5	500	600	700
"	"	"	12 x 1.5	1,500	1,800	2,100
"	750	60	2 x 1.5	1,800	2,100	2,500
"	"	"	3 x 1.5	4,400	5,500	6,500
"	"	"	3 x 4	2,000	3,000	3,500
"	"	"	3 x 10	3,500	4,500	5,200
"	"	"	3 x 50	3,000	3,800	4,500
"	"	"	10 x 1.5	700	1,000	1,200

Table II-19

Typical Wiring Requirements

Lead and Neoprene Covered

Volts	Hz	Dimensions in mm^2	25-75,000 DWT Tanker ft.	75-150,000 DWT Tanker ft.	150-300,000 DWT Tanker ft.
250	60	2 x 1.5	18,000	22,500	25,000
"	"	2 x 2.5	800	1,000	1,200
"	"	2 x 4	1,600	2,000	2,400
"	"	2 x 1.6	800	1,000	1,200
"	"	3 x 1.6	1,600	2,100	2,600
"	"	4 x 1.6	1,600	2,100	2,600
"	"	7 x 1.6	500	600	700
"	"	7 x 2.5	600	800	1,000
"	"	8 x 2.5	700	900	1,100
"	"	10 x 1.5	400	600	700
"	"	10 x 2.5	1,600	2,000	2,400
750	"	2 x 1.5	400	450	500
"	"	2 x 2.5	1,800	2,000	2,200
"	"	2 x 3.5	250	300	350
"	"	2 x 50	400	500	600
"	"	3 x 1.5	2,500	3,000	3,500
"	"	3 x 2.5	600	750	900
"	"	3 x 10	500	600	700
"	"	3 x 95	3,000	3,500	4,000

Table II-20

Typical Wiring Requirements

Armoured Cable

System or Subsystem	Unit Factor	MANHOURS/UNIT FACTOR 25-75,000 DWT Tankers	75-150,000 DWT Tankers	150-300,000 DWT Tankers
Machinery, Shafts Properllers and Aux. Machinery	SHP	0.99	0.92	0.88
Electric Plant Navigation, Communication, Lighting, etc.	KW	28.2	26.7	24.8
Hull Outfit	Ton	179	158	146
Machinery Piping	Ton	269	216	184
Joiner Work Accommodation	Ft^2	1.60	1.39	1.2
Bilge, Ballast etc. Piping Outside Machinery	Ton	209	179	165
Heating, Ventilation, Air Conditioning	Ton	288	250	230
Cargo Piping System	Ton	138	109	90
Hull Equipment incl. Steering, etc.	Ton	32	26	23

Table II-21

Alternative Allocation of System

Unit Manpower Utilization Factors

	MUF		
System	25-75,000 DWT Tankers	75-150,000 DWT Tankers	150-300,000 DWT Tankers
Machinery Installation	6.495/SHP	4.946/SHP	4.142/SHP
Piping System	1.38/SHP + 1.232/DWT	1.17/SHP + 0.945/DWT	0.985/SHP + 0.705/DWT
Electrical System	14.68/KW + 9800 + 0.36/ft^2 + 0.13/DWT	12.15/KW + 12,000 + 0.3/ft^2 + 0.1/DWT	11.40/KW + 15,000 + 0.26/ft^2 + 0.08/DWT
Hull Equipment	0.109/DWT	0.090/DWT	0.078/DWT
Ventilation & Air Cond.	0.39/SHP + 0.32/ft^2	0.32/SHP + 0.28/ft^2	0.30/SHP + 0.25/ft^2
Super-structure Outfit	2.187/ft^2	2.093/ft^2	2.002/ft^2
Hull Outfit	0.818/Disp. Ton	0.569/Disp. Ton	0.488/Disp. Ton

Table II-22

Tanker MUFs by Major Propulsion and Outfit System

Material and Overhead Costs

Tanker Material Costs vary widely and are affected by origin, specifications, etc. Base Steel prices (Export and domestic) are presented in Table I-4 and I-5 for heavy steel plate. These prices must generally be multiplied by a factor of 1.10 - 1.18 in order to derive the price of predominant qualities of ship steel plate. In tanker construction the percentage of high tensile steel (HTS) among steel plate used may vary from zero to up to 40% or more. The cost of HTS is usually 12-16% above that of the average class of ship mild steel. As a result, the average cost per metric ton of steel plate for tanker construction will be about 1.13 times the cost of heavy steel plate. The amount of scrap or wastage in shipbuilding may vary from 5% in very large tankers to over 9% for handy sized tankers. The costs of steel shapes is usually 30%-50% higher than those for steel plate. As the weight of formed shapes varies from 2-3% of steel weight in tanker construction, depending on tanker size and structural design we obtain the steel weight and price indices as shown in Table II-23. As a result, the average cost of steel for a tanker can be estimated to be the average cost of heavy steel plate multiplied by the steel price index and the hull steel weight.

The weight and cost allowances presented are averages of existing designs, built by normal construction method. The availability of very wide plates and shipyard facilities to handle them or other factors may obviously alter these results.

A domestic transportation allowance of 8% of mill price was included. This is an average for Europe and Japan. In many other countries this cost may assume a higher value. If imported steel is used the transportation and handling costs often assume values as high as 15% of average mill price.

Major tanker material, equipment and component costs were summarized for a typical steam turbine (200,000 DWT - 35,000 SHP) tanker in Table I-6. General formulations for the weights and costs of these materials and equipments are presented in Table II-24, in terms of applicable variables.

Overhead costs vary among countries and individual shipyards. The average overhead among shipyards of various major shipbuilding countries was estimated from available direct cost and price data and based on an assumption of a uniform 5-7% profit on revenues. It is recognized, that the profit margin varies more widely, and that some shipbuilders had negative profits as a result of low contract prices or for other reasons. The estimates of overhead though as presented in Table II-25 are believed to be a fair average. Overhead in this case includes:

Table II-23

Tanker Steel Price and Weight Indices

Tanker Size	25,000	100,000	200,000	300,000
% Weight Wastage	9%	7%	6%	5%
% Weight HTS (average	-	10%	12%	15%
% Weight Welding Material	6%	5%	4%	3%
% Weight Shapes	14%	10%	6%	4%
Unit price heavy steel plate	100%	100%	100%	100%
Ship Plate Quality and Size Addition	10%	14%	16%	18%
HTS cost increase	-	1.2%	1.4%	2.5%
Welding Material Allowance	5%	4%	3%	3%
Shape Allowance	5.6%	4%	2.6%	1.8%
Average unit cost of tanker steel	120.6%	123.2%	123.0%	125.3%
Wastage Allowance	9%	7%	6%	5%
Total Average unit cost of purchased steel	129.6%	130.2%	129.0%	130.3%
Transportation and Handling	8%	8%	8%	8%
Price Index	137.6%	138.2%	137.0%	138.3%

1) Indirect Labor
2) Depreciation and Interest
3) Service Costs
4) Management and Administration
5) Training
6) Hiring and Layoff
7) Marketing
8) Supplies
9) Other

Overhead costs are tabulated as a percentage of direct labor costs.

It should be observed that no distinction was made between direct shipyard and subcontract labor. As appreciable amounts of direct labor are often subcontracted, the hourly wage costs must be adjusted to reflect the effect of such subcontracting on average labor costs. The percentage costs of overhead are found not to be affected appreciably by variations in percent subcontracting of direct labor.

Typical Tanker Hull Steel and Outfit Weights (including propulsion and hull engineering) are presented in Figure II-13. There we also show the total coating area of various sizes or tankers. The high cost of materials and application of modern tanker coatings require detailed analysis of this cost item.

The material and equipment costs presented in this section were summarized by major categories. It is found from experience, that detailed item by item costing does not necessarily increase accuracy of preliminary cost estimates as usually required in design or engineering studies.

Table II-24

Typical Tanker Propulsion and Outfit Equipment and Material Costs (1972)

	Section	Costs in Dollars	
		U.S.	Foreign
3000	Hull & Deck Fittings Ports, Carpenter Joiner, Painting, etc.	$162{,}000\left(\frac{DWT}{1000}\right)^{0.49}$	$116{,}000\left(\frac{DWT}{1000}\right)^{0.49}$
4000	Deck Machinery Ventilation Heating	$34{,}300\left(\frac{DWT}{1000}\right)^{0.69}$	$24{,}500\left(\frac{DWT}{1000}\right)^{0.69}$
5000	Main Machinery and Aux. Machinery 1) Steam	$1{,}040{,}000\left(\frac{SHP}{1000}\right)^{0.51}$	$778{,}000\left(\frac{SHP}{1000}\right)^{0.51}$
	2) Medium Speed Diesel	$880{,}000\left(\frac{SHP}{1000}\right)^{0.59}$	$598{,}000\left(\frac{SHP}{1000}\right)^{0.59}$
	3) Direct Drive Diesel	$860{,}000\left(\frac{SHP}{1000}\right)^{0.53}$	$610{,}000\left(\frac{SHP}{1000}\right)^{0.53}$
6000	Piping Systems	$32{,}400\left(\frac{DWT}{1000}\right)^{0.7}$	$25{,}700\left(\frac{DWT}{1000}\right)^{0.7}$
7000	Wiring, Communication, Navigation, etc.	$37{,}300\left(\frac{DWT}{1000}\right)^{0.51}$	$25{,}700\left(\frac{DWT}{1000}\right)^{0.51}$

Table II-25

Tanker Construction Overhead Costs as a Percentage of Direct Labor Costs

Country	Average Overhead Costs as Percentage of Direct Labor Costs
Japan	50.4
U.K.	70.1
Sweden	32.7
Norway	38.0
Denmark	33.2
Germany	42.4
Spain	70.4
Holland	58.6
U.S.A.	55.8
Taiwan	74.2

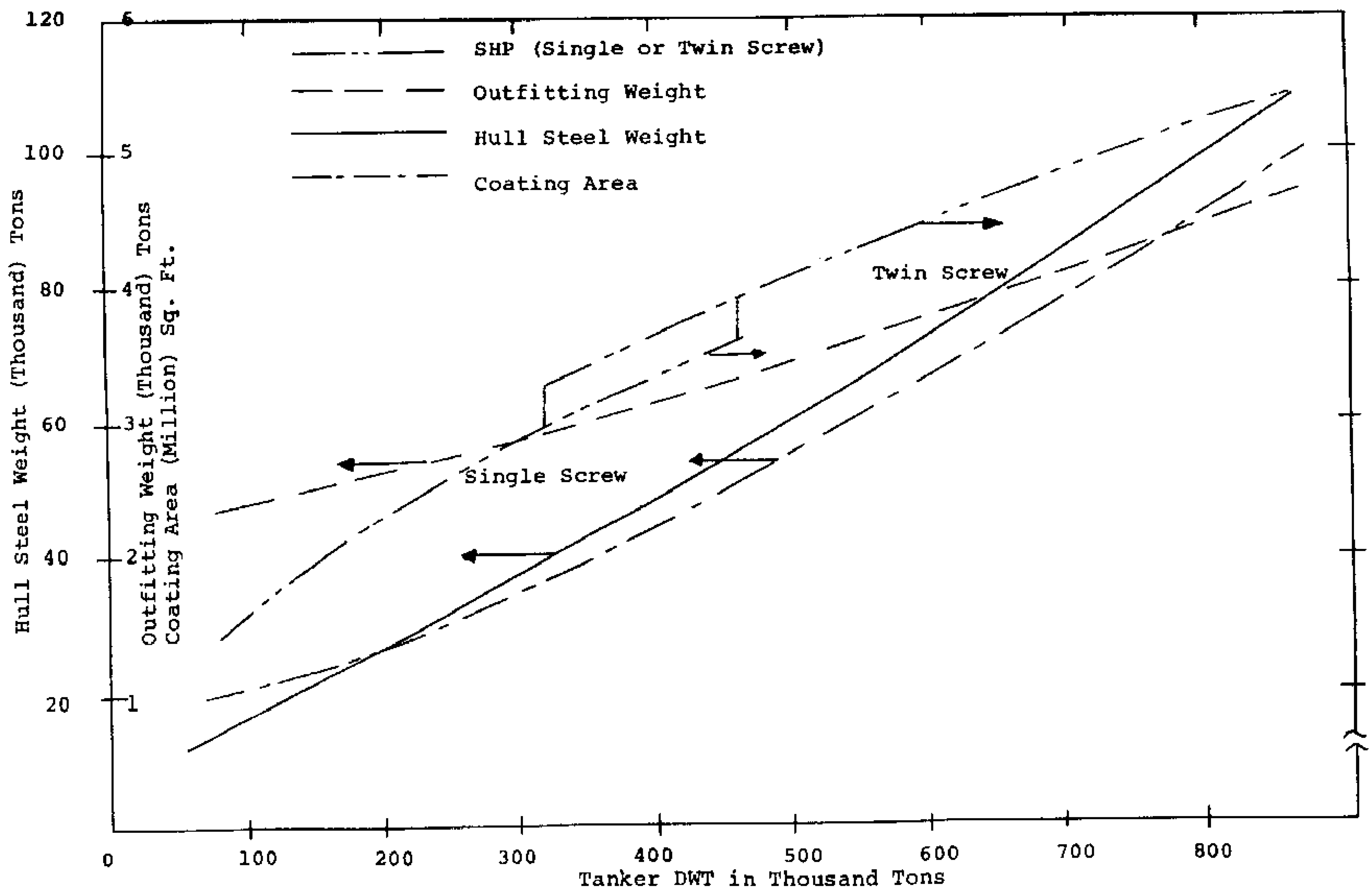


Fig. II-13: Tanker Material Quantities

Tanker Ship Costs

The costs of a tanker of a particular design to be constructed in a selected yard can be estimated from using the formulations presented in sections 7.2.1-4. For our purposes we will divide tanker building costs into:

Direct Labor Costs	= DL
Overhead, Indirect Labor, etc. Costs	= OH
Material and Equipment Costs	= MC
Learning Cost Savings	= LS
Profit	= P

Direct labor costs can be computed, using the MUFs presented for Hull Steel and propulsion and outfit as presented. The resulting direct labor manhours are multiplied by the unit manhour costs (burdened) for the particular country and year of delivery (it can be assumed that the average unit labor cost is that of the year of expected delivery, as tanker building time is usually only a fraction of one year).

Overhead costs are calculated by adding the average overhead rate for the particular country of construction to direct labor costs.

Material and Equipment costs are computed from steel weights multiplied by steel cost indices and unit steel costs for the country of construction. The unit steel costs are usually determined for the time of expected delivery minus one year.

Learning cost savings apply if more than one vessel is constructed. It is usually assumed that savings accrue to a builder in multiple ship orders which are reflected in costs. An average learning cost slope of 93.5%[1)] is often assumed. The resulting learning cost saving factors are shown in Figure II-14.

In case more than one ship is to be built the cost of additional ships (as determined for the time of <u>their delivery</u>) is multiplied by the learning curve cost saving factor as shown.

Other cumulative learning cost saving slopes may be applied if additional data is available.

Financial costs of construction loans are not included, as financing terms vary too widely. They should obviously be included in costs.

1) J. C. Couch, "The Cost Savings of Multiple Ship Production," International Shipbuilding Progress, Aug. 1963.

To show how the proposed method for the derivation of tanker ship cost works, two examples are presented.

EXAMPLE I.

Input: Tanker 250,000 DWT

Crude Oil

7 rows of tanks (6 bulkheads)

Steam Turbine 32,000SHP, 1 shaft, 1 boiler

Accommodation 25,000 ft^2

Electric Capacity 3000 KW

Cargo system all Sluiced

This tanker to be built in Spain in a shipyard with a 100 ton maximum crane lift capacity, no flat panel line, building on ways and not possessing separate stern building position. Degree of preoutfitting is deemed lower than standard (Japanese practice).

<u>Ship Corrections:</u>

1) Derive DWT deviation from mean correction coeff. = 0.958.

2) List of MUFs for major propulsion and outfit systems for size range.

   a) Machinery Installation = 4.142/SHP

   b) Piping System = 0.985/SHP + 0.705/DWT

   c) Electrical System = 0.08/DWT + 0.26/ft^2 + 11.4/KW + 15,000

   d) Hull Equipment = 0.078/DWT

   e) Ventilation and Air Conditioning = 0.3/SHP + 0.25/ft^2

   f) Superstructure Outfit = 2.002/ft^2

   g) Hull Outfit = 0.488/Displacement ton

<u>Ship Configuration Corrections:</u>

3) MUFs for cargo and ballast piping multiplied by 0.74. Therefore Piping System MUF is now 0.985/SHP + 0.613/DWT.

<u>Shipyard Corrections:</u>

4) a) Relative productivity index Spain = 1.362

   b) Crane Lift limitation (100 tons) multiply all MUFs except c) by 1.044.

   c) Building ways without additional stern position multiply all MUFs except d), f) and g) by 1.1.

d) Flat panel effect multiply cargo piping by 1.02.

e) Preoutfitting effect multiply all MUFs by 1.05.

Example II.

Input: Tanker 100,000 DWT
Crude Trade
5 bulkheads
Diesel Direct Drive
20,000 SHP - 2000 KW
25,000 ft^2 accommodation

This tanker, to be ordered in Sweden, is to be built in a yard with a building dock, stern position, 200 ton crane capacity, and otherwise close to the Japanese standard.

Considering Example I, hull steel weight (finished) is estimated at 33,800 tons. The resulting steel manhours are 1,482,000. Adding this to the propulsion and outfit manhours of 847,480 (Table II-26), total direct manhours are 2,329,480. We then obtain the following building costs.

Example I (1972 Delivery)

DL = Direct Labor Costs (at $1.43/hr)	= $ 3,330,400
OH = Indirect Labor and Overhead = 0.734xDL	= $ 2,430,000
Total Labor and Overhead	= $ 5,760,000
Steel Cost (at $1.72/ton) = 172x1.376x33,800	= $ 8,080,000
Propulsion and Outfit Equipment and Material Costs	= $ 9,020,000
Total Material Cost	= $17,100,000
Total Costs	= $22,860,400
Profit 5%	= $ 1,180,000
Total Cost (excl. engineering)	= $24,040,400

In other words, a tanker ordered in Spain in 1969 for delivery in 1972 should cost about $24.04 Million, excluding engineering. If indicated escalations in labor and material costs are applied (and overhead remains constant), then the cost of the same tanker ordered for delivery in 1975 should be about $33.8 Million (excl. engineering), using average escalation of labor and material of 10.2%.

Considering next Example II, hull steel required is about 16,000 tons. Resulting steel manhours are 640,000 and propulsion and outfit manhours of 388,720 for a total of 1,028,720 manhours. (See Table II-27.)

Example II (1972)

DL = Direct Labor Costs	= $ 3,800,000
OH = Overhead = 0.362xDL	= $ 1,380,000
Total Labor and Overhead	= $ 5,230,000
Steel Costs (at $1.65/ton)	= $ 3,620,000
Propulsion and Outfit Equipment and Material Costs	= $ 5,235,000
Total Material Cost	= $ 8,855,000
Total Costs	= $14,085,000
Profit 5%	= $ 701,000
Total Cost (excl. engineering)	= $14,786,000

Therefore a diesel tanker of 100,000 DWT ordered for 1972 delivery in Sweden should cost about $14.8 Million. Considering applicable escalation in labor and material costs such a tanker ordered for delivery in 1975 should cost about $18.6 Million, using average escalation of labor and material of 9.6%. The above cost formulations were found to be accurate (within about 5%) for labor, outfit and propulsion material costs. Steel prices paid by yards in specific countries vary widely and must be determined from recent data. Similarly overhead rates quoted are estimated averages for individual countries. There obviously are major differences in overhead costs among yards of each country.

Engineering and design costs may be expanded by the shipyard or owner or both. Because of large differences in approach these costs were not included in building costs. Generally engineering and design costs for a tanker are about 12-20% of first ship labor costs. About 90% of these costs are assumed by the shipyards and included in first ship costs. As a result, first ship costs including engineering are estimated using the data presented at:

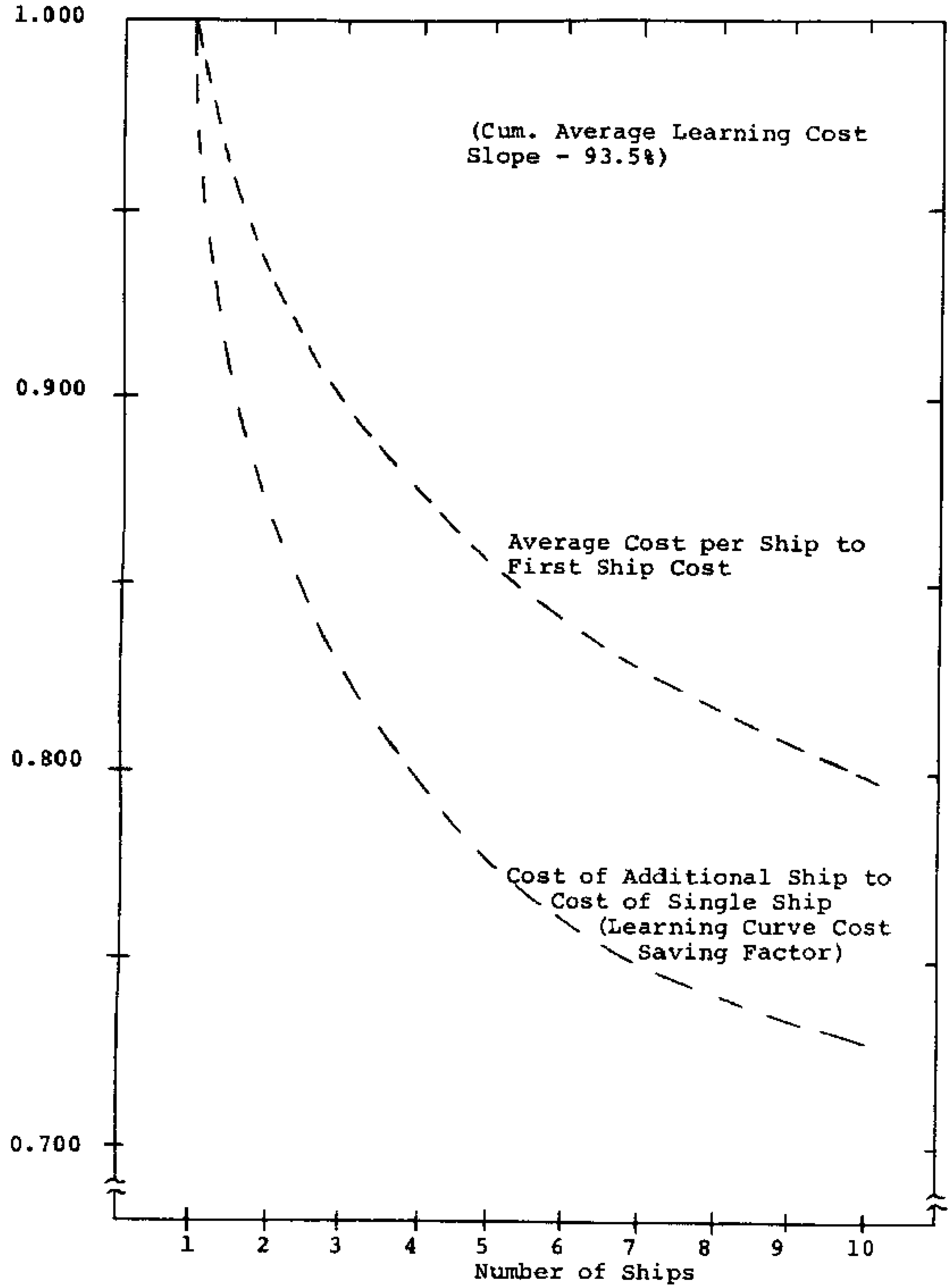
Example I - 250,000 DWT Tanker (Spain)

1972 Costs	$25.14 Million
1975 Costs	$35.08 Million

Example II - 100,000 DWT Tanker (Sweden)

1972 Costs	$15.50 Million
1975 Costs	$19.30 Million

Fig. II-14
Learning
Curve Cost Saving Factors



System	Correction Coefficients	Resulting MUF	Total Manhours
a) Machinery Installation	0.958 x 1.362 x 1.044 x 1.1 x 1.05	6.5/shp	206,000
b) Piping System	0.958 x 1.362 x 1.044 x 1.05 and (0.74 x 1.02) Cargo and Ballast	14.15/shp + 8.7/DWT	263,400
c) Electrical System	0.958 x 1.362 x 1.1 x 1.05	0.1205/DWT + 0.39/ft^2 + 17.1/KW + 22,600	85,980
d) Hull Equipment	0.958 x 1.362 x 1.044 x 1.05	0.109/DWT	27,300
e) Ventilation & Air Cond.	0.958 x 1.362 x 1.044 x 1.05	0.42/SHP + 0.351/ft^2	22,300
f) Super-structure Outfit	0.958 x 1.362 x 1.044 x 1.05	2.83/ft^2	71,000
g) Hull Outfit	0.958 x 1.362 x 1.044 x 1.05	0.686/Disp. ton	171,500
		TOTAL	847,480

Table II-26

Computation: Example I

Manhours for Propulsion and Outfit Subsystem

System	Basic MUF	Correction Coeff. DWT	Correction Coeff. Productivity	Correction Coeff. Diesel	Corrected MUF	Manhours
a) Machinery Installation	4.946/SHP	1.04	0.905	0.995	4.64/SHP	92,800
b) Piping System	1.17/SHP + 0.945/DWT	1.04	0.905	0.998	1.105/SHP + .885/SWT	110,600
c) Electrical System	12.15/KW + 12,000	1.04	0.905	--	11.45/KW + 11,300 + 0.283/ft^2 + 0.084/DWT	50,680
d) Hull Equi Equipment	0.09/DWT	1.04	0.905	--	0.0849/DWT	8,490
e) Ventilation & Air Cond.	0.32/SHP + 0.28/ft^2	1.04	0.905	--	0.3/SHP + 0.263/ft^2	13,150
f) Super-structure Outfit	2.093/ft^2	1.04	0.905	--	1.96/ft^2	49,000
g) Hull Outfit	0.569/Disp. ton	1.04	0.905	--	0.54/Disp. ton	64,000
					TOTAL	388,720

Table II-27

Computation: Example II

Manhours for Propulsion and Outfit Subsystem

Chapter III

DRY BULK CARRIER COSTS

Dry bulk carrier costs bear a close relationship to those of tankers. They have similarly increased greatly in recent years. For our purposes dry bulk carrier costs will also be divided into labor, material and overhead cost categories. Labor and material costs for dry bulk carrier construction are furthermore effectively subdivided into:

1) hull steel, labor and material
2) hull & deck, fitting, carpenter, joiner, painting, etc., labor and material
3) Deck Machinery, Ventilation and heating, labor and material
4) Main and auxiliary Machinery, labor and material
5) Piping, cargo handling system, labor and material
6) Wiring, Communication, Navigation, labor and material

The manpower utilization factors (MUF) derived for tankers apply to large dry bulk carriers as well, with the exception of cargo piping manhours per unit factor (Table II-16) which are replaced by manhour unit factors for dry bulk cargo system installation.

Similar to the computation of MUFs in tanker construction, the various correction coefficients presented in Figures II-1 to II-10 are applicable. These account for ship particulars and shipyard characteristics. Figure II-11 does not apply to dry bulk carriers. Our study results indicate that the MUFs are not seriously affected by particular trade details (commodity type) or use of dry bulk carriers, and that they apply equally well to OBOs or other combination carriers.

Hull Steel Labor Costs

Hull steel manhours per ton of net hull steel in dry bulk carrier construction are generally 3-7% higher than equivalent manhours per ton in tanker construction. As a result, hull steel manhours presented in Table II-2 can be used with some modifications.

For general dry bulk carriers, hull steel manhours are increased by 3% and for combined carriers 6% over the corresponding MUFs for tankers.

Outfitting and Propulsion System Labor Costs

Outfit and Propulsion System manhours in dry bulk carrier construction are a function of:

1) Dry bulk carrier Size
2) Dry bulk carrier Type
3) Dry bulk carrier Service (combined-single)
4) Dry bulk carrier Speed
5) Dry bulk carrier Cargo handling system

6) Shipyard facilities and experience
7) Unit manpower, productivity
8) Number of identical ships in series

The product listing of Table II-5 applies with the addition of a separate group for dry cargo handling system. The list of products comprised by this group consists of such items as conveyors, belt drives, loading/unloading arms, hatch covers, etc.

Similarly Tables II-6 and II-7 can be renamed, "Dry Bulk Carrier Configuration Variables and affected Dry Bulk Carrier Components" and "Shipyard Variables and affected Dry Bulk Carrier Components" respectively without any changes.

The manhour unit factors presented in Tables II-15 to II-27, for tankers apply equally to Dry Bulk Carriers, with the following modifications:

1) In Table II-9 items "Cargo Piping tanks incl. valves," "Cargo Piping Machinery incl. valves" and "Butterworth-Jet Cleaning" apply only to OBOs or similar combined petroleum/dry bulk carriers when these MUFs are adjusted to correspond to the petroleum DWT capacity of the combined carrier. For simple single purpose or all dry combined service dry bulk carriers these MUFs are zero.
2) In Table II-10, "Hull equipment and Ventilation," an an additional item, "Cargo Handling Equipment," is added. The average manhours per ton of dry bulk DWT capacity are estimated at 0.50/DWT for a 50,000 DWT carrier, 0.40/DWT for a 112,500 DWT carrier, and 0.315/DWT for a 245,000 DWT carrier. For intermediate sizes, DWT correction factors presented in Figure II-6 apply.
3) In Table II-12, "Hull Outfit" items, "Manholes, Hatch-covers, etc." are replaced by 0.40, 0.24, and 0.19 respectively.

As a result we obtain the manhour requirements for major propulsion and outfit systems of Dry bulk carriers as shown in Table III-1.

<u>Material and Overhead Costs</u>

Dry Bulk Carrier material costs vary widely and are affected by origin, specifications, etc. Unit Hull Steel costs for dry bulk carriers average 5% more for single service and 8% more for combined service carriers compared to tanker steel costs as a result of added cost of steel quality and size. Therefore Dry Bulk Carrier Steel Price and Weight Indices are as estimated in Table III-2. These indices are multiplied by

System	MUF		
	25-75000 DWT	75-150,000 DWT	150-300,000 DWT
Machinery Installation	6.495/SHP	4.96/SHP	4.142/SHP
Piping Systems	1.38/SHP + 0.532/DWT	1.17/SHP + 0.39/DWT	0.985/SHP + 0.215/DWT
Electrical System	14.68/KW + 9800 + 0.36/ft^2+ 0.13/DWT	12.15/KW + 12,000 + 0.3/ft^2 + 0.1/DWT	11.40/KW + 15,000 + 0.26/ft^2+ 0.08/DWT
Hull Equipment	0.109/Disp. ton + 0.05/DWT	0.09/Disp. ton + 0.4/DWT	0.078/Disp. ton + 0.315/DWT
Ventilation and Air Cond.	0.39/SHP + 0.32/ft^2	0.32/SHP + 0.28/ft^2	0.30/SHP + 0.25/ft^2
Superstructure Outfit	2.187/ft^2	2.093/ft^2	2.002/ft^2
Hull Outfit	1.09/Disp. ton	0.789/Disp. ton	0.662/Disp. ton

Table III-1

DRY BULK CARRIER MUFs FOR MAJOR PROPULSION AND OUTFIT SYSTEMS

DWT	25,000		100,000		200,000	
	Dry Bulk	Combined	Dry Bulk	Combined	Dry Bulk	Combined
% Weight Wastage	9%	9%	7%	7%	6%	6%
% Weight HTS	-	-	10%	12%	12%	14%
% Weight Welding Material	6%	6%	5%	5%	4%	4%
% Weight Shapes	14%	15%	11%	12%	7%	8%
Unit Price Steel	100%	100%	100%	100%	100%	100%
Quality and Size Addition	15%	16%	15.2%	18.2%	18.4%	19.4%
HTS Cost Increase	-	-	3%	5%	4%	6%
Welding Material Allowance	6%	6%	5%	5%	4%	4%
Shape Allowance	5.6%	6%	4%	4.5%	2.8%	3%
Average Unit Cost	126.6%	128%	127.2%	133.5%	129.2%	132.4%
Wastage Allowance	9%	9%	7%	7%	6%	6%
Total Average Unit Cost	135.6%	137%	134.2%	140.5%	135.2%	138.4%
Transportation and Handling	8%	8%	8%	8%	8%	8%
Price Index	143.6%	145%	142.2%	148.5%	143.2%	146.4%

Table III-2

DRY BULK CARRIER PRICE AND WEIGHT INDICES the hull steel weight and the unit steel costs to derive the hull steel material costs.

The weight and cost allowances incorporated in the indices are averages for existing designs, built by normal construction methods. Availability and facility to use very wide plates and other factors may obviously alter these results.

Typical Dry Bulk Carrier Propulsion and Outfit Equipment and Material costs are summarized in Table III-3 in terms of the applicable variables.

Overhead costs are identical to those used in tanker construction and as presented in Table II-25.

Total Dry Bulk Carrier Costs

The configurations, arrangements and equipment of dry bulk carriers vary more widely than those of tankers. Service, cargo handling, stowage and other requirements may impose particular design or equipment details which affect labor and material costs. As a result only costs for basic single purpose standard dry bulk carriers can be effectively estimated.

Using the data tabulated we may proceed as in the examples presented in Section II-D in which typical tanker costs were determined by two examples.

Table III-3

Typical Dry Bulk Carrier Propulsion and Outfit Equipment and Material Costs (1972)

Section		Costs in Dollars U.S.	Costs in Dollars Foreign
3000	Hull & Deck Fittings, Ports, Carpenter, Joiner, Painting, etc.	$220,000\left(\frac{DWT}{1000}\right)^{0.49}$	$157,000\left(\frac{DWT}{1000}\right)^{0.49}$
4000	Deck Machinery Ventilation Heating	$47,200\left(\frac{DWT}{1000}\right)^{0.69}$	$34,000\left(\frac{DWT}{1000}\right)^{0.69}$
5000	Main & Aux. Machinery 1) Steam	$1,040,000\left(\frac{SHP}{1000}\right)^{0.51}$	$778,000\left(\frac{SHP}{1000}\right)^{0.51}$
	2) Medium Speed Diesel	$880,000\left(\frac{SHP}{1000}\right)^{0.59}$	$598,000\left(\frac{SHP}{1000}\right)^{0.59}$
	3) Direct Drive Diesel	$860,000\left(\frac{SHP}{1000}\right)^{0.53}$	$610,000\left(\frac{SHP}{1000}\right)^{0.53}$
6000	Piping System	$17,800\left(\frac{DWT}{1000}\right)^{0.7}$	$13,500\left(\frac{DWT}{1000}\right)^{0.7}$
7000	Wiring, Communication, Navigation, etc.	$37,300\left(\frac{DWT}{1000}\right)^{0.51}$	$25,700\left(\frac{DWT}{1000}\right)^{0.51}$

Chapter IV

GENERAL CARGO SHIP COSTS

General cargo ship costs were derived from data obtained for recent constructions in a number of countries. Contrary to tankers, general cargo ships vary quite widely in design, speed, arrangement and equipment. Similarly service requirements differ usually among such vessels. The class of general cargo ships comprises simple single or multipurpose ships as represented by various "Liberty" ship replacement types such as the Freedom and other vessels. It also includes a high class liner type vessel usually designed for higher speeds and for particular scheduled service requirements. In this section weights and costs for typical general cargo ships are presented. Cargo ship weights are summarized in Table IV-1. These weights are for standard vessels equipped with cargo winches, mechanized cargo hatches, remotely controllable main propulsion plant, single screw, vessels manned by a crew of about 35 men accommodated in single cabins.

General Cargo ship costs (U.S. and Foreign) are shown in Table IV-2. These are for ships with machinery located at about 1/4L forward of the aft perpendicular.

Outfit and Hull Engineering includes section 3000, 4000, and 7000, and part of 6000 as noted in Table I-6.

Main and Auxiliary Machinery (section 5000) includes all piping which forms an essential part of main and auxiliary machinery.

Table IV-1

Typical Cargo Ship Weights

Machinery Weight = WM

Steam Turbine (Single Screw) $= 225\left(\frac{SHP}{1000}\right)^{0.52}$

Medium Speed Diesel (Single Screw) $= 192\left(\frac{SHP}{1000}\right)^{0.64}$

Direct Drive Diesel (Single Screw) $= 276\left(\frac{SHP}{1000}\right)^{0.69}$

Steel Weight = WS[1] =

$$380\left(\frac{CN}{1000}\right)^{0.9}\left(0.675 + \frac{C_B}{2}\right)\left(0.006\left[\frac{L}{D} - 8.3\right]^{1.8} + 0.94\right)$$

Outfit and Hull Engineering = WO[1] = $180\left(\frac{CN}{1000}\right)^{0.61}$

CN = Cubic Number = $\frac{LBD}{100}$

B = Beam

D = Depth to Uppermost Continuous deck

L = Length between perpendiculars

C_B = Block Coefficient at Design Draft

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1) Derived from H. Benford, "The Practical Application of Economics to Merchant Ship Design," Marine Technology, Vol. IV, Jan. 1967, pp. 522-23, with modified coeff. and exponent to account for recent trends.

	U.S.	Foreign
Cost of Hull = CH	790 WS + 168,000	452 WS + 112,000
Cost of Outfit and Hull Engineering = CO	$280{,}000(\frac{CN}{1000})^{0.81} + 150{,}000(\frac{CN}{1000})^{0.75} + 47{,}000(\frac{CN}{1000})^{0.62}$	$168{,}000(\frac{CN}{1000})^{0.81} + 90{,}000(\frac{CN}{1000})^{0.75} + 28{,}000(\frac{CN}{1000})^{0.62}$
Cost of Machinery = CM Steam Turbine (Single Screw)	$830{,}000(\frac{SHP}{1000})^{0.51}$	$620{,}000(\frac{SHP}{1000})^{0.535}$
Diesel Medium Speed (Single Screw)	$784{,}000(\frac{SHP}{1000})^{0.59}$	$544{,}000(\frac{SHP}{1000})^{0.60}$
Diesel Direct Drive (Single Screw)	$762{,}000(\frac{SHP}{1000})^{0.53}$	$568{,}000(\frac{SHP}{1000})^{0.54}$

Table IV-2

TYPICAL GENERAL CARGO SHIP COSTS (INSTALLED)
(1970 Dollars)

Chapter V

CONTAINERSHIP COSTS

Containerships come in a variety of forms. Most modern containerships use cellular guides for vertical stowage of containers and are not equipped with ship board gantries. Containerships are generally designed for volume cargo and often require extensive permanent and liquid ballast to carry their fully designed load of containers. Oceangoing containerships vary in length from 400 ft. - 940 ft. and carry from 280 to 2400 containers of the 20 ft. ISO equivalent. Speeds usually range between 20 and 33 knots.

Basic relationships of containership parameters, subsystem weights and costs are presented in Tables V-1 to V-3. Assuming a 5% profit margin the resulting price (1972) of a containership can be estimated from: Price = 1.05(CH+CO+CM). A different containership cost model was developed recently by A.D. Little, Ltd. for the National Ports Council (England). A summary of the model is published in the Research and Technical Bulletin, Vol. 6, 1970, National Ports Council. The results of this study were transformed into dollar costs and are summarized in Table V-4. Both models give closely comparative cost estimates. The A.D.L. model breaks container guide systems out of hull steel costs and hatch covers out of outfit costs. This approach permits larger deviations from standard containerships to be evaluated.

The U.S. costs (1972) presented are before construction subsidy and can be assumed to escalate at about 6.8% per year. Foreign containership costs (1972) are expected to grow at an annual rate of 7.8%. Large changes in the relative value of currencies makes it difficult to establish meaningful and comparative dollar costs at this time.

It should be noted, that the hull, outfit and machinery subsystem costs in the model include all material, labor, service, and overhead cost elements, while these are added in the National Ports Council Model. A more detailed cost analysis can be performed using modified manhour standards such as presented in the section on tanker costs.

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1) Based in part on J.R. Hancock, "An Economic Planning Model of an Integrated Ship Terminal and Container System," MIT Thesis, 1972.

Table V-1

Containership Parameters

Number of Containers (20'ISO)	= N	$= \frac{35.7 \times CN}{1000}$
Length between Perpendiculars	= L	= 0.211N + 406
Beam	= B	= 0.147L - 4.5 $L \leq 750'$
	= B 1)	= 105.5 $750' < L \leq 980'$
Depth	= D	= 0.07L + 6.5
Draft	= H	= 0.01L + 24
Block Coefficient	= C_B	$= 2.1/V^{0.4}$
Effective Horsepower	= EHP	$= \frac{0.55 \times V^3 \times (Displ)^{2/3}}{427.1}$
Inst. Shaft Horsepower	= SHP (single screw)	$= \frac{1.25 \times 1.02 \times 0.95 \times 1.03 \times EHP}{(0.924 - .0067V)}$
Inst. Shaft Horsepower	= SHP (twin screw)	$= \frac{1.25 \times 1.03 \times 1.12 \times 0.95 \times EHP}{(0.900 - 0.01V)}$

1) This constraint is imposed by Panama Canal restrictions but may not apply to ships with length in excess of 980'.

Table V-2

Containership Weights
(tons)

Machinery Weight = WM

Steam Turbine (Single Screw)	$= 214(\frac{SHP}{1000})^{0.5}$
Steam Turbine (Twin Screw)	$= 1.15 \times 214(\frac{SHP}{1000})^{0.5}$
Gas Turbine (Single Screw)* Aircraft Type	$= 110(\frac{SHP}{1000})^{0.5}$
Gas Turbine (Twin Screw)* Aircraft Type	$= 1.1 \times 110(\frac{SHP}{1000})^{0.5}$
Medium Speed Diesel (Single Screw)	$= 182(\frac{SHP}{1000})^{0.62}$
Medium Speed Diesel (Twin Screw)	$= 1.12 \times 182(\frac{SHP}{1000})^{0.62}$
Direct Drive Diesel (Single Screw)	$= 302(\frac{SHP}{1000})^{0.55}$
Direct Drive Diesel (Twin Screw)	$= 1.02 \times 302(\frac{SHP}{1000})^{0.55}$

*For Industrial Type[1] Gas Turbines the coefficient 110 is replaced by 172.

Steel Weight[1] = WS

$$380(\frac{CN}{1000})^{0.9}(0.675 + \frac{C_B}{2})(0.00585[\frac{L}{D} - 8.3]^{1.8} + 0.939)$$

Outfit Weight[2] (Incl. hull engineering) = WO

$$[-0.71(\frac{CN}{1000})^2 + 93.5(\frac{CN}{1000}) - 104]$$

1) From H. Benford, "The Practical Application of Economics to Merchant Ship Design", Marine Technology IV Jan. 1967, pp. 522-523.
2) From D. S. Miller, "The Economics of the Containership Subsystems."

	U.S.	Foreign
Cost of Hull = CH	860WS + 200,000	476WS + 122,000
Cost of Outfit = CO (Incl. hull eng.)	4,300WO - 1,900,000	2,288WO - 1,000,000
Cost of Machinery = CM		
Steam Turbine single screw	$850{,}000\left(\frac{SHP}{1000}\right)^{0.51}$	$620{,}000\left(\frac{SHP}{1000}\right)^{0.535}$
Steam Turbine twin screw	$1.15 \times 850{,}000\left(\frac{SHP}{1000}\right)^{0.51}$	$1.22 \times 620{,}000\left(\frac{SHP}{1000}\right)^{0.535}$
Gas Turbine single screw (Aircraft type)	$650{,}000\left(\frac{SHP}{1000}\right)^{0.5}$	$600{,}000\left(\frac{SHP}{1000}\right)^{0.52}$
Gas Turbine twin screw (Aircraft type)	$1.1 \times 650{,}000\left(\frac{SHP}{1000}\right)^{0.5}$	$1.1 \times 600{,}000\left(\frac{SHP}{1000}\right)^{0.52}$
Gas Turbine single screw (Industrial type)	$780{,}000\left(\frac{SHP}{1000}\right)^{0.5}$	$718{,}000\left(\frac{SHP}{1000}\right)^{0.52}$
Gas Turbine twin screw (Industrial type)	$1.1 \times 780{,}000\left(\frac{SHP}{1000}\right)^{0.5}$	$1.1 \times 718{,}000\left(\frac{SHP}{1000}\right)^{0.52}$

* A 14% and 18.5% must be applied to U.S. and Foreign Costs respectively to bring these costs to the 1972 level.

Table V-3

CONTAINERSHIP COSTS (INSTALLED)*
(Dollars)
(1970)

	U.S.	Foreign
Diesel Medium Speed		
Single Screw	$802{,}000\left(\frac{SHP}{1000}\right)^{0.59}$	$562{,}000\left(\frac{SHP}{1000}\right)^{0.60}$
Twin Screw	$1.12 \times 802{,}000\left(\frac{SHP}{1000}\right)^{0.59}$	$1.15 \times 562{,}000\left(\frac{SHP}{1000}\right)^{0.60}$
Diesel Direct Drive		
Single Screw	$756{,}000\left(\frac{SHP}{1000}\right)^{0.53}$	$590{,}000\left(\frac{SHP}{1000}\right)^{0.54}$
Twin Screw	$1.02 \times 756{,}000\left(\frac{SHP}{1000}\right)^{0.53}$	$1.05 \times 590{,}000\left(\frac{SHP}{1000}\right)^{0.54}$

Table V-3 (continued)

Table V-4

National Port Council

Containership Cost Model

Parameters

Number of 20 ft. ISO Containers = N

Shaft Horsepower = SHP = $0.07N^{0.50}V^{3.07}$

Cubic Number = CN = $564^{0.84}V^{0.91}$

Beam = B = $65.86(CN/10^{6})^{0.29}$

Length/Beam = L/B = $3.54N^{0.06}V^{0.08}$

Gross Tonnage = GT = 7380LBD x 10^{-6}

Draft Loaded = H = $1.23N^{0.17}V^{0.65}$

Depth = D = CN/LB

Costs

Flush Steel Wt. = FSW = $0.0007L^{1.76}B^{0.71}D^{0.37}$

Deckhouse Wt. = DW = (129.63LDB x 10^{-6}) - 5

Guide System Wt. = GW = $0.713N^{0.92}$

Net Steel Wt. = NS = FSW + DW

Gross Steel Wt. = GS = 1.1NS

Gross Steel Wt. Total = GST = 1.1(NS + GW)

Steel Cost S_1 = \$148/Ton Mild Steel

S_2 = \$176/Ton HTS

Average Steel Costs = S = $f_1S_1 + f_2S_2$

Percentage mild Steel Weight = f_1 (HTS wt = f_2)

Sundries and Forgings = 17%

Total Steel Wt. = TS = 1.17GS

Total Steel Material Cost = S x TS

Steel Manhours = SM = $1060(GS)^{0.71}$

Guide Systems Manhours = GM = 310GW

Total Steel Manhours = U(GM + SM)

Unit Steel Labor Cost = U(\$/hour)

Outfit Equipment Costs = OE = $630(LDB)^{0.425}$

Outfit Material Costs = OM = $375{,}000(LDB \times 10^{-6})^{0.65}$

Hatch Cover Costs = HC = $475(LB)^{0.57}$

Outfit Material Costs = (OE + OM + HC)

Outfit Labor Manhour = OM = $411{,}600(LBD \times 10^{-6})^{0.60}$

Outfit Labor Costs = (OM x U)

Miscellaneous Labor Costs = 0.16U(OM + GM + SM)

Overhead, etc. = OH = 2.32 x U(OM + GM + SM)

Machinery Costs

Single Screw = MC = $610{,}000\left(\frac{SHP}{1000}\right)^{0.535}$

Twin Screw = MC = $775{,}000\left(\frac{SHP}{1000}\right)^{0.527}$

Profit = P = 5% of sum of all costs

Table V-4 (continued)

PART 5

OCEAN BARGING, A REVIEW

by

E. G. Frankel

Introduction

Following the revolution of ocean shipping technology, ocean barge transportation has undergone major changes in recent years, and as a result has been able to attract increasing traffic and applications. Barging has become a major factor in coastal and short to medium distance offshore ocean transportation.

The size of barges has moved in the last ten years from a maximum of 10,000 tons to nearly 40,000 tons capacity per barge and offshore barges of good DWT are currently contemplated. Simimarly, methods for towing barges have radically changed from simple hawser (line)towing to push towing in offshore operations. Various techniques for effectively coupling tug-barge trains have been devised which facilitate increasing the size, and sometimes the numbers of barges that can be handled in one barge train (by single tug) at speeds greatly in excess of conventional barge-tug speeds.

Barge transportation provides not only the lowest ton/mile cost for most commodities (except pipeline cost over some distances), but also a degree of flexibility offered by few competing transportation systems.

Many industries and economies owe much of their viability to the low cost of obtaining essential materials and fuels. Some industries also can only reach markets, otherwise inaccessible, by means of waterborne transport. Coal mining, steel, chemicals, oil refining, electric energy and farming are among water transport dependent industries.

For commodities which can be moved in large tonnages and which do not require precision scheduling, waterborne movement provides transportation for only a fraction of the charges of any other transport mode. Rail and road transport usually requires at least 4 times the revenue per ton-mile of that necessary to profitably carry bulk commodities by barge while offshore ship transport would usually require about twice the revenue. Similar comparisons would apply to petroleum products, chemicals, metallic ores, crushed stone and a wide variety of other high tonnage commodities. For this reason, a very large sector of world industry has developed, both for transportation and water supply, at water-based locations and built its logistical system on low-cost barge transportation.

Much of the efficiency of barge transportation, in turn, is attributable to aggressive innovation in the design of floating equipment. Over the past 10 years, in the face of rather drastic price inflation elsewhere in the economy, the average charge for U.S. barge transportation has gone down about 25 percent, from 4 mills to 3 mills (US costs) per ton-mile. With sharply higher costs, especially higher labor rates, this achievement had been possible only by virtue of continuous increase in the size of the unit of movement.

A modern tow in open water, often carries as much as 40,000 tons of freight instead of the maximum of about 10,000 tons of a few years ago. Progressive innovation in carrier equipment associated with improved navigation, has combined with rising sophistication in carrier operations to produce this result.

The key to high-tonnage push-towing is the diesel-powered screw-propelled towboat. The power of towboats has been increasing year by year, from an average (which includes a large number of small harbor craft) of 512 horsepower in 1956 to 754 horsepower 10 years later. Towboats having 5,000 or 6,000 horsepower are common, and the large offshore tug boats have in excess of 12,000 SHP installed.

Low horsepower requirement is one of the inherent advantages of water transportation. The average horsepower per ton moved on the railroads falls in the range of 0.8 to 2.6, and highway trucking requires about 7.0 horsepower per ton. Barge transport horsepower requirement per ton generally falls in the range of 0.1 to 0.25. The rising horsepower of towboats thus means a corresponding increase in the tonnage moved with a single crew in a single tow of barges. Similarly the manhours per ton are a fraction of that required by any other mode.

The bigger the tow, the greater the premium on maneuverability. The towboat has to push a rigid barge often through narrow channels, with or against a current. Maneuverability is often obtained by multiple screws (usually two) which operate independently of each other, each with a steering rudder behind it.

Controls are usually highly refined. Sonic depth-finder, far away on the bow of the forward barge, reports soundings in the pilot house. Anchor windlasses are often radio controlled.

Offshore barges, while less complex than ships, are far from simple. Unlike oceangoing ships, barges are subjected to intense transverse strains in tow maneuvering, but cannot economically tolerate elaborate reinforcing because of shallow-draft limitations on capacity. They must be highly resistant to impact under the intense pressures of external contact with mooring walls and the like, and also on the interior with clamshell buckets and other unloading devices. Inexpert loading places severe strains on the barge hull more usually than is true of ocean vessels.

Hopper barges, both open and covered, are the pack mules of barge transport. They carry almost any bulk cargo such as grain, coal, ores, steel, machinery, salt, sugar, sulphur, dry bulk chemicals, sand, fertilizers, and crushed stone. Hopper barges represent the largest share of barge investment. A typical open hopper barge costs about $38-$62 per ton of capacity. By way of comparison, new open hopper railway cars cost about $120-$180 per ton of capacity. Hopper barge covers must be designed for light weight, watertight protection, resistance to deflection, and maximum accessibility to the hold when open.

An increasing portion of both hopper barges and tank barges are double-skinned. This reflects, in addition to pollution prevention, concern in the rising values of waterborne cargoes and vulnerability to contamination. A barge often carries a succession of cargoes incompatible with each other, such as, coal and grain. The inner skin is unencumbered by structural members, permitting rapid and thorough cleaning. In addition, the inner skin prevents contamination from bilge water. In the event of an accident involving puncturing of the hull of a tank barge, the inner skin confines hazardous cargoes, such as certain chemicals or flammable materials, preventing leakage into the river current. Double-skinned tank barges are now more popular than single-skinned. The investment cost penalty of a double skinned-barge is about 12-18% above that of a single-skinned barge, while operating cost increases are usually marginal (3-7%).

Standards of cargo care become ever more exacting. Anhydrous ammonia or chlorine may be carried in barge tanks under pressures of 250 pounds per square inch or more. Temperatures in the range of -260° up to 200° Farenheit may have to be maintained. A growing number of barge tanks have protective linings of such materials as aluminum, stainless steel, plastic, or rubber. By such developments, the variety of cargoes which may be transported by water is increasing continuously. Unlike the deep-draft shipbuilder, the bargebuilding industry must design its product for operation under constraints such as overhead bridge clearances, depth and width of channel.

The full potentials of ocean barge tramsportation have not yet been achieved. Developments in more effective push-tow coupling are expected to open the way to transocean barge operations, which are estimated to become operational by 1980. A particular incentive for this development is provided by the increasing insufficiency of existing port facilities to handle large liquid and dry bulk carrying ships. Ocean going barges can be designed with drafts of less than 80% of that of equivalent deadweight ships. Barge transportation offers major port turn-around advantages by virtue of the separation of transport and power units. It not only permits the number of tugs to be smaller than the numbers of barges or barge-trains they propel, but also provides an ability to use barges as floating warehousing, or storage at terminals. Not only does the latter reduce transfer and/or handling requirements and costs but it often offers lower cost storage than equivalent shore based facilities. As a result the total costs and benefits of ocean barge transportation can only be determined if the total transport and terminal (transfer and storage) system is studied as an integral whole.

Chapter I

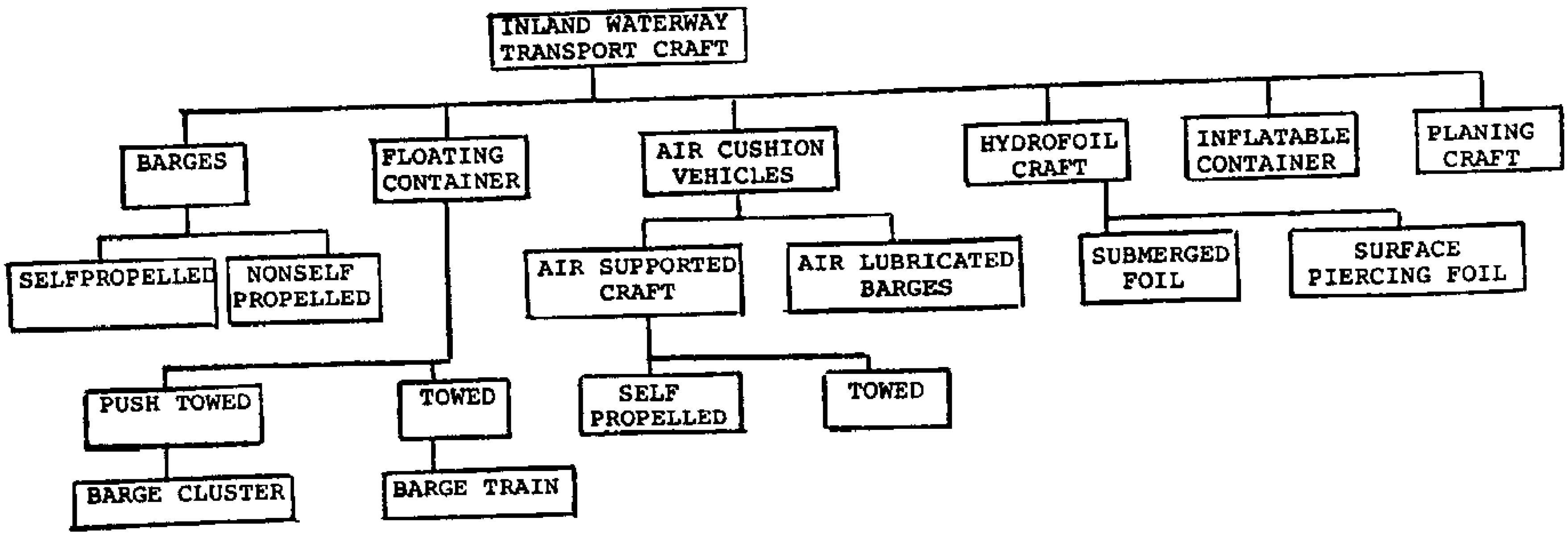
OCEAN BARGE OPERATIONS AND TECHNOLOGY

Ocean barge transport craft vary more widely than ocean-going ships because of the much more varied conditions under which they operate. This oldest of all transport modes is usually affected by environmental conditions such as draft, channel width, currents, radii of water curvature and waterway bottom conditions, as well as the basic transport demand for service. As a result, ocean barge transport includes some of the most archaic and most advanced technology extending all the way from simple junks driven by triangular sails to fully automated push-tows steering barges loaded with tens of thousands of tons of cargo through the water at speeds in excess of 10 knots. Similarly, modern technology permits the complete integration of barge systems to trans-ocean shipping by the use of barge containers designed for dock transfer between modes. In addition to these extremes of technology, a large number of special craft such as ground effect machines, rigid wall air lubricated barges, hydrofoil craft, inflatable bulk containers, self-propelled barges, amphibians, ro-ro flat bottom craft, and others have been developed for specific purposes.

Ocean barge transportation requires comparatively little static investment for the development of a transport network and comparatively simple terminals. Similarly, the operating skill and maintenance requirements for various components of such a system are relatively simple and can easily be obtained with little training and expense. Finally, an extensive barge transportation system can probably be implemented more rapidly than any other type of commodity transport system.

Barge transportation technology has been subjected to major changes in recent years. Although barge commodity transportation remains the predominant mode, the economic size, speed and operational methods have changed radically. In addition many novel types of transportation modes have been introduced as indicated in Fig. I-1.

Similarly air lubricated barges, hydrofoils, and ground effect machines are among novel craft increasingly used particularly for passenger and high value cargo transport. Roll-on/Roll-off principles of cargo transfer and inflatable or collapsible cargo containers are other new and increasingly used technologies. Among the most important yet little advertised technologies have been those contributing to the power and maneuverability of towboats. Kort nozzles, Voit Schneider propellers, side thrustors, jet propulsors are among many approaches which make effective and high density towing possible.



OCEAN BARGE TRANSPORT TECHNOLOGY

Figure I-1

The major concerns in barge technology developments are:

1) Draft restrictions.
2) Currents and water-speed differentials.
3) Physical obstructions and/or special navigational aids such as locks and sluices.
4) Terminal facilities both draft and access.
5) Quantity and type of commodities available for potential inland waterway carriage.
6) Frequency of service required, seasonality of cargo movement, and intermittency of movements.
7) Storage and/or marshalling capacity for loading and discharging at terminals.
8) Capacity, cost, frequency of service, and quality of service of competing transport modes.
9) Type, cost, and capacity of feeder transport at the loading and discharging terminals.
10) Transfer devices available for loading and discharging of cargo.
11) Manpower available for operation, repair, and management of inland waterway transport service.
12) Repair and maintenance facilities available along the inland waterway route.

All of the above considerations affect the type of operational requirements applicable to a particular transportation problem.

The various types of barge transport vehicles currently available, their maximum capacities and speed are shown in Table I-1. In addition to the various types of hull configuration and hydrodynamic forms to assure the required life, a large variety of propulsion methods are available as shown in Table I-2. These will be affected by the particular considerations and constraints defining the route of interest. For example, waterjet or retractable propeller type of thrusts are preferable in shallow water operations or where the waterway bottom is muddy and eroding.

Other developments of interest are changes in materials used for the construction of barges. These are shown in Table I-3, which indicates that novel materials such as fiber glass, aluminum and ferro-cement are making major inroads as hull construction materials for such craft. Particularly ferro-cement has become extremely popular as a ship construction material requiring a minimum of technology and manufacturing ability for use.

The various types of craft mentioned in the preceding tables are not necessarily mutually exclusive. Low value, particularly bulk cargoes are still carried most effectively by tug-barge systems, preferably pushed to improve propulsive efficiency and control. Various methods of pushtowing are presented in Figures I-2 through I-6. Some of these methods are equally effective in river estuaries and coastal waters. Their adoption may therefore provide an efficient linkage between inland and coastal shipping which requires a more economic and flexible system than the comparatively large vessels currently used and/or planned. The proliferation of river ports and minor coastal ports makes the adoption of disengagable multi-unit barge systems highly sttractive.

The American inland water barge cluster pushtowing system, whereby barges are rigidly tied in rows of 2 to 5 transverse barges with 2 to 5 rows coupled together, all pushed and maneuvered by a single tug, provides a very efficient system, the length of the inland waterways and proliferation of terminals make a drop-off and pick-up system highly desirable.

Barge transportation can produce more ton-miles of freight movement per unit length of right-of-way than any other surface mode of transportation. Waterway transportation provides a unique capability in the distribution of natural resources which is required to sustain the expanding population and the mounting national product flow this population will demand.

Concept	Type	Arrangement	Payload Range tons	Comment
Tug - Barge	Deck Barge Tank Barge Container Barge Bulk Barge	Tug - Ahead Tug - Astern Tug - Alongside	10 - 8000 100 - 40000 10 - 5000 100 - 30000	Self unloader Nonself unloader Barge Trains of 1-15 barges
Self-propelled Barges	same	Barge alone Barge - Barge	200 - 2800 500 - 8000	Self unloader Nonself unloader Barge Trains 1-4 Barges
Inflatable Barges	Tank (Liquid Bulk)	Tug - Ahead	10 - 600	Selfstoring
Air lubricated Barges	Deck Roll on-Roll off Passenger	Barge alone Barge - Barge	50 - 500 100 - 1000	Self-propelled Nonself-propelled Rigid Wall Surface Effect
Hydrofoil Craft	Passenger	Surface Piercing Hybrid Foils Fully Submerged	10 - 100	High Speed
Surface Effect Ships	High Value Cargo Passenger	Flexible Skirt Semi Rigid Skirt Amphibious Non Amphibious	10 - 100	High Speed
Riverships	General Cargo Liquid/Dry Bulk Passenger	Flat Bottom	100 - 1800	- - -
Ferries	same	same	100 - 2500	- - -
Riverboat	same	same	10 - 400	- - -

BARGE TECHNOLOGY - HULL SYSTEM TYPES

Table I-1

Table I-2

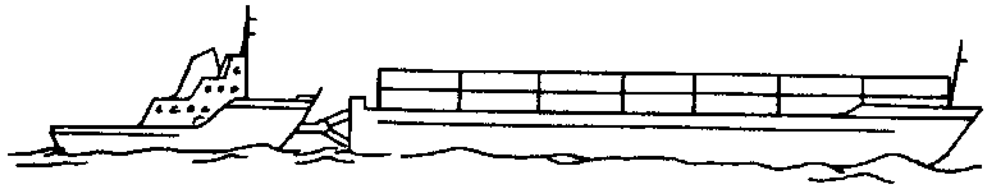
BARGE/TUG TECHNOLOGY - PROPULSION SYSTEMS

TYPE	ENGINE	RATING EHP	APPLICATION
Propeller-Open Shaftmounted	Diesel-Gasoline Gas Turbine-Steam Reciprocating Steam Turbine Combined Plants	50-12000	Tug-Self-propelled Barge-Hydrofoil Rigid Wall Surface Effect Ship-Ferry-Passengership-Rivership-Riverboat
Propeller-Ducted Shaftmounted	Same	50-12000	Same
Propeller-Open/ Ducted Retractable (Hinged or Telescoping)	Diesel-Gasoline Gas Turbine	50- 1800	Same
Propeller Vertical (Voit-Schneider)	Same	200- 500	Tug-Self-propelled Barge-Ferry Passenger-Rivership
Waterjet Thrustor	Same	100- 3000	Self-propelled Barge Hydrofoil Rigid Wall
Air Propeller	Same	400- 8000	Hydrofoil Surface Effect Ships (all types)
Two Phase (Mist) Jet Thrustors	Same	400- 5000	Same
Side or End Wheeler	Diesel-Steam Reciprocating	200- 2000	Riverboat-Ships-Ferry Tugs

Table I-3

BARGE/TUG TECHNOLOGY - HULL MATERIALS

MATERIAL	APPLICATION	MAXIMUM DISPLACEMENT INLAND WATERWAY VESSEL BUILT (TONS)
Wood	Barge - Tug Self-propelled Barge Ferry-Passengership Riverships-Riverboat	2800
Steel	Same	7000
Aluminum	Same plus Hydrofoil-Surface Effect Ships Air Lubricated Barges	800
Ferro-Cement	Same	180
Fiberglass	Hydrofoil-Surface Effect Ships Air Lubricated Barges Riverboats	40



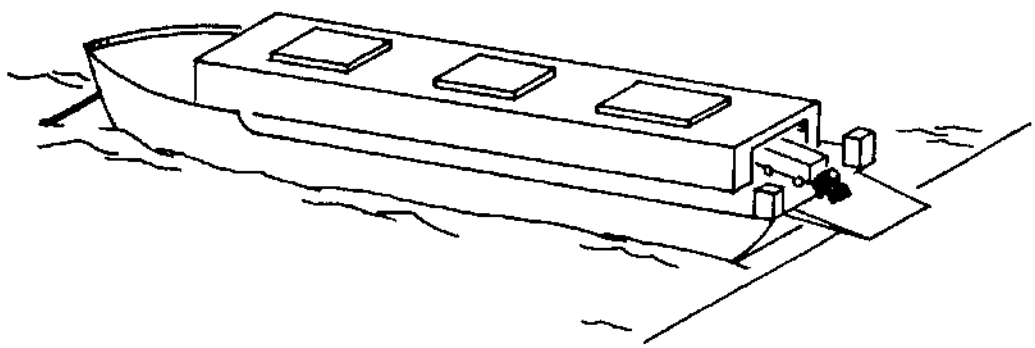


Figure I-2

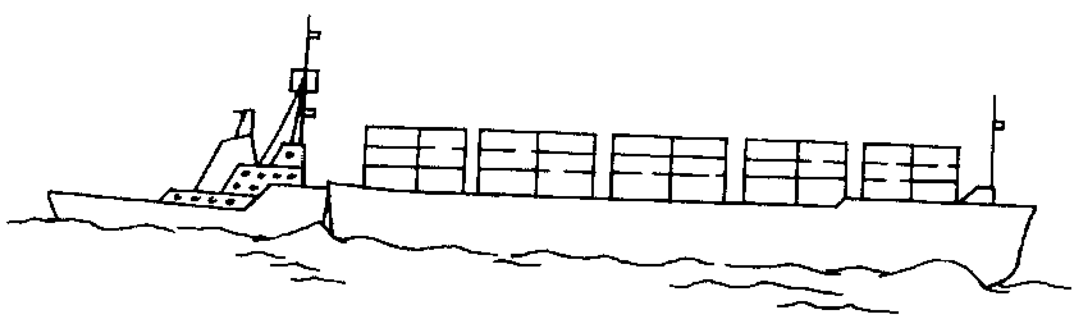


Figure I-3

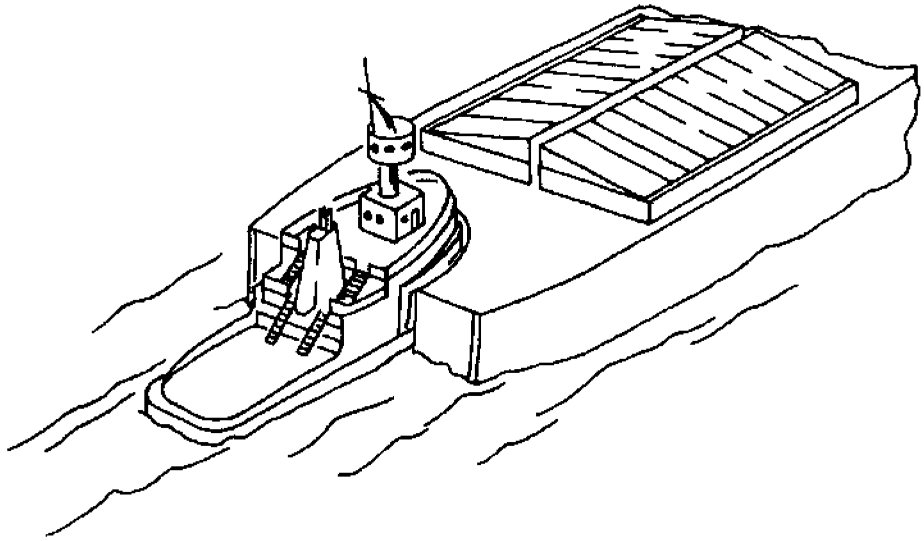


Figure I-4

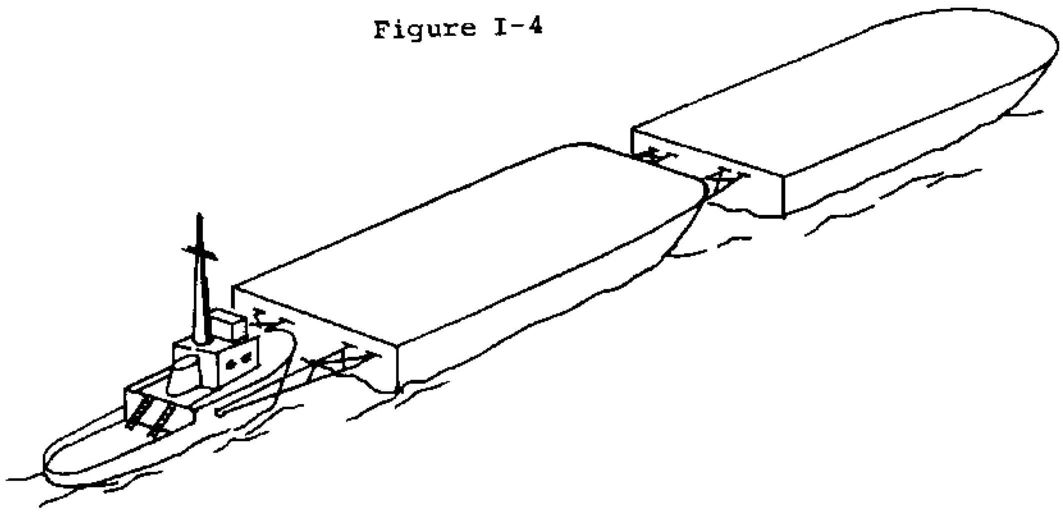


Figure I-5

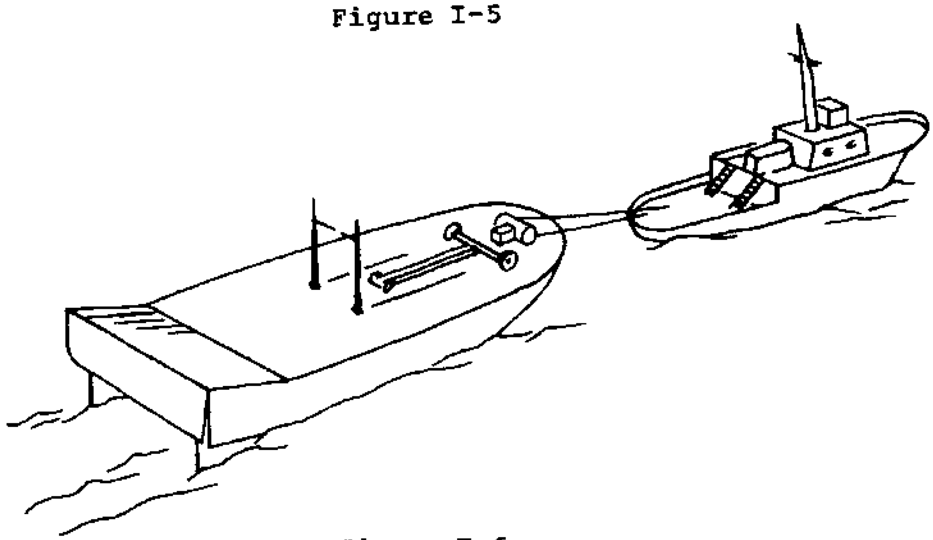


Figure I-6

Chapter II

OFFSHORE OCEAN BARGING

The continued attempts to achieve improved and cheaper ways of moving coastwise and offshore ocean bulk and other cargoes have brought major changes and resulting implications to the design and operation of large unmanned ocean barges. These barges have not only grown substantially in size but also often incorporate facilities for push as well as pull towing. As a result, much more effective offshore ocean barge operations are now feasible. Push towing in addition also introduces marked potentials for improved towing efficiency by close integration of the tug-barge tow and better directional and operational control. In this section we will summarize the major advances, systems and techniques currently in use and comment on the developing technology. These developments have a large effect on the economy of offshore ocean barge operations by virtue of the:

Increase in Speed
Economy of Size
Improved Maneuvering Ability and Control
Better Cargo Handling and Stowage
Shorter Turnaround
Reduced Manning and Productivity
Improved Utilization of Barge Inventory.

Traditionally barges in offshore service are towed on a hawser. Larger barges require towline cables of up to 3" diameter which are difficult to handle and involve problems of towline surging and towline drag resistance, both of which affect the speed (loss of 1-2 knots) and control of towing. Until quite recently barges in this type of service had maximum deadweight of not much above 10,000 DWT. Some of these barges were also equipped with a stern notch primarily designed for pushing in rivers or during calm weather in the open sea. The inconvenience and time loss of changeover from hawser to push tow made this feature only of use when substantial calm water or river distances had to be covered by an oceangoing barge. Speeds of 10 knots or more are only feasible with push towing. Various methods for coupling tugs to barges in offshore services have been developed. Some of these are as yet experimental. Push towing connections of barges in offshore ocean service is usually divided into non-rigid, pin jointed, gimbeled, semi-rigid and rigid connections.

<u>Non-Rigid Connections</u> - usually consisted of the tug within the barge notch (wall sided) secured by cables or hawsers. This provides essentially only longitudinal connection with limited vertical constraint.

Pin Jointed Connections - consist of retractable or fixed pins fitted on the tug or in the notch of the barge which when projected extend into a bearing hole or recess in the other vessel. The horizontal pin axis is usually located at about the quarterpoint of the tug. The receiving holes or recesses may have elastic padding or be elastically supported in the vertical directions. In some designs, the vertical position of pin or receiving holes (bearings) can be adjusted mechanically in one or more degrees of freedom (direction).

Gimbeled Connections - usually consist of a two axis double gimbel linkage connecting a conventional tug to a barge equipped with a flat transom. The pin connection on the tug is usually close to the plane in line with the CB of the vessel. The linkage hinged to the barge is generally equipped with a spread equal to the beam of the barge.

Semi-Rigid Connections - generally consist of multiple short structural engagements in the slot with counterparts on the tug. These engage whenever the tug drives into the notch and vice versa. The distance of engagement and disengagement is usually short. The engagement structures can be longitudinal tapered projections arranged at various heights in the notch.

Rigid Connections - usually consist of continuous longitudinal guides top and bottom, attached to the near parallel notch. These contain and capture the tug when entered and rigidly couple it. Relative engagement and disengagement distance is equal to the length of the longitudinal guides. In some designs, the lower support consists of a closed double bottom structure extended to about one half the length of the tug.

Various offshore barges have been developed using these coupling systems and a number of proprietary coupling methods have recently been developed. Among these is a push towing system developed on the U.S. West Coast which has been applied to barges of about 10,000 DWT and consists of a gimbel using a universal swivel joint on one side of the tug and a hinge at the stern of the barge. This system permits relative vertical motion while providing directional and horizontal thrust control. Another system is a rigid coupling system recently installed in a large 30,000 DWT barge by the Ingram Corporation.

Interstate Oil Company has developed various types of hinged as well as semi-rigid connections and has successfully pushtowed barges in ocean transportation of up to 30,000 DWT. The Fletcher "Artubar" is a semi-rigid articulated method with pins connecting the tug to the barge. This system is becoming of increasing importance and is being considered for multiple barge design. Various rigid connections have also been developed in Europe and Japan.

Ocean barging has developed rapidly in the last 10 years and today serves a significant portion of coastal and offshore transportation requirements worldwide. It is usually applied most effectively for bulk commodity movements over distances from 100 to 1500 miles and in waters up to 500 miles offshore. Among the major reasons for the growth in offshore barges are:

1) The greatly reduced investment cost of tugs and barges compared to ships or pipelines.

2) Better utilization of investment by more effective use of the manned power unit (tug), as the number of tugs may be significantly smaller than the number of barges required for a transportation system.

3) Reduced operating cost as a result of lower manning scales, less stringent regulatory requirements and warehouse ability provided by a barge. Similarly costs per man are appreciably lower for tug-crews when compared to oceanshipping.

4) Flexibility and versatility of a tug-barge system in providing for various matches of power and cargo units as well as a variety of speeds and cargo transfer system selection.

5) Ability to specialize. Serve specialized routes and/or terminals. Custom design and operation to suit service requirements.

6) Reduction in terminal requirements and access; barges can effectively be handled at terminals that are significantly simpler and cheaper than those required by ships, pipelines or other bulk transport modes. Similarly, their drafts are significantly less than those of equivalently sized tankers or bulk carriers providing more ready access by barges to a variety of terminals.

Offshore barges have been developed for a variety of purposes. Among these are 1) crude oil transportation, 2) petroleum product transportation and distribution, 3) cement transportation, 4) sugar and molasses, 5) various grains, 6) sand and gravel, 7) gypsum, 8) chemicals in liquid or dry form, 9) coal or ore, 10) steel ingots or plate, 11) unitized cargo, 12) roll-on roll-off trailer operations, and 13) liquid gas. Under some circumstances such as for most dry or liquid bulk commodities, barges will be equipped with self-unloading capability. Similarly, barges can be designed for multiple purposes, including backhaul cargoes. Typical dimensions and characteristics of barges are presented in Table II-1. Offshore barges can usually be built to much simpler rules than ships, which permits substantial savings in steel weight and resulting cost. A listing of some existing barges constructed recently and successfully operated is provided in Table II-2.

Typical relations of ocean going barge lengths versus DWT (deadweight carrying capacity) is presented in Fig. II-1. Various types of ocean going barges are considered in the derivation of these relationships and include petroleum (crude and product), chemical, dry cargo, asphalt, lumber and dump barges.

It will be noted, that the requirements for sea and speedkeeping assure fairly close consistency in length/DWT relationships of such barges independent of the service. On the other hand beam/depth, and length/depth ratios vary widely for given DWT as shown by example of Fig. II-3 and Fig. II-4.

Table II-1

TYPICAL DIMENSIONS AND CHARACTERISTICS OF OFFSHORE BARGES
(Barges in Excess of 4000 DWT)

Length	= 200 + 0.0135 · (DWT)
DWT	= (Length − 200)/0.0135
CN	= Cubic Number = DWT/1.73
L/B	= Length/Beam = 3.8 to 6.6
B/T	= Beam/Draft = 2.5 to 5.0
$\Delta/(0\ \text{Oil})^3$	= Displacement/$(0\ \text{Oil})^3$ = 200 to 400
C_B	= Block Coefficient = 0.78 to 0.92
S_R	= Stern Profile Rake = 15° to 25°
S	= Wetted Surface Area = 36.7 $\left(\frac{B+2T}{BT}\right)$ ←

Table II-2
LIST OF TYPICAL OFFSHORE BARGES

OWNER	G.T.	DWT	LENGTH ft.-in	BEAM	DEPTH ft-in	TYPE	BUILDER	CUBIC # x 100	B/D	L/D
Interstate Oil	6409	12,000	400	66	27	Oil	Avondale	712,800	2.44	14.81
Spenton Bush	6600	14,000	390	68	29	Oil	Avondale	769,080	2.34	13.44
Gulf Coast Transit	7985	18,000	420	80	35	Bulk	Gulfport Shipbldg.	1,176,000	2.29	12.0
Gulf Coast Transit	9542	23,000	420	80	40	Bulk	Gulfport Shipbldg.	1,344,000	2.00	10.5
Catano Borg Corp.	2648	5,200	264	53	22	Oil	Wyatt Industries	307,824	2.41	12.0
J. J. Tennant	7377	14,000	328	68	24-6	Lumber	Todd, Houston	546,448	2.78	13.38
Energy Transport	9815	19,000	430	80	32-6	Bulk	Avondale	1,118,000	2.46	13.23
Sheridan Tow	6074	12,000	350	66	31-6	Bulk	Avondale	727,650	2.10	11.11
Carribean Barge	8224	18,000	474-5	75	35	Bulk	Bethlehem Md.	1,245,562	2.14	13.56
Humble	2502	5,000	297-6	54	14	Oil	Dravo	224,910	3.86	21.25
Interstate Oil	4864	10,000	348-6	66	25	Oil	Gulfport	575,025	2.64	13.94
Gulf Coast Transit	7998	18,000	420	80	35	Bulk	Gulfport	1,176,000	2.29	12.0
United Trans.	4133	10,000	300	75	21	Oil	Pacific Coast Almeda	472,500	3.57	14.28
Pittson Marine	3642	7,000	300	60	23	Tank-Asphalt	Todd Houston	414,000	2.61	13.04
Greyhound Leasing	5057	10,000	324	74	22-6	Oil & Dry Cargo	Todd San Pedro	539,460	3.29	14.40
Falco, Inc.	2016	5,000	250	54	17-6	Oil	American Marine	236,250	3.09	14.20
Interstate Oil	6430	12,000	400	70	27-6	Oil	Avondale	772,800	2.55	14.55
Bouchard Co.	3965	8,000	320	65	23	Oil	Gretna	478,400	2.83	13.91
Turecamo Tankers	4361	8,100	334	64	23-9	Oil	Gulfport	510,886	2.69	14.06
United Trans.	5800	15,000	360	80	27-6	Oil	Gunderson	792,000	2.91	13.09
Interstate Oil	2940	7,900	310	64	21	Oil	Jeff. Boat	416,640	3.04	14.76
Poling Transport	4272	9,000	333	64	23-9	Oil	Todd Houston	506,160	2.69	14.02
Gulf Coast Tr.	7998	18,00	420	80	35	Bulk	American Bridge	1,176,000	2.29	12.0
Sheridan	6074	13,000	349-10	66	31-6	Cargo	Avondale	727,442	2.10	11.11
Southern Term.	3425	7,000	290	62	23	Tank-Acid	Eq. Equipment	413,540	2.70	12.61
Allied Chemical	3894	7,500	340	68	22	Tank-Chem.	Port Houston	508,640	3.09	15.45
Gulf Coast Tr.	7998	18,000	420	80	35	Bulk	American Bridge	1,176,000	2.28	12.0
Sheridan	6074	12,500	349-10	66	31-6	Bulk	Avondale	727,234	2.10	11.107

Figure II-1: Plot of Length vs. DWT for Various Barges

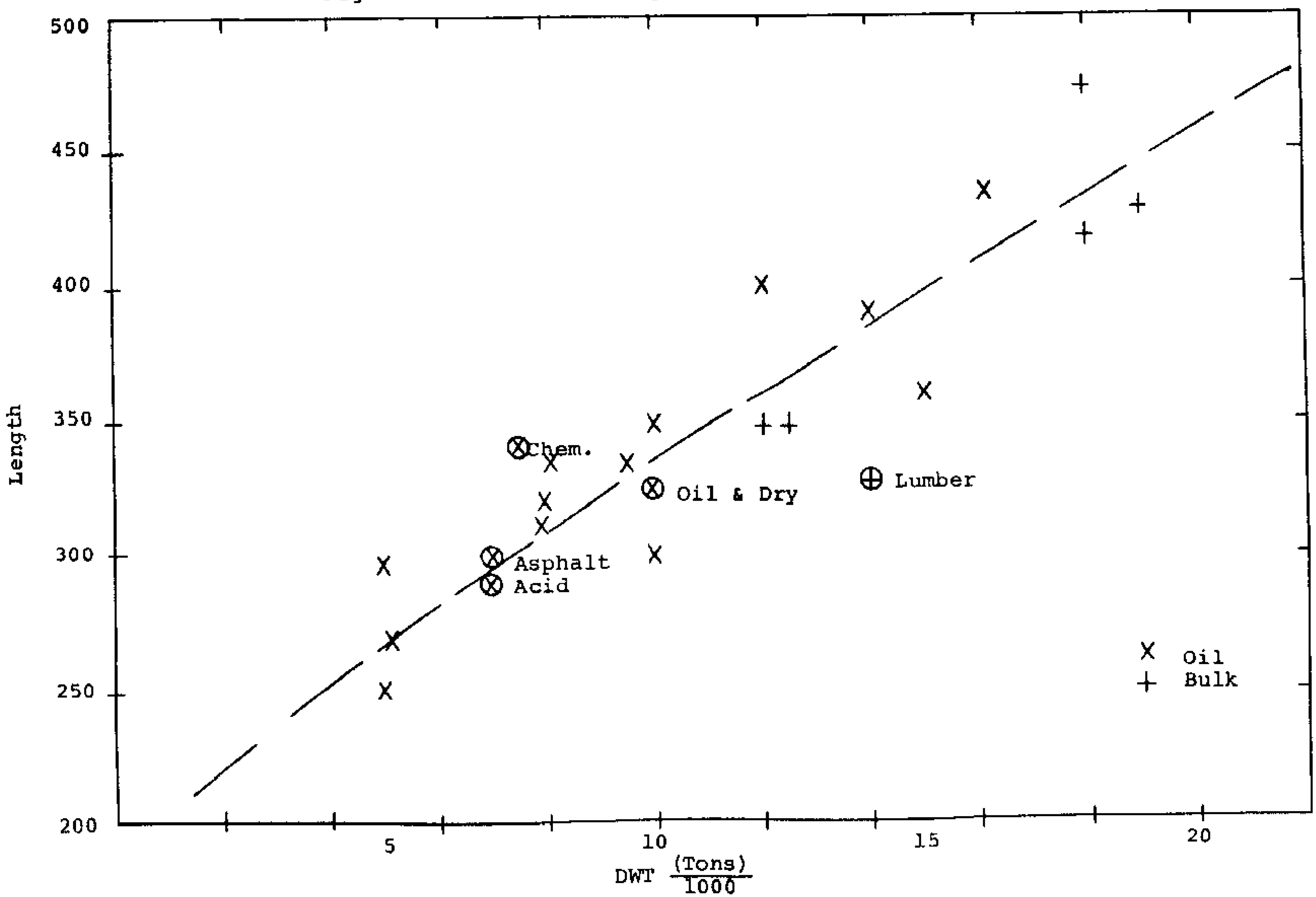
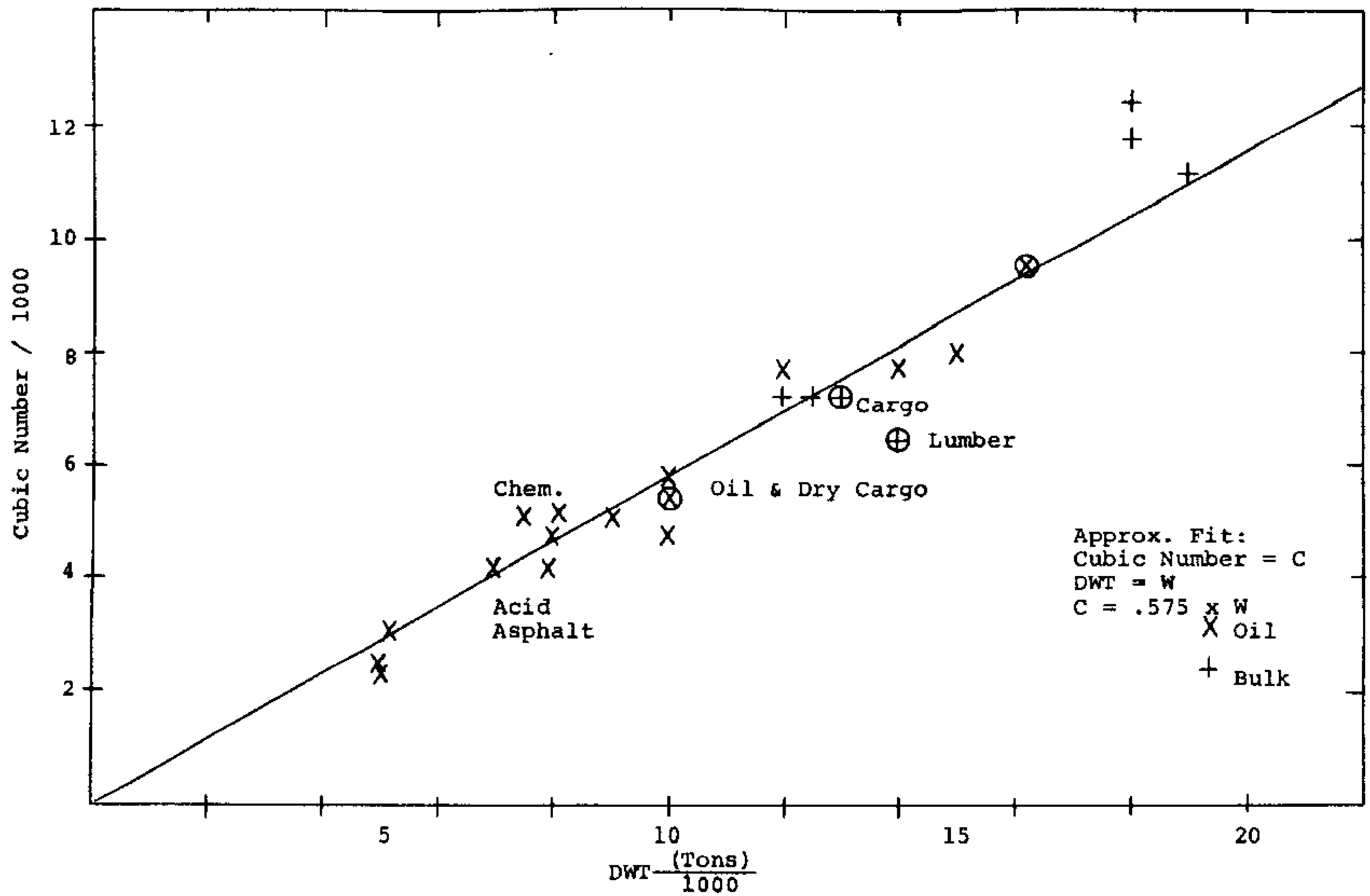


Figure II-2
Plot of DWT vs. Cubic Number for Various Barges

$$\text{Cubic Number} = L \times B \times D \times \frac{1}{100}$$



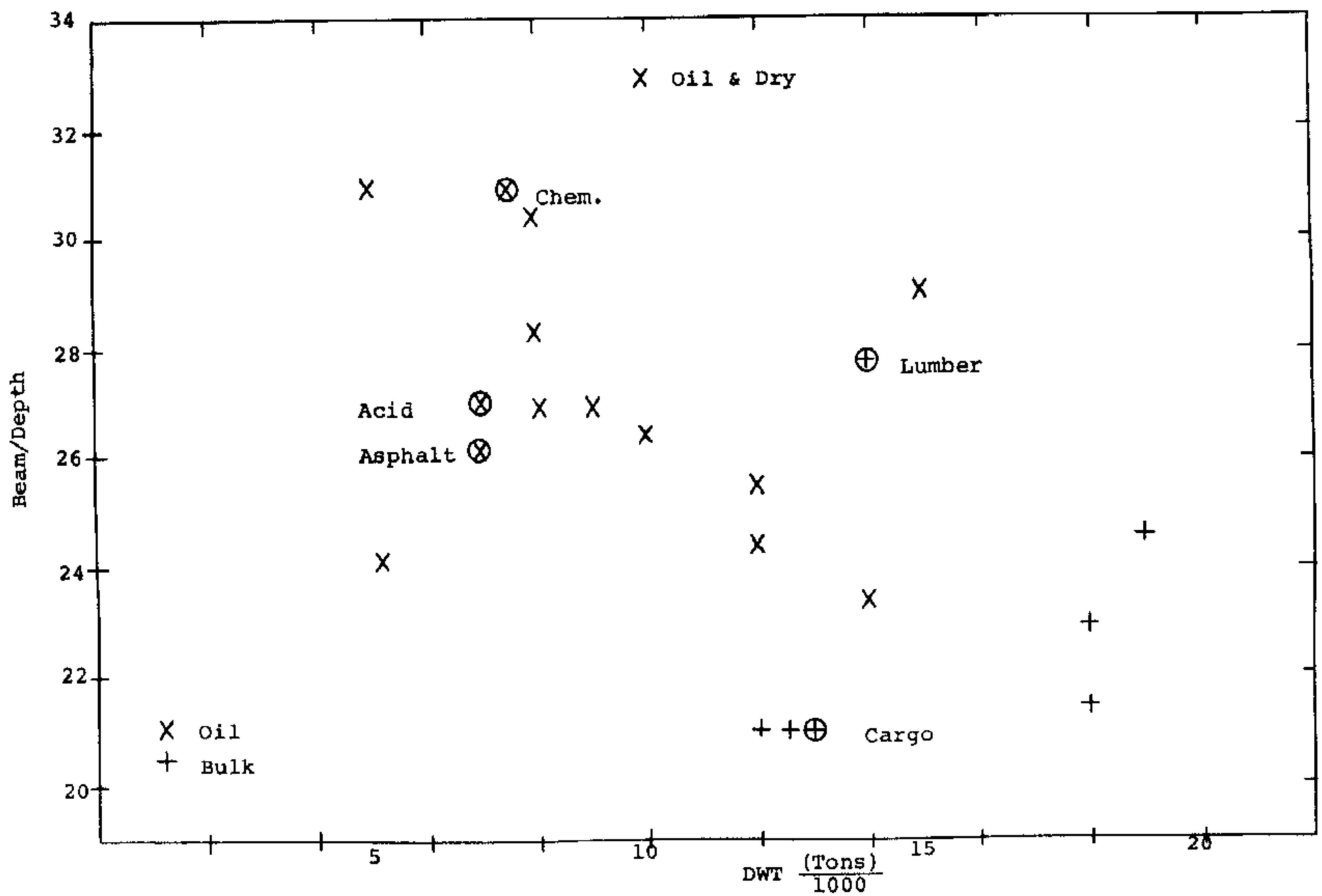
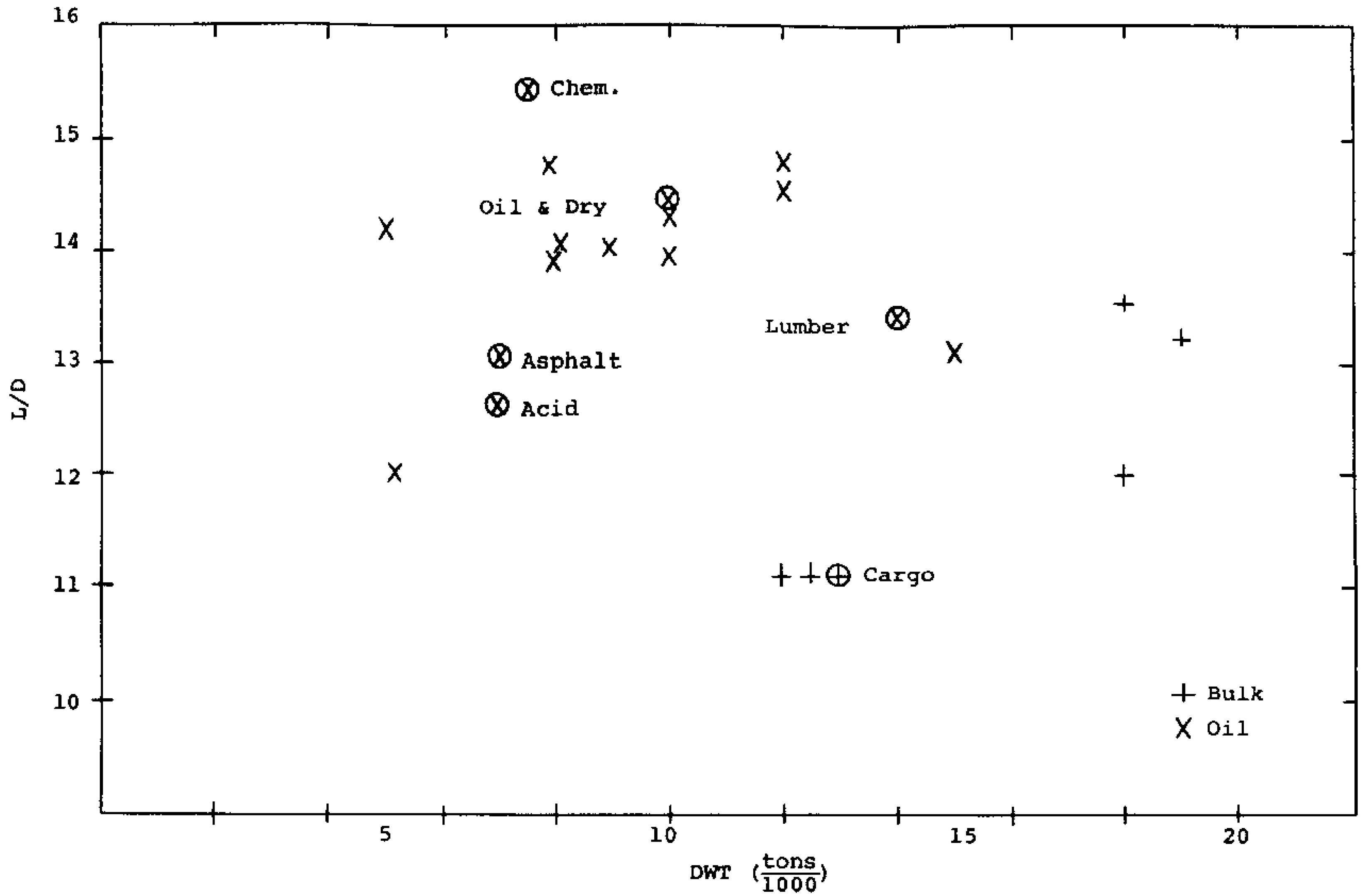


Figure II-3: Plot of B/D Ratio vs. DWT for Various Barges

Figure II-4: Plot of L/D Ratios for Various Barges



Chapter III

OCEAN BARGING COSTS

To determine general investment and operating costs of ocean barging a preliminary study of speed/resistance and dimension/weight relationships was performed.

Speed/resistance relations for offshore barges were developed, for barges varying from 10,000 to 50,000 DWT. Similar speed resistance curves were developed for tugboats and tugs chosen for various offshore barge operations. From these, tug-barge speed-power curves were determined to provide the required combinations of tug and barges for various speeds and deadweight requirements. To determine barge resistance, various empirical procedures and actual operating data were consulted. Using for wetted surface of a barge = $S - 36.7\ (B+27)/BT$ resistance computations were performed. Residual resistance versus block coefficient C_R/C_B is shown in Figure III-1.

The smaller beam/length ratio of oceangoing barges result in larger differences between full load and light conditions than in inland barges. For oceangoing barges the ratio of S(light)/S(full) varies from 0.600 at 5000 DWT to about 0.675 at 50,000 DWT. Typical wetted surface dimensions of oceangoing barges are presented in Table III-1, while ratios of S(light)/S(full) for oceangoing barges are presented in Fig. III-2. All barges are assumed to be equipped with skegs and spoon bows to assure directional stability. The resulting total resistance of oceangoing barges as calculated are presented in Fig. III-3. Resistance of integrated barge trains depends largely on the method and configuration of the train which in turn is determined by such factors as:

1) Dimension and loading of barges

2) Characteristics of available tugs

3) Maneuvering and control requirements

4) Selectivity from among barge train

5) Skill of operating crew

6) Route characterisitcs

7) Terminal configuration and procedures

In general, the resistance of an integrated (closely coupled) barge train will be equal to 70-90% of that of the sum of the individual barges and tugs. On the other hand, if barges and tugs are not closely integrated but tied by hawsers the total resistance of the barge train will usually be 5-10% more than that of the sum of the

Figure III-1: Residual Resistance Coefficients (C_R) vs. Block Coefficient (C_B) for Bare Hull

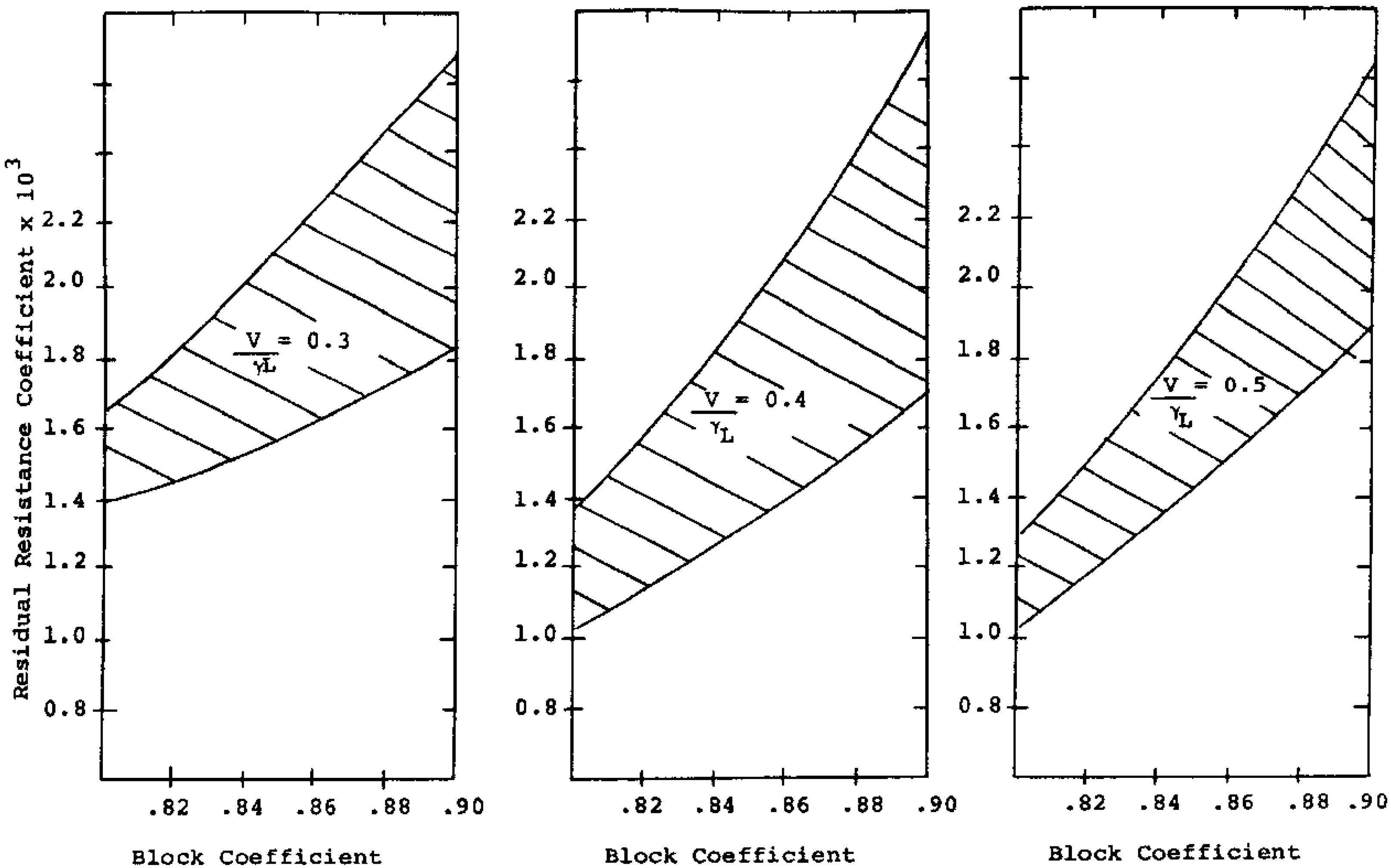


Figure III-2: Full Load/Light Load Wetted Surface of Barges

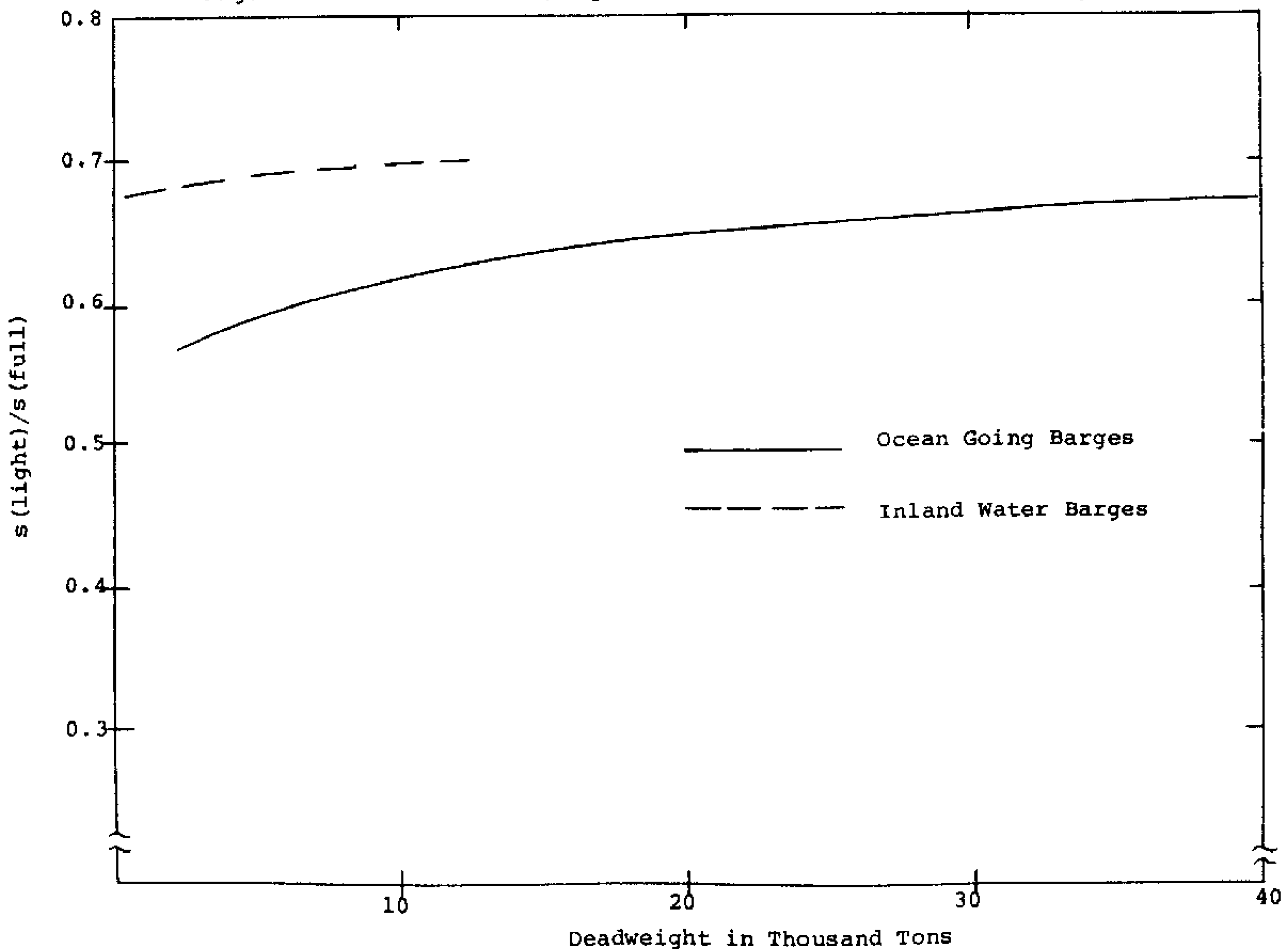


Table III-1

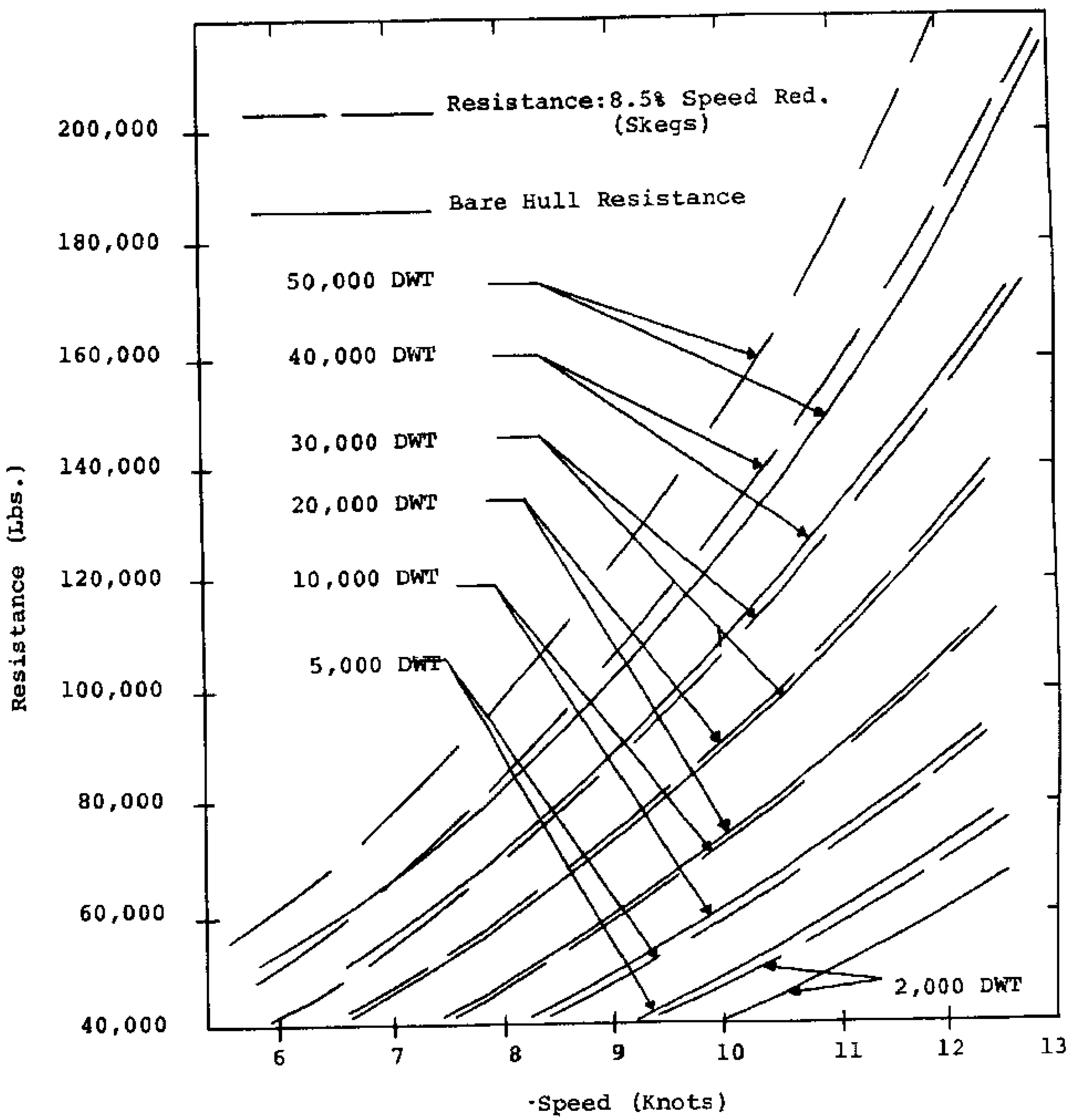
Typical Wetted Surface Dimension Oceangoing Barges

			30,000	40,000	50,000
Full Load	B		90.4	99.4	106.9
	T		28.2	31.2	33.5
	Δ		34,940	46,580	58,180
Light Condition	B		90.4	99.4	106.9
	T		4.00	4.38	4.70
	Δ		4,940	6,580	8,180
	S	Full	73,800	89,300	103,600
	S	Light	49,400	60,500	69,500
Rt Lt. / Rt Full	S Light / S Full	=	.668	.672	.674

Fig. III-3

Speed Resistance for Ocean-going Barges

Resistance Curves for Large Barges



resistance of the individual components.

The resistance of oceangoing tugs is presented in Fig. III-4. The relationships between effective and shaft-horsepower of typical ocean and inland water tugboats was determined and is presented in Fig. III-5.

The results of the resistance computations were next used to determine effective tug-barge combinations for various speeds and services. In Figure III-6 we present tug- power required for various oceangoing barge DWT pushed at different speeds while Figure III-7 shows the average speed of towed and pushed barges and required towline pull for a typical (9000 Ton) operation. The number of possible combinations of towed or pushed barge trains and tugs are too large to be presented in graphical form. The basic barge and tug resistance information developed in this section is therefore used on a case by case basis.

The basic steel and outfitting weights for various types of barges were determined and are presented in Figure III-8.

These weights are based on typical petroleum (liquid-bulk) barges with deep well pumps, and dry bulk barges (non-self-unloading).

Fig. III-4: Speed/Resistance for Oceangoing Tugs
Resistance Curves for 3,000,6,000,9,000 and 12,000 SHP Tugs

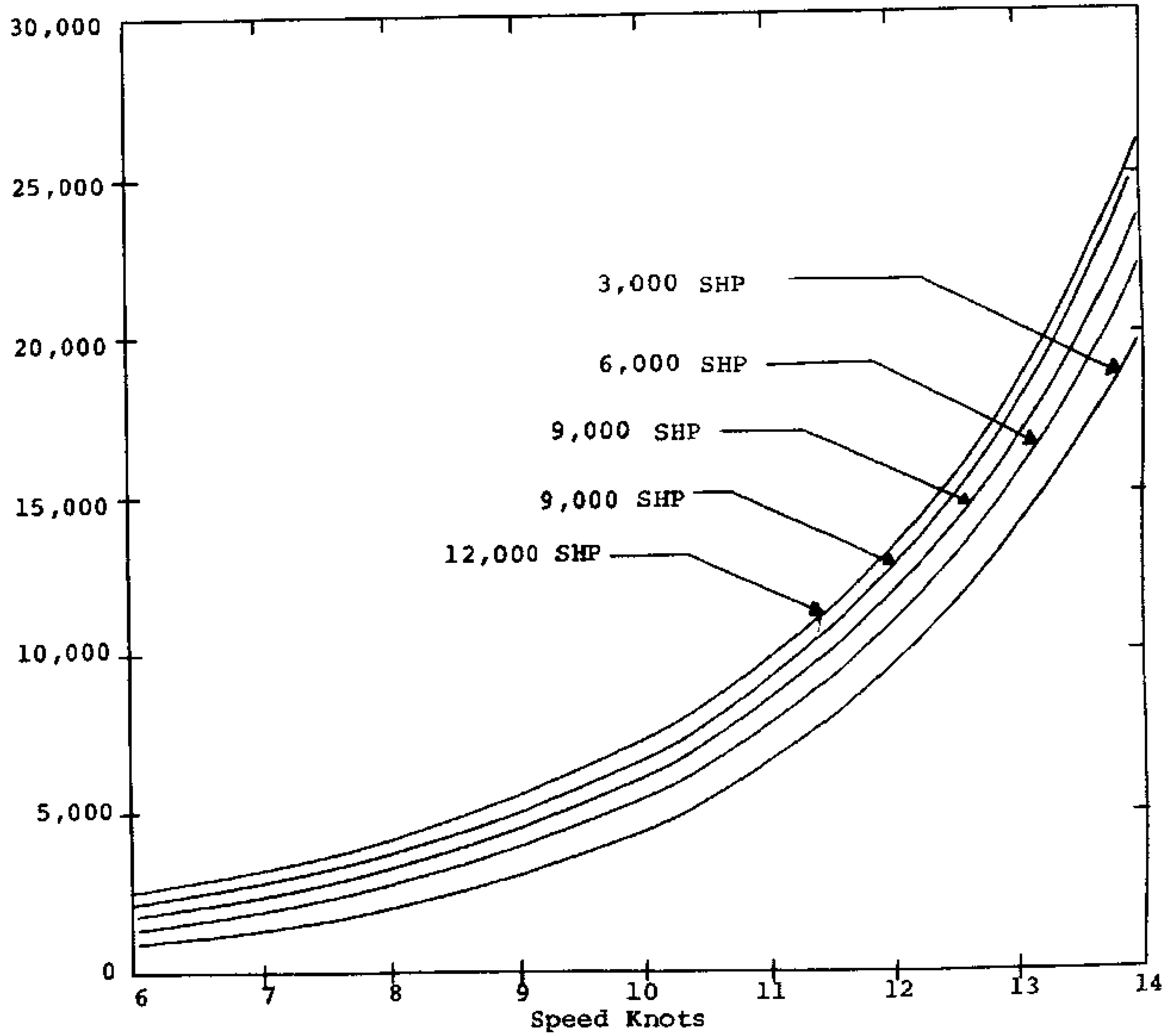


Figure III-5

Effective versus Shafthorsepower of Tugs
(Propulsive Coefficient: From Sname Data Sheets, Sname Transactions, Vol. 62)

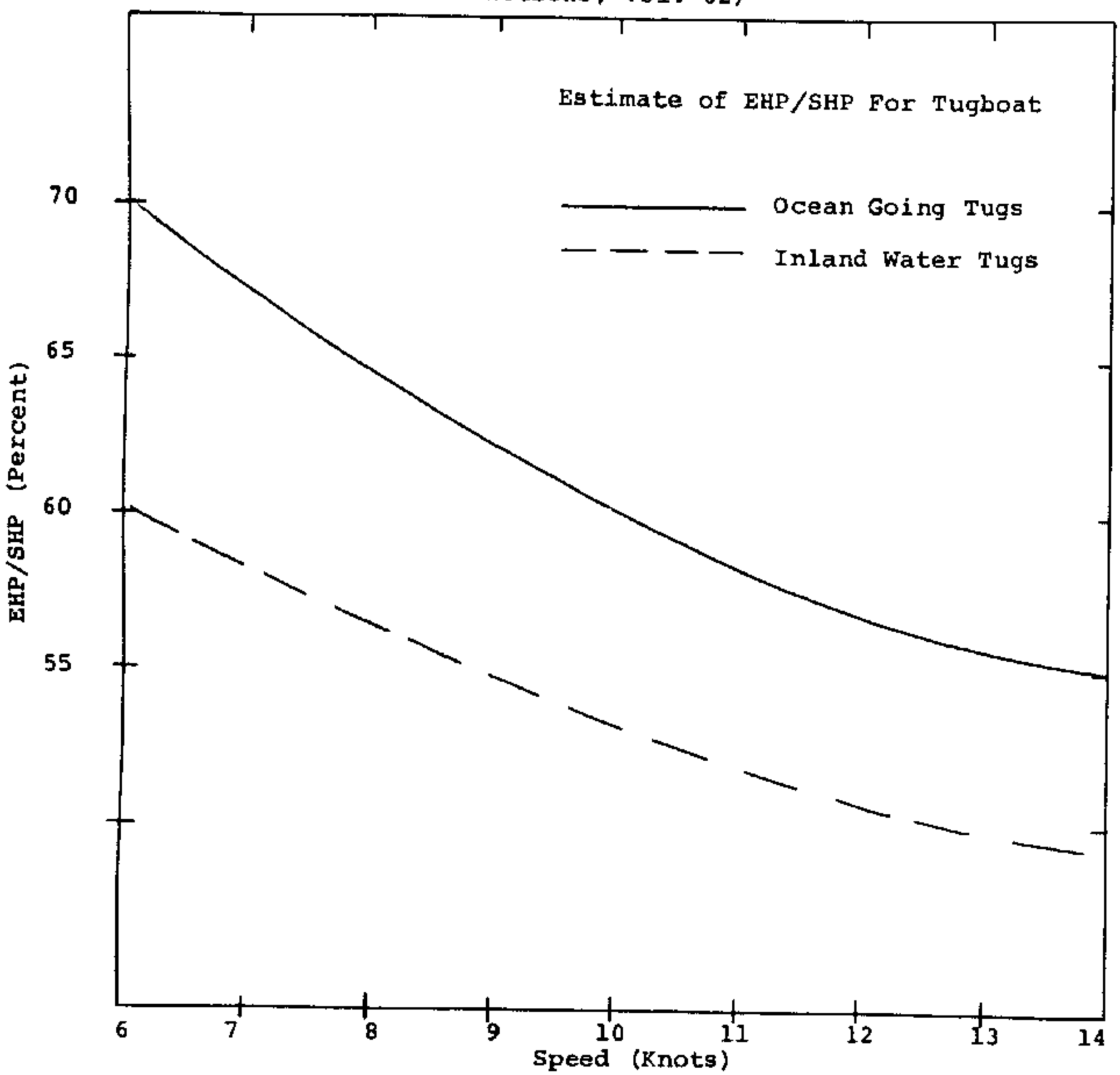
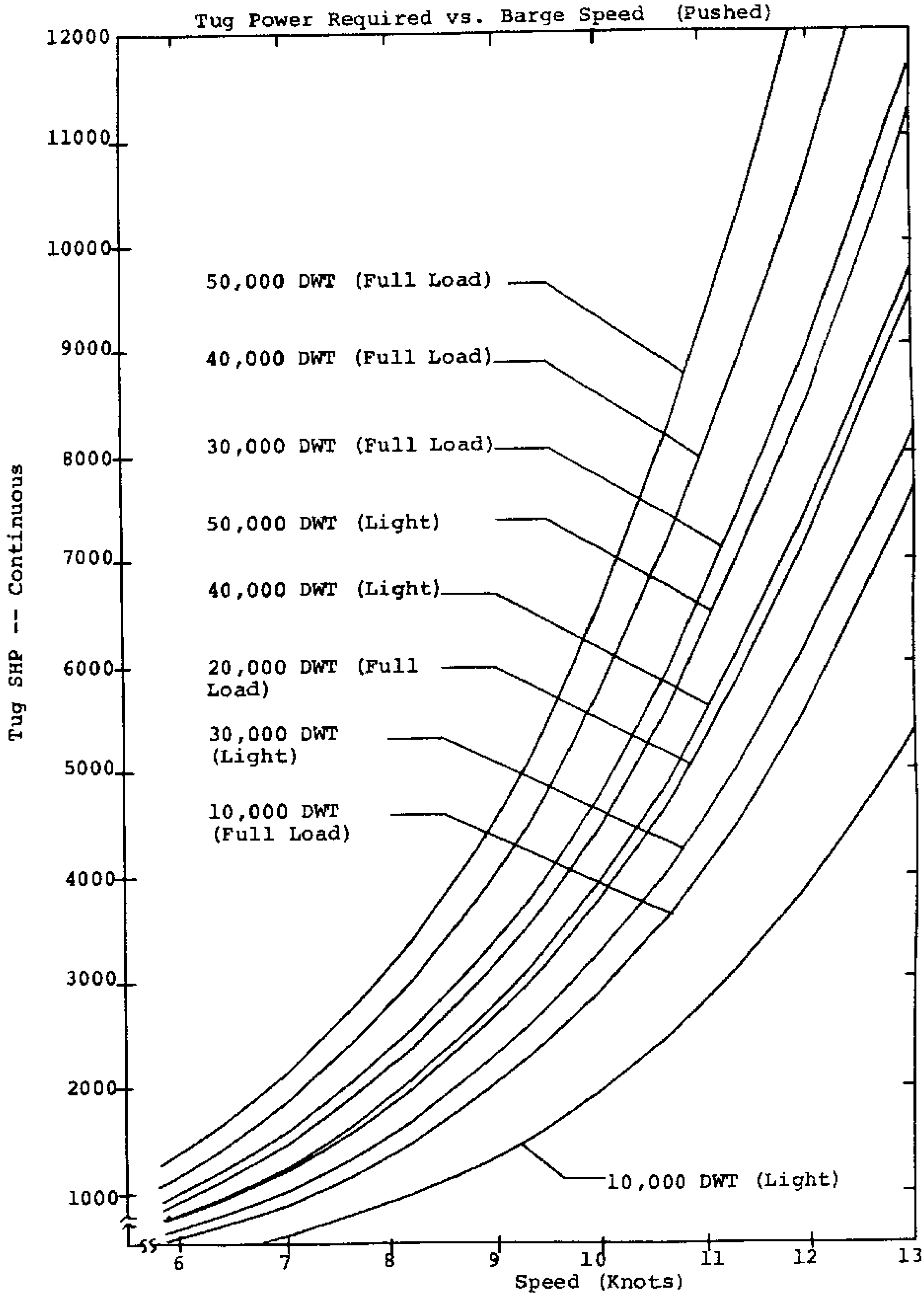


Fig. III-6
Ocean-going Tug-Barge Power



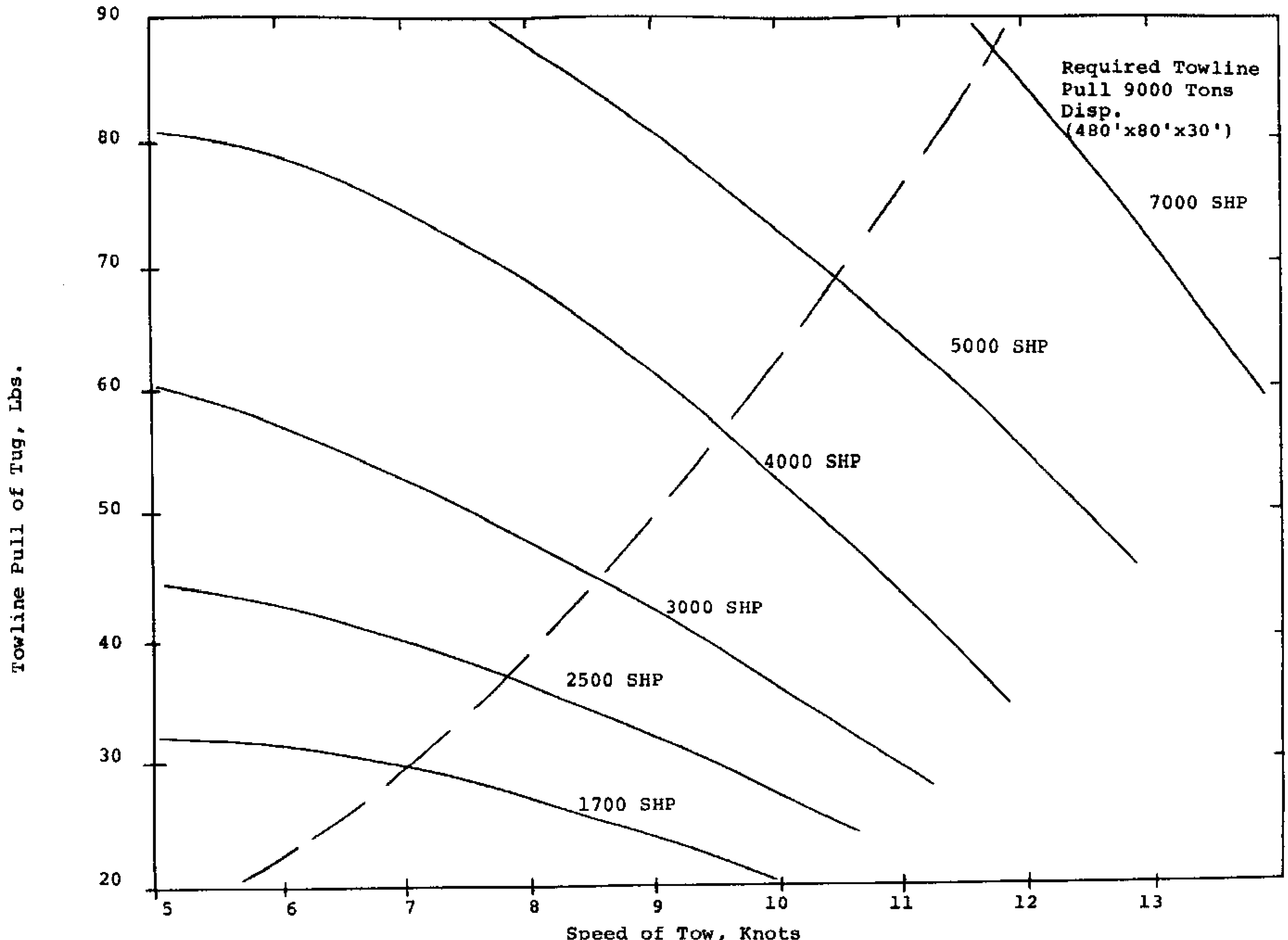
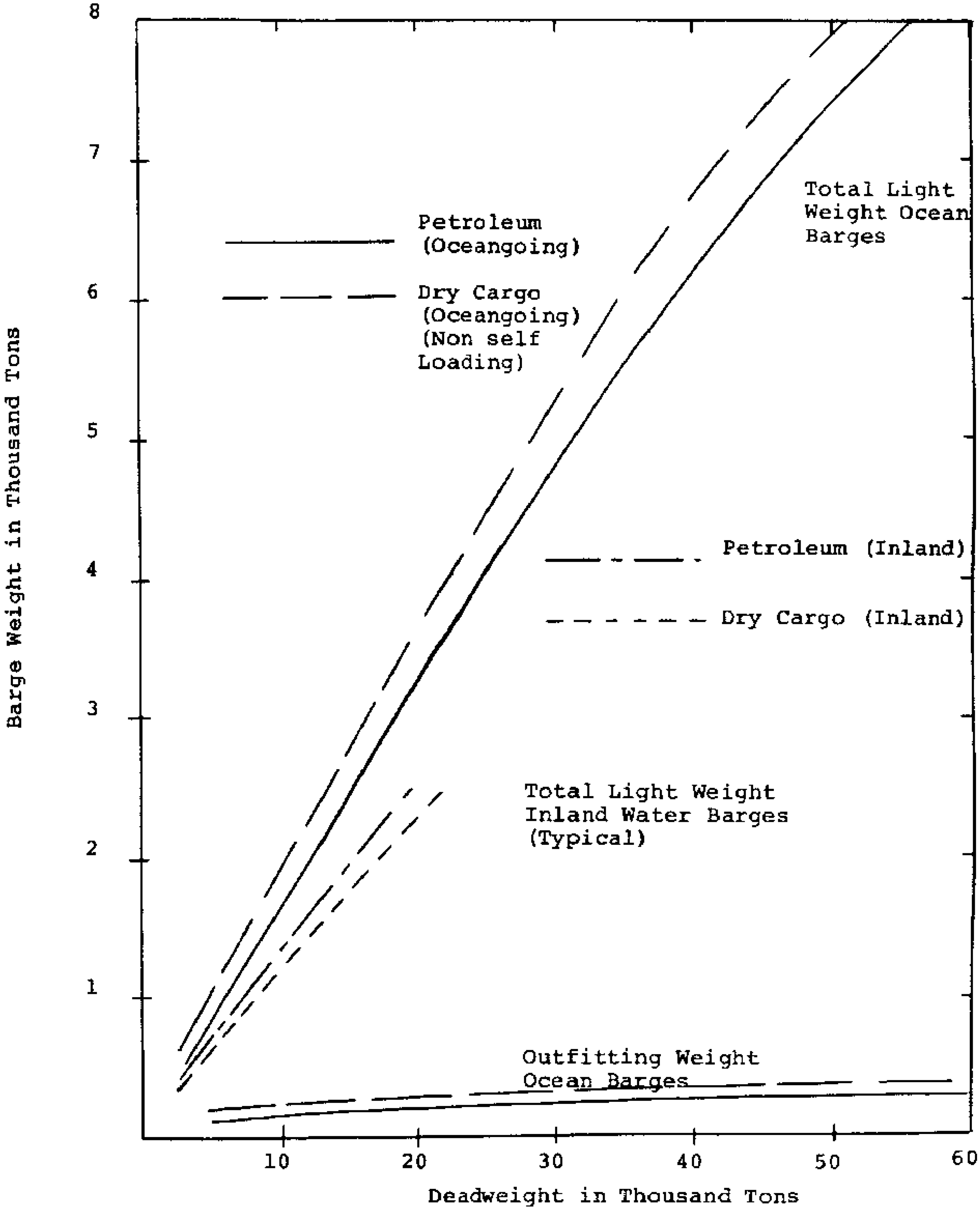


Fig. III-7: Average Speed of Towed and Pushed Barges (Oceangoing)

Fig. III-8
Steel and Outfitting Weights of Inland and Ocean Barges



Chapter IV

BARGE AND TUG INVESTMENT COSTS

Unit costs for the construction of barges were obtained for both U.S. and Japanese shipbuilders and used to develop estimates of the cost of offshore barges presented in Figure IV-1. Similarly, computations for typical characteristics of tugs for offshore barge operations were performed and tug characteristics determined which are presented in Table IV-1. These characteristics were then used to compute tug costs which are presented in Figure IV-2. Capital costs for barges include:

- Hull (without special tank coatings)
- Cargo or Ballast Pumps (Deep submergence pumps for petroleum barges)
- Deck Machinery (Hydraulic with remotely controlled anchor windlass for ocean going barges, otherwise defined by classification and/or sales)
- Rudders (Skegs) Lockable and only if required Deckhouse (if required for crew and equipment)

The costs quoted are an average of various bids received from a number of U.S. and foreign shipyards in 1971. It should be noted that barge characteristics vary widely. This was shown dramatically in Figure II-3 and II-4. Obviously variations of B/D by as much as 40% and L/D by as much as 30% for one and the same deadweight have a major effect on barge weight and resulting costs. Similarly special equipment and/or outfitting will influence barge investment costs. The costs presented should therefore be assumed to be average costs for barges of standard configuration, with minimum outfit and without the cost of special coupling devices or arrangements.

Similar comments apply to tug costs.

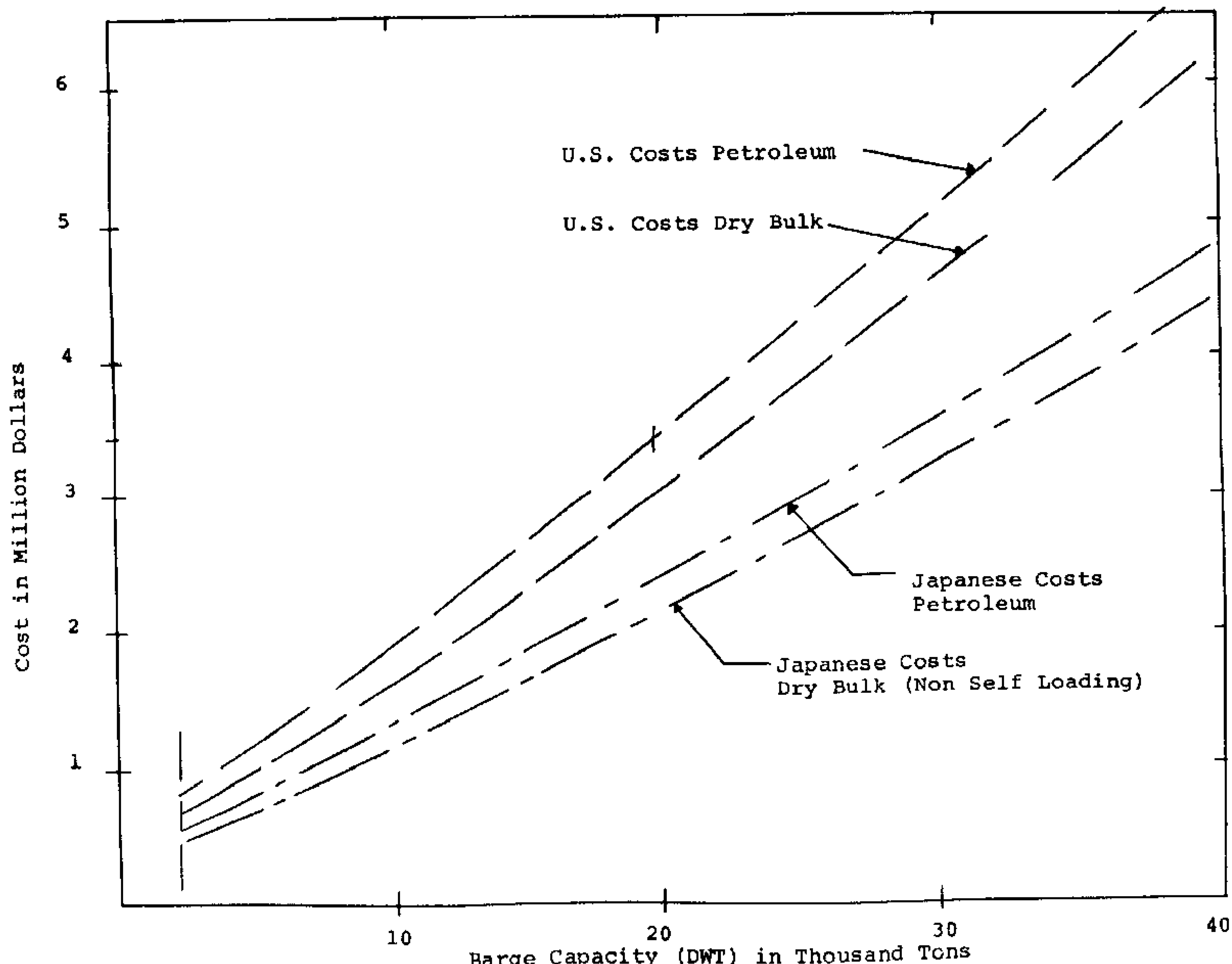


Fig. IV-1: Costs of Off-shore or Dual Purpose Barges (1971)

Table IV-1

Typical Tug Characteristics

Oceangoing or Dual Purpose Tugs

SHP	LENGTH	NO. SCREWS
1500	112'	1
3000	120'	1
5000	130'	2
7000	140'	2

Inland Towing Tugs

SHP	LENGTH	NO. SCREWS
1000	92'	1
2000	104'	1
3000	114'	1

Inland Pusher Tugs

SHP	LENGTH	NO. SCREWS
2000	94'	2
4000	104'	3
6000	112'	4

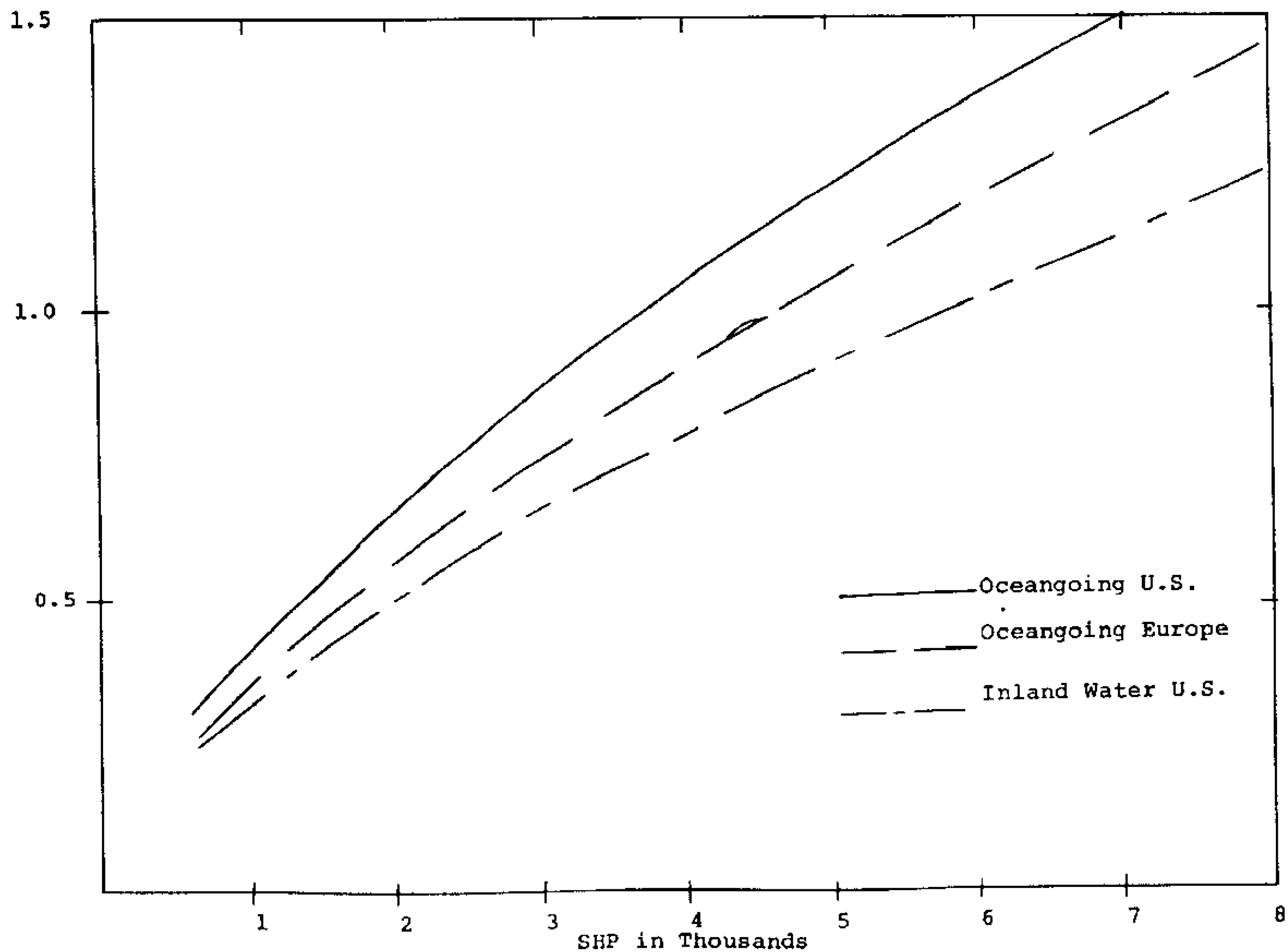


Fig. IV-2: Tug Costs

Chapter V

BARGE AND TUG OPERATING COSTS

Barge and tug operating costs vary widely with the route, type of service, schedule, labor contract, terminal facilities, cargo carried, etc. Therefore only general cost relationships can be presented which are believed to be average operating costs incurred by a U.S. ocean barge operator in liquid or dry bulk coastal ocean service. A 25 year useful life and linear depreciation was assumed for barges and tugs and a 6% interest on capital was used. Manning costs are those of a typical large interstate barge operator. Smaller operators often manage to pay lower wages. Wage scales, fuel, and lubricating costs are those prevailing in 1972.

Loading and discharge times versus loading and discharge rates are presented in Fig. V-1, while round trip times for various tug-barge combinations are shown in Fig. V-2. Major operating cost elements are as follows:

1.) Financial Costs

(Listed in Table V-2 and Figure V-3)
Tug depreciation and interest costs and
Barge depreciation and interest cost.

2.) Insurance Costs

Usually 2% of Investment cost/year plus 0.2-1.0% of value of cargo (dependent on type) and voyage.

3.) Manning Costs

(Listed in Table V-1)

4.) Fuel and Lubricating Oil Costs

$4.15/barrel (U.S.) diesel oil
$0.98/gallon (U.S.) lubricating oil with average consumption of diesel oil assumed 0.37 lb/SHP hr. and 4 grams of lub oil/SHP hr. Fuel oil and lubricating oil costs for tugs are listed in Figure V-4 and for barges in Figure V-5.

5.) Maintenance and Repair Costs

Assumed to be about 4% of tug investment cost/year and 2.0% of barge investment cost/year.

6.) Dues and Fees

These vary widely. Typical inspection and other fees are 0.3% of investment cost/year.

7.) Administration and Overhead

Assumed to be 6% of total annual costs/year.

8.) Port Related Costs

These consist of stevedoring, clerk, security, storage, port dues, wharfage, and other related costs, and vary widely among ports. They furthermore differ among commodities. Only port dues and transfer costs usually apply to bulk cargoes (generally handled over proprietory and/or specialized facilities, while all the above cost items apply to general cargo).

Table V-1

MANNING SCALES AND COSTS
(U.S. Costs in Dollars)

Oceangoing Service
Tug Manning Costs in Dollars

SHP	NO. IN CREW	AVERAGE WAGE COST/DAY (excludes overtime)	FRINGE & SOCIAL COST/	VICTUALING COST/ DAY	OVERTIME COST/ DAY	VACATION COST/ DAY*	TOTAL COST/ DAY
1500	8	300	100	16	50	150	616
3000	9	340	112	18	63	170	703
5000	10	382	130	20	76	191	793
7000	11	416	141	22	88	208	875

Basic Wage:		
	Captain	$18000/annum.
	1st Officer	$14000/annum.
	Engineer	$15000/annum.
	Seaman	$8000/annum.
	Cook	$9000/annum.
	Oiler	$8000/annum.

* For every two days on board one day off.

Ocean Barge Manning Costs

Barges of 5000 DWT will usually have a two man crew at a total daily cost of $76.

Fig. V-1

Plot of Loading or Discharge Time vs. Loading or Discharge Rate (Amount of Cargo Transferred)

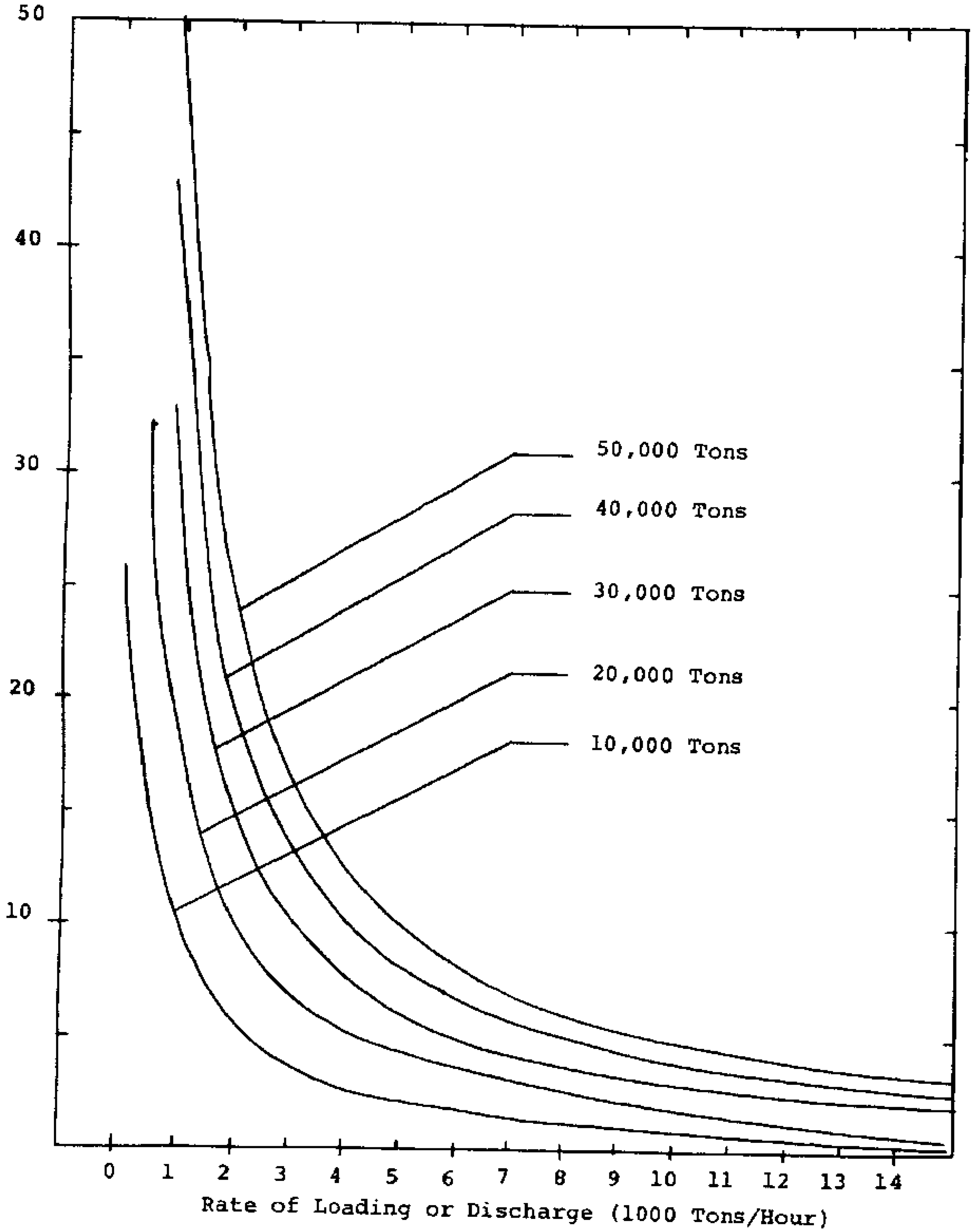


Fig. V-2

Plot of Round Trip-Voyage Time vs. Round Trip Distance for Various Barge DWT-Tug SHP Combinations

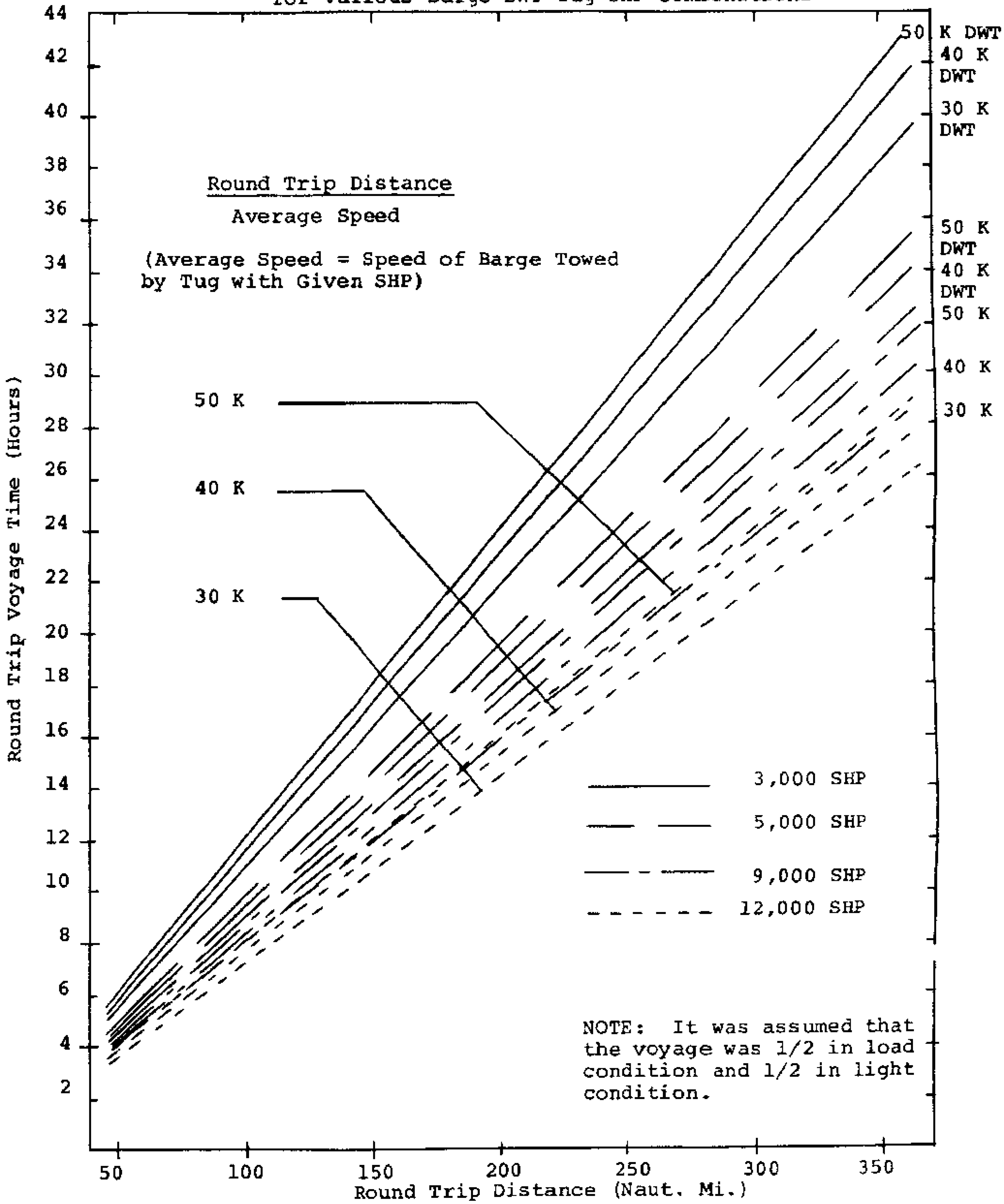


Table V-2

Financial Costs (Dollars)

(U.S. Procurement Costs)

(6% interest)

Ocean Tug-Barge Systems

TYPE	SHP or DWT	INVESTMENT COST	*ANNUAL DEPRE-CIATION	ANNUAL INTEREST	ANNUAL INT. & DEPRE-CIATION
Barge Liquid	5,000	1,150,000	46,000	34,000	80,000
Barge Liquid	10,000	1,900,000	76,000	57,000	133,000
Barge Liquid	20,000	3,480,000	139,000	102,000	241,000
Barge Liquid	30,000	5,080,000	203,000	155,000	358,000
Barge Liquid	40,000	6,600,000	262,000	198,000	460,000
Barge Dry Bulk	5,000	980,000	39,000	29,000	68,000
Barge Dry Bulk	10,000	1,600,000	64,000	48,000	112,000
Barge Dry Bulk	20,000	3,050,000	121,000	91,000	212,000
Barge Dry Bulk	30,000	4,600,000	184,000	138,000	322,000
Barge Dry Bulk	40,000	6,120,000	246,000	182,000	428,000
Tug (Diesel)	1,500	560,000	22,500	16,800	39,300
Tug (Diesel)	3,000	850,000	34,000	25,500	59,500
Tug (Diesel)	5,000	1,200,000	48,000	36,000	84,000
Tug (Diesel)	7,000	1,470,000	58,600	44,000	102,600

* 25 year straight line depreciation.

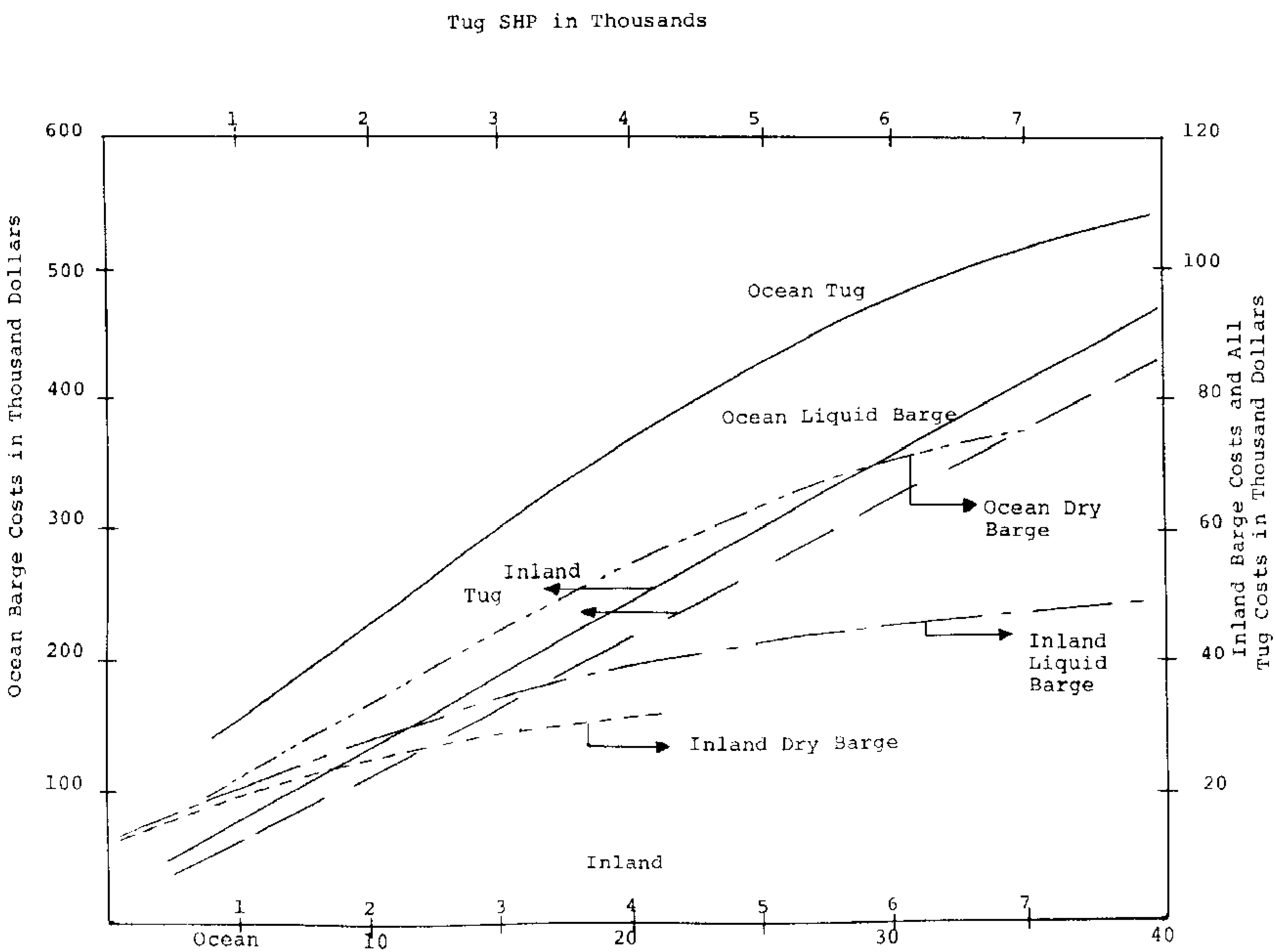


Fig. V-3: Annual Depreciation and Interest Costs

Fig. V-4

Tug Fuel and Lub. Oil Costs Per Hour

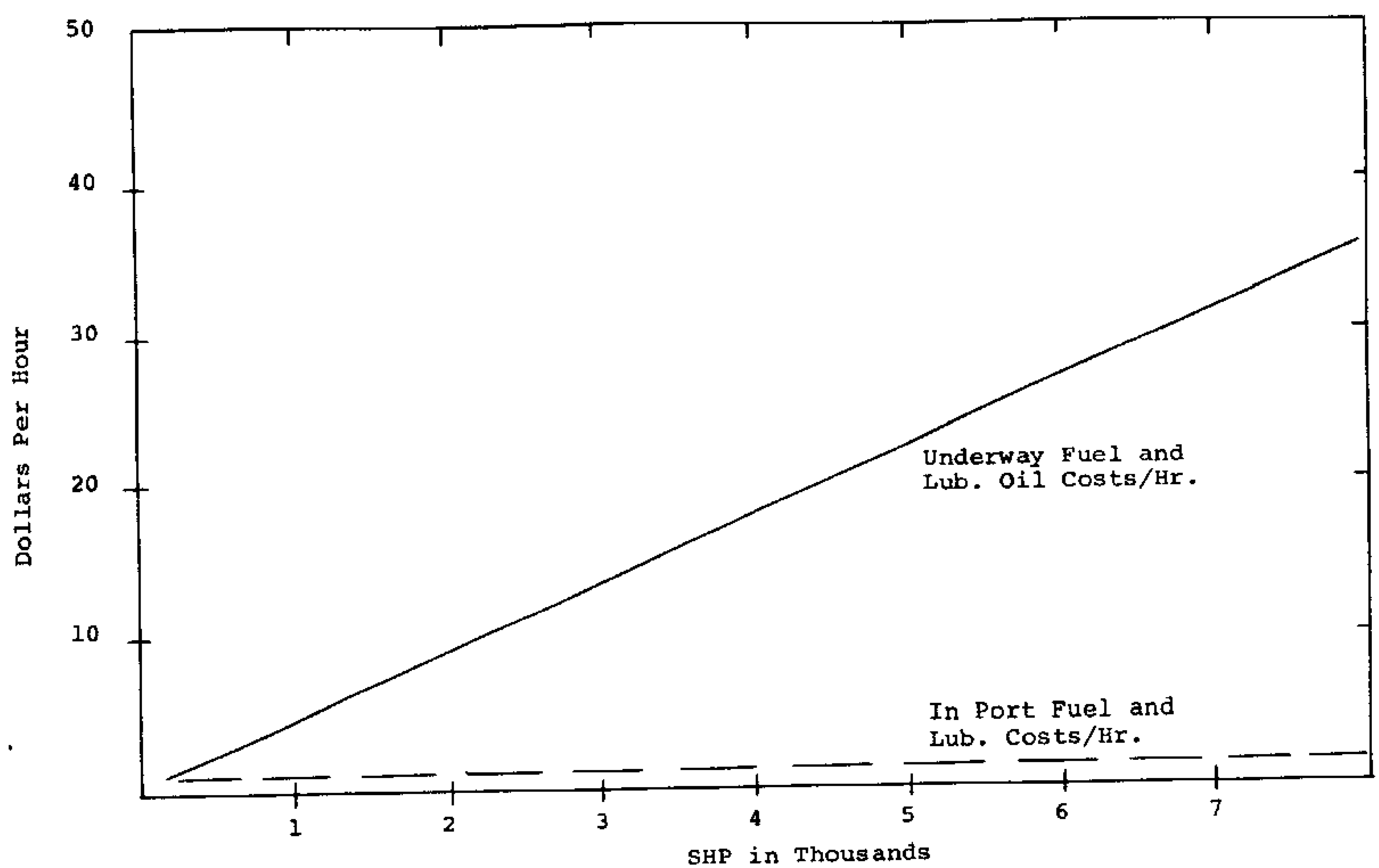
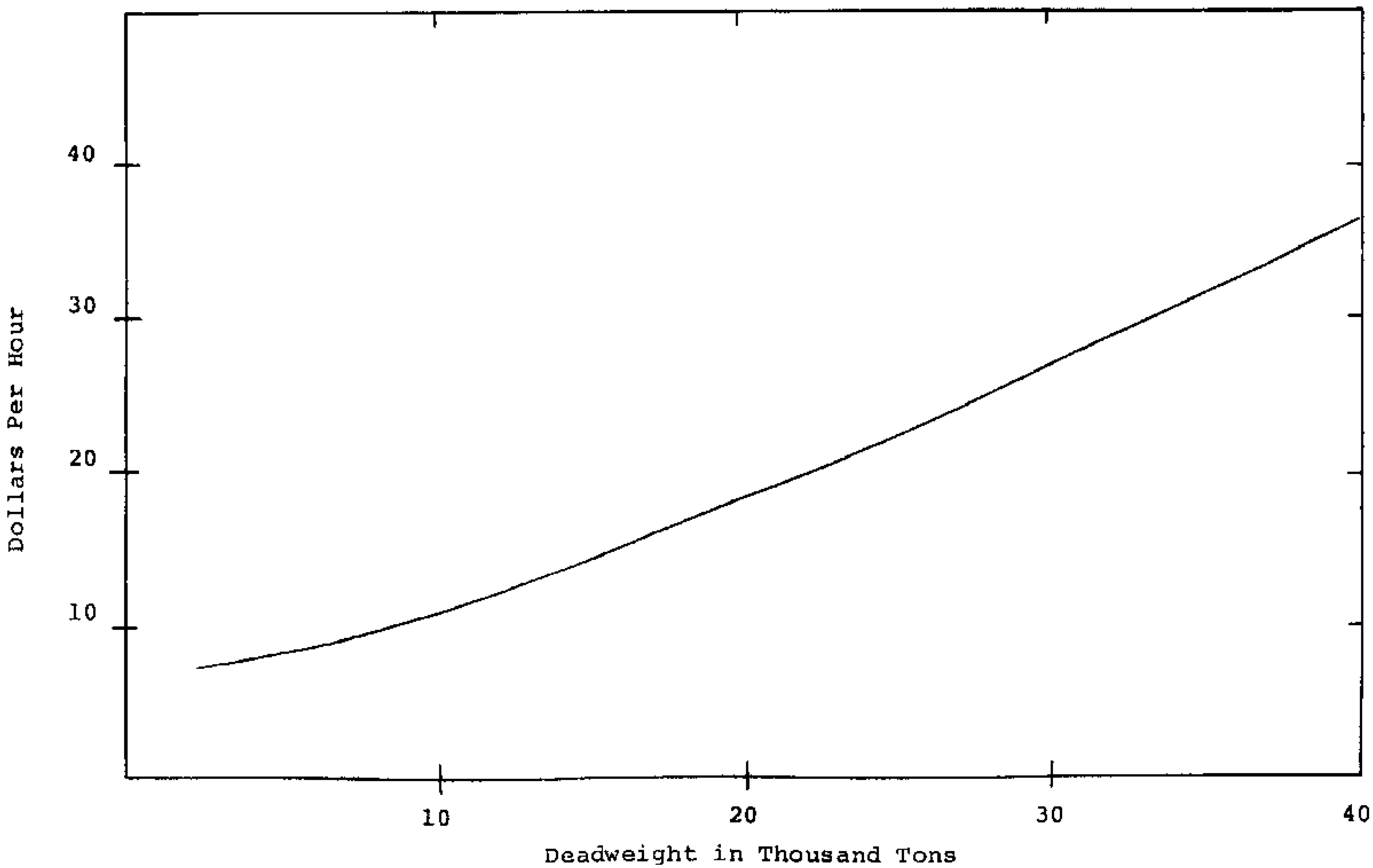


Fig. V-5

Fuel and Lub. Oil Costs per Hour for Self-Unloading Petroleum and Liquid Barges



While barge transportation is the lowest cost mode for a variety of large volume dry and liquid bulk movements it is harder to justify its use in break bulk movements unless an integrated and highly unitized system can be divised. If ocean barging serves as a "unit train" on which such cargo is carried in large containers and which furthermore serves as an inexpensive loading and receiving floating warehouse then such movements may be found effective. Barging has played a special role in movement of natural resources and its availability often has been the deciding factor in raw material exploitation. The importance of barging to actual resource production though is not to be measured solely by waterborne tonnage carried but also by the effect its availability (and cost) has on holding down the rates of competing modes.

Because of its strict cost orientation barge transportation can be termed <u>all economic production</u>. Barge cargo consist largely of standardized commodities and shippers usually determine origins, destinations, service requirements and shipment quantities on a strict cost basis. In this role as carriers of natural resource products, therefore, barge transportation is an essential segment of natural resource production.

In the absence of barge transportation the cost differential of raw materials and natural resources (minerals, agricultural produce, etc.) between surplus producing areas and deficiency areas are generally markedly higher. A large number of examples of this trend are available for both developed and developing countries.

Full utilization of the potentials of barge transportation will continue to be an essential in natural resource development and conservation. Similarly, depending on particular route requirements, navigation potential is usually a joint product of other water resource development objectives and it is often found, that the prospective navigational developments form an essential part in overall project development justification. While the test of economic efficiency itself may be insufficient for large government expenditures for navigational improvements, such policy can usually be guided by the total contribution to GNP, standard of living, and social welfare in comparison with equal expenditure elsewhere in the national economy.

Among the factors affecting the cost of barge transportation are:

1) The availability of transportation facilities
2) The need for storage
3) Transit time requirements and its effect on commodity utility
4) Direct cost of transportation
5) Quantity of commodity likely to be moved in a given time period

6) Cost of capital investment
7) User charges and various other charges
8) Transfer or intermodal costs

The special conditions that give each transportation mode its unique character bring more specific factors into the rating problem. Stop-over services enroute have become routine for railroad movements of certain commodities.

Conversely, the generally lower rate levels of barge transportation reflect the freedom of these modes from capitalization costs. The highway carriers have the distinctive capacity of local "store door" delivery by the hauling unit; truck service thus is most flexible geographically - also in point of scheduling, as storedoor delivery by road units effectively precludes rigid timing of trips. The higher costs of this flexibility make up, to some extent, for the highway carriers' freedom from roadway capital costs. Similarly, the weight-carrying capacity of barging is the specific advantage which makes possible extremely low rates in terms of weight. This advantage is offset to a degree by the fact that low rates per unit of weight make it often necessary for barge lines to impose large minimum weight requirements, large aggregate lading, in order to recover costs.

Special conditions affecting the various modes thus dictate appropriate basic rate levels for each. For all, income from rates must cover costs, but since accurate knowledge of the cost of each movement of any particular commodity is not available, carriers use cost averages in setting rates. And since commodity value changes possible through transportation also cannot be known accurately, average value comparisons between types of commodities are used as indications of the ranges within which rates may be set. Carriers thus plan on handling a variety of commodities at a variety of rates, including lower charges for lower-valued commodities that are offset by proportionally higher charges on higher-valued goods. In this way, carriers expect over time to recover costs and gain return on investments.

Rates below average costs are therefore often part of the business.

Chapter VI

TUG/BARGE COMBINATIONS

An infinite number of tug-barge combinations can be devised. In fact one of the many advantages of ocean barge operations is the fact that the same barge can be propelled by different powers, at different speeds over parts of its route. Conversely, a tug can be used to move different barges at different speeds. This flexibility allows the integration of a fleet of different barges and tugs into a fleet to supply different services in an integrated manner. Resulting utilization is often high, particularly as barges used as pierside storage often earn sufficiently to pay for their operating costs. The loaded and ballast speed of typical push-towed ocean-going barges is presented in Table VI-1. Ballast condition of ocean-going barges is usually interpreted as 20-25% loaded displacement and therefore significantly less than the corresponding ballast condition of ocean-going ships. This practice obviously reduces barge construction and operating costs but introduces difficulties with the use of some tug-barge coupling methods. As ocean-going barges become bigger, the resulting effects on seakeeping, structural loading, and maneuverability must also be considered.

Table VI-1

Top Speeds for Various Tug-Barge Combinations (knots)

	TUG S.H.P. 3,000	6,000	9,000	12,000
F.L. 50,000 DWT	7.90	9.75	10.92	11.85
Light 50,000 DWT	8.85	10.80	12.14	13.25
F.L. 40,000 DWT	8.20	10.15	11.40	12.40
Light 40,000 DWT	9.20	11.25	12.67	13.90
F.L. 30,000 DWT	8.70	10.65	12.00	13.10
Light 30,000 DWT	9.70	11.83	13.35	14.75

Chapter VII

BARGE PORTS AND TERMINALS

Since early days in history, settlement patterns were tied fairly closely to navigable waterways, which provided both sources of water and supply of communication routes. With the coming of roads and railroads about one hundred years ago settlement became less dependent on the water transport and such traffic and commerce greatly diminished in importance.

Today, although barge transportation occupies a minor economic and communication role in the life of the nation, it provides essential transportation for some major industries. Rail and road transport have advantages in terms of speed and geographic reach, but generally suffer from higher costs.

The costs of ocean barge transportation is low because the waterways are free, transport vehicles/unit load are cheap to buy and operate, and because barges can be loaded and unloaded at any reasonably level area on the banks or shore that the floating craft can approach closely enough. This freedom of service location has been preserved for the carriers into the present, through the contributions of cargo-handling technology. For most commodities, handling systems have been developed that are inexpensive enough, and easy enough to install on any reasonably level bank. Consequently, terminals, or cargo-handling installations, are located where needed. Some may be in service only temporarily; for example, oil companies at times set up channelside pumping stations for loading or unloading oil from barges, using portable pipe sections for the lines and a pump mounted on an appropriate mobile vehicle. Carriers need only to know the bank and river mile location a short time in advance to arrange to serve such casual terminals. Waterway transportation thus is able to serve the convenience of en-route patrons quite responsively, without investing heavily in locations on land.

In barge transportation, usually customers rather than carriers or communities provide terminals and facilities for cargo transfer between land and barge. A barge port or terminal often implies simply a harbor where barges can float alongside simple transfer facilities or anchor for such transfers in relatively sheltered waters. Barge terminals usually do not have the facilities, warehouses, solid piers and similar structures which customarily serve as berth for ocean-going ships.

Barge terminals are in most cases custom-designed to a service which generally connects a bulk commodity supplier and consumer (or distributor). As a result, the barge system becomes an integral part of the total transport, storage and distribution system and barge size is often included in the computation of inventory capacity.

Barge ports and terminals vary widely in size, service, and waterfront development and may be classified accordingly. Generally a distinction is made between degree of waterfront development, cargo transfer capability, specialization and so forth. Barge ports or terminals may be ordinary piers within a regular port which double as berths for sea-going ships. More generally we use specialized barge terminals. It should be recognized, though, that non-port terminals consisting of transfer and simple berthing facilities on non-improved waterfronts are the most common type of barge berth. As a result barge operations provide great flexibility and an ability for ready service relocation.

Chapter VIII
CONCLUSIONS

Ocean barging nas emerged as a major competitor to domestic and coastal shipping as a result of:

1) Economic advantages
2) Operational flexibility
3) Better integration with inland barging

Technologically, we are set to develop trans-ocean barging by 1980. Such a development can be expected to have a major effect on international trade, largely as a result of its effects on port development requirements. It would permit opening of multiple trading routes, particularly in developing countries, which are presently inaccessible or uneconomic.

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PART 6

A REVIEW OF MARITIME LABOR

AND A

STUDY OF THE LONGSHORE INDUSTRY

by

C. F. Horr

H. S. Marcus

E. G. Frankel

INTRODUCTION

Maritime labor has a very important effect on both the U.S. merchant marine and even our nations' economy. While just one of the many seafaring unions can halt the movement of a fleet of ships, one of the two major longshoring unions can close down the ports on an entire U.S. sea coast. Needless to say, the effect on industries depending on imports and exports is substantial if not critical. The recent attempt by the longshore unions to close down all U.S. ports points out a vital need for better management-labor relations in this industry.

This report gives an overview of all maritime labor unions showing how the longshore unions fit into the complex pattern of organized maritime labor. The majority of this paper is devoted to an analysis of the present state of the U.S. longshore industry. The alternatives for action in the near future available to the two longshore unions, the International Longshoremen's Association on the East and Gulf Coasts and the International Longshoremen's and Warehousemen's Union on the West Coast, the shipping companies, and the U.S. government are analyzed. Background information on the unions and the industry in general are discussed as well as the contract negotiations and strikes of 1971-1972. The impact of the past longshore strikes, in terms of both economic and social aspects, is analyzed, along with the possible mergers among the transportation unions. Proposals for new legislation pertaining to longshore strikes are studied.

Chapter I

MARITIME LABOR AND SOCIAL IMPACT

Before beginning an in-depth analysis of the U.S. longshore industry, it is necessary to provide an overview of labor conditions in the entire maritime industry. This overview serves to explain how the longshore industry fits into the general maritime picture. This chapter will provide the necessary overall background for the reader.

Introduction

Among the important factors of ocean transportation, maritime industry is the most volatile and largely unpredictable. U.S. maritime labor, while nearly exclusively unionized, is highly fracitonalized. In no other major maritime nation are there as many separate labor organizations. As a result, job definition, work rules, and contract negotiations assume great complexity. Most U.S. maritime labor unions are affiliated with the AFL-CIO but this fact seems to have little effect on their basic independence. Some of the unions (especially seafaring) have only a few hundred members and their viability as a negotiating and representing entity may be questionable in an industry which is spread over the whole nation and is by itself composed of a multitude of employers. In this section we attempt to present an up-to-date review and status of U.S. maritime labor, its history, development, organization, working conditions and prospects.

As capital costs assume an important place in an analysis of ocean transportation, shipbuilding labor aspects and costs are included.

Recent developments in ocean transportation technology, operational methods, financing, regulation and government involvement have a pronounced effect on maritime labor, particularly in the United States. Adamancy in maintaining manning levels under conditions of improved and less labor-intensive technology has resulted in lower productivity gains than those achieved by non-U.S. ocean shipping. As a result, demand for new and/or replacement shipping has been less than expected (or possible with available federal subsidy funding). This, in turn, produced an unexpectedly rapid decrease in the number of U.S. general cargo (particularly liner) and passenger or combination vessels which, in turn, has brought seafaring and stevedoring employment to a low point. It may be argued that a more cooperative stance by labor may have resulted in lower unit ship manning and crew costs which, in turn, may have brought a much larger demand for new tonnage with a resulting effect on total employment and productivity. Indications are that were such a position taken by maritime labor in the mid-sixties, the large reduction in seafaring employment may not have occurred, or may have been only temporary. It can be similarly argued that the total flow of trade is largely dependent on the variable costs such as stevedoring. Higher stevedoring productivity per manhour may therefore also affect growth in volume and resulting overall required employment.

Organization of U.S. Maritime Labor

Maritime labor is composed, for the purpose of this study, of seafaring personnel, shipyard workers, and longshoremen working under the realm of the United States. The seafarers are men employed on ships sailing in the U.S. flag fleet, represented by any one of a number of seafaring unions. The shipyard workers are employed in U.S. shipyards, either private or Naval. The longshoremen work along the Atlantic, Gulf, and Pacific Coasts and on the Great Lakes.

The great majority of all maritime labor is represented by unions for the purpose of collective bargaining and contract maintenance. Figure I-1 shows a breakdown of the largest grouping of maritime unions and Table I-1 explains the symbols. Shown are the relationships among the various maritime unions affiliated with the American Federation of Labor and the Congress of Industrial Organizations (AFL-CIO). The AFL-CIO Maritime Trades Department is composed primarily of unions representing seamen sailing on the non-subsidized sector of the U.S. fleet. Also represented are several shipyard unions. Making up the AFL-CIO Maritime Committee are, for the most part, unions representing personnel of the subsidized sector of the fleet. The East and Gulf Coasts longshoring union and a shipyard union are also members.

There are also a great many other unions representing U.S. maritime labor which are not affiliated with the AFL-CIO, but the power used by unions in behalf of maritime personnel is for the most part exerted by the AFL-CIO affiliates. An exception is the International Longshoremen's and Warehousemen's Union, (ILWU), which has been independent of the AFL-CIO since 1937. The other independent unions are primarily the tanker associations (see Table I-2), which consist of personnel on tankers owned by individual oil companies.

Following will be a study of the three parts of maritime labor - the seafaring, shipyard, and longshore sectors. The unions will be covered in some detail along with the associations with which contracts are bargained.

Figure I-1

GENERAL ORGANIZATION OF
U.S. MARITIME LABOR UNIONS

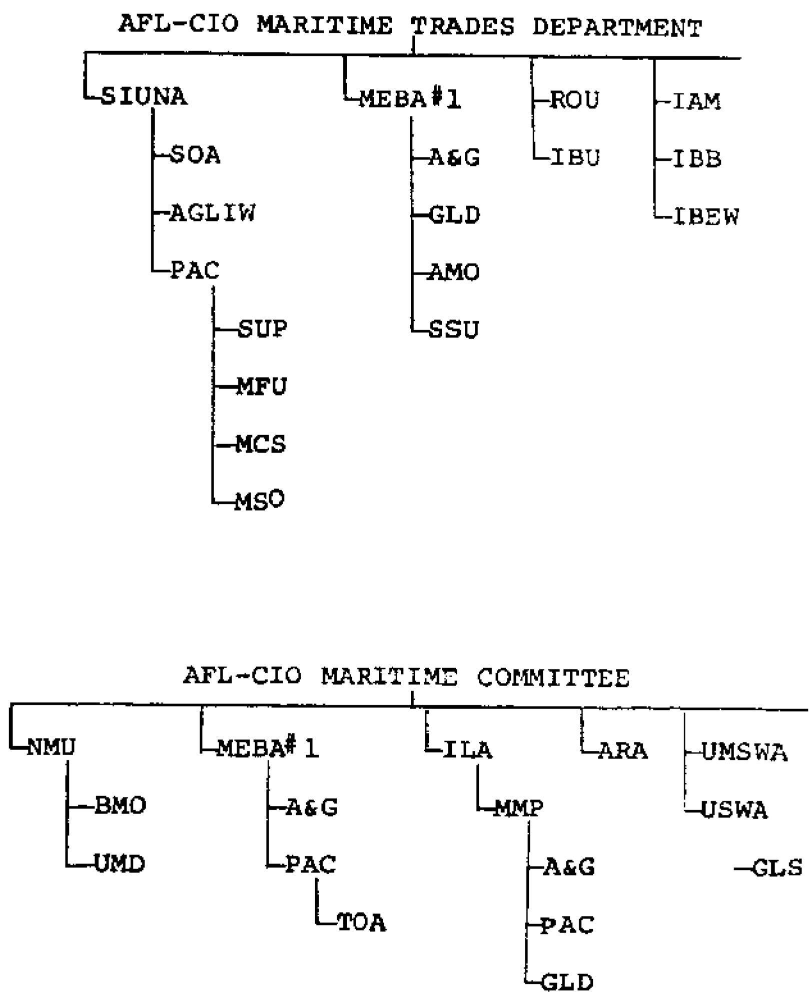


Table I-1

LEGEND OF U.S. MARITIME LABOR UNIONS

AGLIW	Atlantic, Gulf, Lakes and Inland Waterways
A&G	Atlantic and Gulf District
AMO	Associated Maritime Officers
ARA	American Radio Association
BMO	Brotherhood of Marine Officers
GLD	Great Lakes District
GLS	Great Lakes Seamen (Local 5000, USWA)
IAM	International Association of Machinists (Shipyard)
IBB	International Brotherhood of Boilermakers (Shipyard)
IBEW	International Brotherhood of Electrical Workers (Shipyard)
IBU	Inland Boatmen's Union (Harbor Craft)
ILA	International Longshoremen's Association
MEBA#1	Marine Engineers' Beneficial Association, District No. 1
MEBA#2	Marine Engineers' Beneficial Association, District No. 2
MCS	Marine Cooks and Stewards
MFU	Marine Firemen's Union
MMP	Masters, Mates and Pilots
MSO	Marine Staff Officers
NMU	National Maritime Union of America
PAC	Pacific District
ROU	Radio Officers' Union
SIUNA	Seafarers International Union of North America
SOA	Staff Officers Association of America
SSU	Shoreside Supervisors Union (Longshore)
SUP	Sailors' Union of the Pacific
USWA	United Steelworkers of America, District 4
TOA	Tanker Officers' Association (Deck and Eng.)
UMO	United Marine Division, NMU, Local 333
UMSWA	Industrial Union of Marine and Shipbuilding Workers of America

Table I-2

INDEPENDENT LABOR ASSOCIATIONS*

Jersey Standard Tanker Officers' Association	
Esso Radio Officers' Association	
Esso Tankermen's Association	Humble Oil (Esso)
Texas Tanker Officers' Association	
Texas Radio Officers' Association	Texaco
Socony-Mobil Tanker Officers' Association	
Socony-Mobil Tankermen's Association	Socony-Mobil Oil
Tidewater Tanker Officers' Association	
Tidewater Tankermen's Association	Tidewater Oil
Deepwater Officers' Association	Cities Service
Atlantic Maritime Officers' Association	
Atlantic Maritime Employees' Association ...	Atlantic Refining
Sun Marine Licensed Officers' Association	
Sun Marine Employees' Association	Sun Oil
Sabine Independent Officers' Association	
Sabine Independent Seamen's Association	Sabine Transp.
American Tanker Officers' Association...	Amer. Trading & Prod.

*Each of these associations negotiates directly with its respective employer.

Seafaring Labor

Seafaring labor is divided into two main sections: unions representing licensed personnel and unions representing unlicensed personnel as shown in Figure I-2. The unions representing unlicensed personnel are primarily industry-oriented and thus not further divided into sections for the engine, deck and stewards departments, except for the West Coast branch of the Seafarers International Union of North America (SIUNA). The unions representing licensed personnel are divided into unions representing deck, engineering, radio, and staff officers.

A breakdown of the membership of the main seafaring unions is shown in Table I-3. Included is information on the year of organization and area of negotiation.

In the last few years the seafaring unions have had special problems. Due to a decrease in shipping activity, both as a result of a general economic slowdown, and the decrease of U.S. military activity abroad, and the change in maritime technology, the number of U.S. ships is decreasing and jobs are scarcer than ever, as shown in Table I-4.

There are approximately 100,000 active available seagoing workers in the U.S. industry. On the other hand, the number of ships has been declining over the past several years. In 1965, when the supply build-up for Vietnam was accelerating, the number of U.S. ships consisted of about 1150 ships, and this total included about 15 passenger liners. The passenger ships required a large number of workers and they were the mainstay of jobs for some seagoing labor unions such as those representing catering personnel. Now, all but four of the passenger ships, which serve on the West Coast, are idle, sold,

Figure I-2

Seafaring Labor

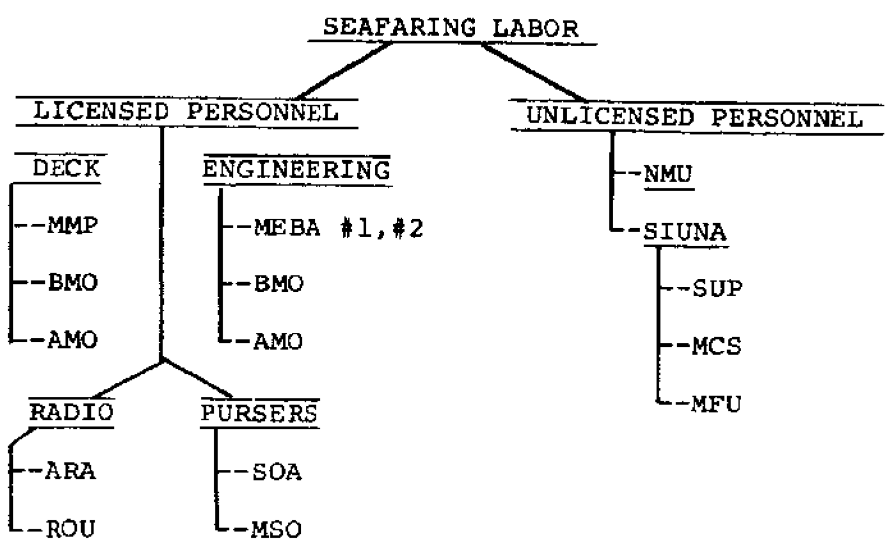


Table I-3

MEMBERSHIP OF SEAFARING UNIONS

Union	Year Organized	Seamen Represented	Approx. Membership	Areas of Negotiation
Officers				
MMP	1887	Deck	12,000	Atlantic, Gulf, Pacific
MEBA	1875	Engine	11,000	Atlantic, Gulf, Pacific
BMO	1936	Deck, Engine	700	Atlantic, Gulf
ARA	1931	Radio	1,500	Atlantic, Gulf, Pacific
ROU	1902	Radio	740	Atlantic, Gulf, Pacific
MSO	1938	Staff	225	Pacific
SOA	1941	Staff	370	Atlantic, Gulf
Unlicensed Seamen				
MCS	1902	Steward's Dept.	4,700	Pacific
MFU	1902	Engine Dept.	2,860	Pacific
NMU	1935	Deck, Engine & Stewards	47,500	Atlantic, Gulf
SIU	1889	Deck, Engine & Stewards	12,000	Atlantic, Gulf
SUP	1885	Deck	6,585	Pacific

Table I -4

TOTAL ACTIVE U.S. FLAG OCEANGOING MERCHANT FLEET

(1000 gross tons and over excluding privately owned tugs, barges, etc.)

Key: C - Combination Passenger Cargo
F - Freighters
T - Tankers

	Total	C	F	T
Sept. 1, 1969	1014	19	740	255
May 1, 1970	836	15	564	257
Nov. 1, 1970	769	13	505	251
May 1, 1971	720	11	459	250
Oct. 1, 1971	625	10	382	233
Dec. 1, 1971	563	4	336	223

Manpower

Seafaring jobs on active oceangoing U.S. ships of 1000 tons and over excluding Great Lakes and civilian manned MSC ships, but including seamen on MSC contract tankers, as of:

Sept. 1, 1969	47,113
May 1, 1970	39,464
Nov. 1, 1970	36,025
Apr. 1, 1971	34,429
Sept. 1, 1971	28,020
Dec. 1, 1971	26,469

or in the process of being sold to foreign interests with the approval of Congress. The total number of ships is down to around 625, while the number of seagoing jobs in the American merchant marine has been reduced to close to 30,000, from around 55,000 in 1965.

The passenger ships have been retired by the companies because of financial losses over the years that have existed in spite of government subsidies. The cargo ships have been decreasing partly due to replacement by ships which are more automated and have shorter round-trip times, thus lowering the need for seamen. The greatest change has been in the replacement of break bulk ships by container ships.

The decrease in ships, especially the loss of the passenger liners from the subsidized sector, has hurt the unlicensed personnel the most. The National Maritime Union (NMU) has been greatly affected by the loss of jobs.

The shortage of jobs and the existence of liberal retirement plans has spurred the retirement of many seamen, straining union pension funds. Contributions to the pension funds are made by existing companies under contract. The decrease in shipping results in fewer seagoing jobs to provide the pension contributions. Pension plans generally provide for a level of monthly allowance for those who retire after a period of years of service (e.g., 20-25) at a certain age (e.g., 55-65). Some unions, such as the NMU, contracted to allow workers to retire on full pension after service of 20 years in the industry regardless of age. At mid-1971 a total of 12,270 members of the NMU were receiving retirement benefits ranging up to $250 per month. This is up from 7700 in 1967. In 1970 the monthly amount of benefits paid out to NMU pensioners was almost $2,850,000.

Many American-based shipowners fly foreign flags on their vessels, primarily due to the lower costs and lower level of genernment regulation. A ship flying a "flag of convenience" may have lower unit wage and fringe benefit costs, lower manning scales, simpler safety requirements, cheaper accommodation standards, lower taxations, and lower repair costs. In addition, foreign government regulation usually permits the owner to build or acquire a vessel anywhere and by any terms.

There is good reason to feel that seafaring unions, encouraged by ship operating subsidies, have had a considerable effect on wages and conditions in the shipping industry. Comparing today's wages and working conditions with those prevalent in the 1930's Table I-5 shows examples of earnings in 1970 compared with those of 1938 for the SIU. These increased benefits can only be welcome; however, it is sometimes claimed that seafaring unions are too powerful and often shortsighted.

Table I-5

SAMPLE COMPARISON OF WAGES, OVERTIME RATES, VACATIONS AND PENSIONS BETWEEN 1938 AND 1970 - SIU*

	Rating	1938	1970
WAGES (Monthly Basic Rates)			
Deck Department	Boatswain	$ 85.00	$657.09
	Able Seaman	72.50	500.55
Engine Department	Oiler	82.50	500.55
	Wiper	60.00	465.03
Steward Department	Chief Steward	130.00	657.09
	Chief Cook	105.00	584.17
	Messman	60.00	388.45
OVERTIME (Hourly Rates)**			
	Entry Ratings	$ .70	$ 2.73
	Middle Ratings	.70	3.44
	Key Ratings	.70	4.48
VACATION PAY (Yearly Rates)			
	Entry Ratings	***	$1000.00
	Middle Ratings	***	1200.00
	Key Ratings	***	1400.00

*These are take home rates excluding social and welfare costs.

**The amount of overtime varies among ratings, type of service, etc. It may account for additional take home pay of 40-60% of base wages.

***All ratings got one week with pay per year of unbroken sea time with the same company.

As a point in fact, union rationing of job opportunities which, although made illegal by the Taft-Hartley Act (1947), still exists in practice. Unions ration jobs by the combination of restricting membership and operating an effective preferential hiring procedure. The unions argue that restriction of membership is necessary since the number of employment opportunities is falling and that the hiring hall is necessary to prevent a return to the bad old days of individual hiring.

One critical problem that has arisen in the past several years is availability of employment for recent graduates of maritime academies, and more recently for graduates of union-run licensing schools. During the fleet build-up of the mid-1960's union schools financed by the shipping companies with which the union is contracted, produced many licensed deck and engineering officers who, through a shorter program and a higher union priority status, obtained many jobs that might otherwise have been filled by graduates of the four-year programs at the five state maritime academies or the federal academy. At this time the graduates of the union schools, whose priority, through seniority, for jobs is less than the older union members, are faced by a much diminished job market, and most union schools are either closing or continuing at a greatly decreased level of operation.

Shipping Management Organizations Responsible for Negotiations with Unions

Most collective bargaining between the seafaring unions and shipping companies is negotiated by management organizations representing the individual companies. All contract items are covered in these negotiations, including wages, hours, work and living conditions, holidays, pension and welfare plans, and hiring procedures. The individual associations have different customs concerning obligation of members to abide by negotiated settlements.

The American Maritime Association (AMA), the Maritime Service Committee (MSC) and Tanker Service Committee (TSC), and the Pacific Maritime Association (PMA) are the major maritime organizations representing shipping companies of the U.S. flag fleet. Table I-6 shows the various unions with which these shipping associations (excluding the TSC) negotiated contracts in 1969. Also, following will be a description of each of the organizations, along with the Collier Owners Association (COA).

Contracts, generally, were last negotiated in 1969, effective for the three-year period June 16, 1969, through June 15, 1972. A common contract expiration date among the various seafaring unions leads to less disruption of the industry that

Table I-6

Shipping Management Negotiating Organizations

	American Maritime Association	Maritime Service Committee	Pacific Maritime Association
Licensed			
Deck:	MMP	MMP*	MMP
Engine:	MEBA #1	MEBA*	MEBA
Radio:	ARA & ROU	ARA & ROU	ARA
Unlicensed			
Pursers:	SOA	SOA	MSO
Deck:	SIU	NMU	SUP
Engine:	SIU	NMU	MFU
Steward:	SIU	NMU	MCS

*American Export/Isbrandtsen negotiates directly with BMO for Deck and Engineering Officers.

is caused by strikes in support of contract demands, but more power can be wielded by a united group of unions negotiating at the same time.

One contract clause that existed in the early and mid-1960's, but has since been abandoned, is the so-called "me, too" clause. Under this contract item a shipping company or association agreed to base the provisions of a union's contract on those of another union. A likely method of improving bargaining efficiency turned into a circular, inflationary increase in benefits among the affected unions. Each union was to get at least what the others got in increases, but these increases kept building.

Maritime Service Committee (MSC)

(Negotiate with MMP,MEBA, ARA, ROU, SOA, NMU)

The Maritime Service Committee has represented owners and operators of dry cargo and passenger vessels on the East Coast in the offshore trades for collective bargaining purposes, but now represents only dry cargo vessels, due to the cessation of U.S. flag passenger service on the East Coast.

The membership of the MSC is composed of seven companies, all operating under subsidization, representing 237 ships. The Committee's negotiations do not bind any member to a contract. The members concur in agreements reached and sign individual contracts. Each may refuse to ratify a settlement, and is not legally bound to accept a contract agreed to by other members. This right is essentially never exercised, though.

American Export/Isbrandtsen is not a member of the MSC, yet it usually follows the same contract settlements.

Tanker Service Committee, Inc. (TSC)

The Tanker Service Committee, Inc., is an independent corporation using the MSC facilities.

Some member companies of the TSC are not affected by the Committee's negotiations, due to their agreements with the Independent Tanker Officer's and Tankermen's Associations.

Collier Owners' Association (COA)

(Negotiate with MMP, MEBA, ROU, NMU)

This association consists of a small group of companies, primarily in the coal trade, whose operating procedures and types of ships do not lend themselves to industry-wide negotiations.

American Maritime Association (AMA)

(Negotiate with MMP, MEBA, ARA, ROU, SOA, SIU)

The American Maritime Association represents 55 shipping companies for the purpose of contract negotiations with the maritime unions. The Association is composed of non-subsidized operators of 179 tankers and dry cargo vessels, including barge lines and other inland waterway operators.

The members of the AMA are not bound to agreements. The bargaining committee reaches a settlement and signs a memorandum of agreement, but the companies then must sign individual contracts. There are virtually never any problems in the individual signings, though.

During the year ending July 1, 1971, AMA companies carried 2.2 million deadweight tons of dry cargo and 1.5 million deadweight tons via tankers.

Seafaring Unions

Unlicensed Personnel

The primary unions representing unlicensed personnel are the National Maritime Union (NMU) and the Seafarers International Union of North America (SIUNA) and its various affiliates. Both of these unions date from 1937 following the disintegration of the old corrupt International Seafarers' Union. As in many industries, the two unions grew up independently due to the separation of the "industrial" unions (CIO) from the "craft" unions (AFL) - the NMU belonging to the CIO and the SIU to the AFL. There are, however, other distinctions which have kept the unions at loggerheads even after the AFL-CIO merger in 1957. The NMU represents most of the crews of the subsidized part of the U.S. Merchant Fleet, while the SIU, in general, represents the unsubsidized sector.

This fact has caused a major divergence in policy over the past years. Formerly it has been the primary object of the NMU to obtain large increases and fringe benefits - an objective made easier by the fact that a large part of such increases are paid for by the federal government through increased subsidies. Meanwhile, the SIU has been much more concerned with the rapidly dwindling size of the nonsubsidized fleet, which wage increases only tend to accelerate. The main objective of the SIU has been, therefore, to halt the flight of American shipowners to "flags of convenience".

It was with this in mind that an attempt was made by both unions to extend National Labor Relations Board (NLRP) jurisdiction over all American-owned ships trading with U.S. ports. This campaign was given support by the NLRB in 1961, but received a setback in 1962 when a Court of Appeals ruled against the holding of a union election for a fleet of American-owned ships flying the Honduran flag. The final step was taken by the U.S. Supreme Court in February 1963, when it ruled that the NLRB does not have control over American-owned ships under a foreign flag. This decision was understandably strongly supported by all foreign maritime countries who saw implications of control over all foreign-flag ships calling at U.S. ports.

National Maritime Union (NMU)

The NMU represents unlicensed personnel of the deck, engine, and stewards departments on the Atlantic and Gulf Coasts, primarily on subsidized carriers. In June 1969, the date of the most recent contract negotiations, collective bargaining agreements were held by the NMU with 195 steamship companies with an employment potential of more than 24,000 unlicensed jobs. The loss of U.S. flag passenger ship service on the East Coast has been costly to NMU, more so than for any other maritime union.

Affiliated with the NMU are the Brotherhood of Marine Officers (BMO), representing licensed deck and engine personnel, and the United Marine Division (UMD).

In 1969 the NMU coordinated its bargaining with that of the MEBA #1 and the ARA.

Seafarers International Union of North America (SIUNA)

The SIUNA comprises over thirty affiliated, yet autonomous unions in the marine and related industries, the major ones of which are the SIU Atlantic, Gulf, Lakes and Inland Waters District, the Staff Officers Association (SOA), the Sailors Union of the Pacific (SUP), the Marine Firemen's Union (MFU), and the Marine Cooks and Stewards (MCS).

The SIU-AGLIW represents unlicensed personnel of the deck, engine and stewards departments. Collective bargaining agreements cover about 60 steamship companies operating from the Atlantic and Gulf Coasts with more than 8,500 jobs on approximately 285 ships.

The SOA represents pursers on the Atlantic and Gulf Coasts. The SUP is composed of unlicensed personnel of the deck department on dry cargo and passenger ships and all three departments on some tankers. The MFU represents the unlicensed personnel of the engine department and the MCS represents the personnel of the stewards department. The jurisdictional area for the SUP, MFU, and MCS is the Pacific Coast.

In the past six years the percentage of the total U.S. fleet personnel represented by the SIUNA has risen from 18 to 35. The SIU has not faced a drastic retrenchment in its job total, as did the NMU, because the Seafarer did not lose the passenger liner positions. The SIU has always operated as a tightly efficient, relatively low membership union.

Licensed Personnel

The unions representing licensed personnel are divided into four main groups: deck officers, engineering officers, radio officers, and staff officers, or pursers.

The main deck union is the International Organization of Masters, Mates, and Pilots (MMP) and the National Marine Engineers' Beneficial Association (NMEBA) is the primary engineering union. The Association of Maritime Officers, (AMO), an affiliate of the MEBA, and the Brotherhood of Marine Officers, an NMU affiliate, both represent some deck and engineering officers.

The two primary unions of radio personnel are the American Radio Association (ARA) and the Radio Officers Union (ROU).

The two main unions of staff officers, the Marine Staff Officers (MSO) and the Staff Officers Association of America (SOA) are both affiliates of the SIUNA.

International Organization of Masters, Mates and Pilots (IOMMP)

The MMP represents ships' masters and deck officers on the Atlantic, Gulf and Pacific Coasts on subsidized and non-subsidized lines. Collective bargaining between the MMP and ship operators is maintained on an industry-wide basis. In 1969 MMP contracts covered about 5,000 jobs on ships operated by about 200 steamship companies.

On March 23, 1921, the MMP affiliated with the International Longshoremen's Association (ILA), becoming the Marine Division of the ILA.

National Marine Engineers' Beneficial Association (NMEBA)

The NMEBA, representing ships' engineering officers, maintains collective bargaining agreements with ship operators on an industry-wide basis for the Atlantic, Gulf, and Pacific Coasts, covering about 5,500 jobs on ships operated by some 190 steamship companies.

The NMEBA is composed of two divisions, the MEBA Districts #1 and #2. MEBA #1 represents engineers primarily in the subsidized sector, on all three coasts. The Tanker Officers' Association (TOA) is affiliated with the Pacific District of MEBA #1. MEBA #2 represents engineers on all coasts, mostly on non-subsidized lines. The Associated Maritime Officers (AMO), representing engineers and mates, is affiliated with MEBA #2.

MEBA #1 coordinated bargaining in 1969 with the NMU and the ARA. MEBA #2 is more closely associated with the SIU.

American Radio Association (ARA)

The ARA represents ships' radio officers in collective bargaining agreements covering more than 600 jobs aboard ships operated by steamship companies on the Atlantic, Gulf, and Pacific Coasts. In 1969 the ARA coordinated bargaining with the MEBA #1 and the NMU.

Radio Officers Union of the Commercial Telegraphers Union (ROU)

The ROU represents ships' radio officers on all three coasts in contracts with steamship companies involving nearly 400 jobs.

Shipyard Labor

The primary unions representing employees of U.S. shipyards are the Industrial Union of Marine and Shipbuilding Workers of America (UMSWA), the International Association of Machinists (IAM), the International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers, and the International Brotherhood of Electrical Workers. Unlike the seafaring and longshoring unions, the unions representing shipyard employees bargain with individual companies for members who are not necessarily the only, or main, contingent of union members.

Over the past several years, the employment at private U.S. shipyards has continued at a fairly steady pace (see Table I-7), but in the last few years the level has dropped substantially. The exception to this is the area of the Gulf Coast, where employment rose during 1971.

Employment at the naval shipyards (see Table I-8) over the last decade has varied much more than the level at private shipyards, and the last three years have shown a steady decline in total employment.

Table I-9 compares the average hourly earnings in shipbuilding for the last ten years in the United States with five of the top six shipbuilding countries in the world in terms of new construction underway or on order as of July 1, 1971.

Tables I-10 and I-11 show more specifically the rise in the rate of hourly earnings for the various geographical areas of the United States.

In Table I-12 is portrayed a profile of the shipbuilding and ship repair industry for the last five years of the 1960's. This shows a steady increase of the dollar value added per production worker man-hour, but an overall decrease in the dollar value added per dollar of wages for the production workers.

Labor Costs Aboard U.S. Flag Cargo Vessels

The crew or manning costs on U.S. flag vessels are appreciably higher than the sum of the basic wages and fringe benefit costs such as sick, holiday, vacation pay and health insurance costs. Basic wages on U.S. flag vessels are high in

Table I-7

PRIVATE SHIPYARD EMPLOYMENT - ALL EMPLOYEES

(Yearly Average in Thousands)

	Total	North Atlantic	South Atlantic	Gulf	Pacific	Great Lakes and Inland
1965	128.9	48.0	24.3	32.3	14.5	10.0
1966	143.6	52.6	24.8	35.6	20.7	9.9
1967	140.0	48.4	26.1	34.8	20.7	10.0
1968	141.0	46.2	27.0	36.5	22.4	8.9
1969	142.0	45.8	26.0	37.6	25.2	7.4
1970	132.4	43.8	23.2	38.8	20.2	7.9
1971*	127.5	40.7	21.6	40.3	16.9	8.1

*through July, 1971

Table I-8

NAVAL SHIPYARD EMPLOYMENT - ALL EMPLOYEES

(Yearly Average in Thousands)

	Total	Boston New York* Portsmouth Philadelphia	Norfolk Charleston	Puget Sound San Francisco Los Angeles Pearl Harbor
1961	98.4	41.4	18.2	38.8
1962	97.8	40.5	18.1	39.2
1963	93.9	38.7	17.5	37.7
1964	87.4	33.8	16.8	36.7
1965	83.8	28.9	17.4	37.5
1966	85.4	25.5	19.3	40.6
1967	94.5	27.8	21.5	45.2
1968	95.2	28.5	21.7	45.0
1969	91.0	27.6	20.6	42.8
1970	83.0	24.4	19.1	39.5
1971**	76.0	21.2	18.4	36.5

*Closed June 1966

**through July 1971

Table I-9

AVERAGE HOURLY EARNINGS ($/HOUR) IN SHIPBUILDING

Yearly Average	U.S.A.	a/ Germany	b/ Netherlands	c/ U.K.	d/ Japan	e/ Sweden
1960	2.82	0.73	0.58	-	0.40	1.17
1961	2.93	0.81	0.68	-	0.43	1.29
1962	3.01	0.93	0.75	0.94	0.48	1.36
1963	3.12	0.97	0.79	0,97	0.53	1.46
1964	3.15	1.08	0.90	1.04	0.57	1.55
1965	3.16	1.19	0.98	1.16	0.62	1.69
1966	3.32	1.27	1.08	1.30	0.68	1.81
1967	3.45	1.36	1.17	1.34	0.75	2.00
1968	3.59	1.39	1.25	1.24	0.86	2.09
1969	3.80	1.56	1.36	1.36	1.02	2.22
1970	3.96	1.88	1.47		1.15	2.52
1971	4.12					

a/ 9/20/49 - 3/5/61 DM 4.20 = $1.00; 3/6/61 - 10/69 DM 4.00 = $1.00; 10/69 - early 1971 DM 3.66 = $1.00; as of 7/29/71 DM 3.46 = 1.00

b/ 9/21/49 - 3/6/61 DG 3.80 = $1.00; 3/7/61 to date DG 3.62 = $1.00.

c/ 9/18/49 - 11/17/61 £ = $2.80; 11/18/67 to date £= $2.40.

d/ Transportation equipment industry 11/70.

e/ Iron and metal works (men) replaced by metalworkers January, 1969.

Table I-10

INDEXES OF STRAIGHT TIME HOURLY EARNINGS

(OCTOBER 1951 = 100)

Selected Private Yards Engaged in

Steel Vessel Construction

January Each Year	All Areas	Atlantic	Gulf	Great Lakes	Pacific
1961	155.4	157.2	161.6	151.5	148.4
1962	159.5	161.3	164.1	158.9	153.4
1963	164.1	167.1	163.9	162.3	157.9
1964	170.5	174.0	168.5	164.6	162.7
1965	172.6	176.2	169.8	161.4	167.2
1966	175.6	180.1	172.0	167.1	170.1
1967	183.2	188.3	179.5	177.7	175.1
1968	185.9	193.2	185.6	187.6	186.5
1969	199.8	206.9	193.3	.92.5	197.5
1970	210.9	219.3	206.8	200.3	204.3
1971	221.3	231.0	212.9	217.1	215.9

	Weekly Hours			Hourly Earnings			Weekly Earnings		
	C.C.	D.G.	S.&R.	C.C.	D.G.	S.&R.	C.C.	D.G.	S.&R.
1961	36.9	40.3	40.0	3.20	2.49	2.93	118.08	100.35	117.20
1962	37.0	40.9	40.4	3.31	2.56	3.01	122.47	104.70	121.60
1963	37.3	41.1	41.0	3.41	2.63	3.12	127.19	108.09	127.92
1964	37.2	41.4	40.7	3.55	2.71	3.15	132.06	112.19	128.21
1965	37.4	42.0	40.5	3.70	2.79	3.16	138.38	117.18	127.98
1966	37.6	42.1	41.5	3.89	2.90	3.32	146.26	122.09	137.78
1967	37.7	41.2	40.5	4.11	3.00	3.45	154.95	123.60	139.73
1968	37.4	41.4	40.5	4.41	3.19	3159	164.93	132.07	145.40
1969	37.9	41.3	40.7	4.78	3.39	3.80	181.16	140.01	154.66
1970	37.4	40.3	39.9	5.22	3.56	3.96	195.23	143.47	158.00

C.C. - Contract Construction

D.G. - Durable Goods

S.&R. - Shipbuilding and Repair

Table I-11

AVERAGE HOURS AND EARNINGS FOR SELECTED INDUSTRIES

Table I-12

SHIPBUILDING AND SHIP REPAIR INDUSTRY PROFILE

	1965	1966	1967	1968	1969
Total Employment					
Number	130,429	135,309	138,800	142,000	143,200
Payroll ($1,000)	946,008	1,058,157	1,076,000	1,133,100	1,214,400
Production Workers					
Number	109,470	114,277	114,200	117,500	117,900
Man Hours (1,000)	222,958	236,760	231,000	232,600	235,700
Wages ($1,000)	737,918	819,093	819,400	867,300	928,300
Value Added ($1,000)	1,204,108	1,362,030	1,430,400	1,345,900	1,454,400
Value of Work Done ($1,000)	2,078,237	2,338,931	2,518,200	2,488,300	2,567,600
Capital Expenditures ($1,000)	44,564	52,793	66,000	75,900	88,200
$ Value Added as Percent of Work Done	57.9	58.2	56.8	54.1	56.6
$ Payroll Per Employee	7,253	7,820	7,760	7,980	8,480
$ Wages Per Production Worker	6,741	7,168	7,160	7,364	7,874
$ Value of Shipments Per Production Worker	18,985	20,467	22,000	21,177	21,777
$ Value Added Per Production Worker Man-Hour	5.40	5.75	6.21	6.19	6.63
$ Value Added Per Dollar of Wages (Production Worker)	1.63	1.66	1.75	1.55	1.57
$ Wages Per Production Worker Man-Hour	3.31	3.46	3.55	3.72	3.94
Annual Man-Hours Per Production Worker	2,037	2,072	2,025	1,980	1,999

*Reference: American Shipbuilders Council comparison with those paid on foreign flag vessels. In addition it is generally found that the basic seagoing wages are 10%-20% higher than those currently paid for equal skills and experience in U.S. industries. Moreover, the cost of labor on U.S. flag vessels is often a multiple of the basic wages. This is largely due to fringe benefits, work rules, special conditions, and other factors which often result in average annual take home pay equaling double the base wage, and wage costs to the operator equaling twice the basic negotiated wage.

The last factor is largely the result of the fact that crew members often work no more than 8 months per year for a whole year's wage which requires the operator to pay one and one-half wages plus all benefits for each crew berth on a ship.

Our study comprised only typical unsubsidized operators. Information on subsidized operator crew costs are available through public documents of the Maritime Administration, U.S. Department of Commerce. Subsidized operator manning scales are usually higher than unsubsidized operator manning scales but the annual costs per berth are often higher for the unsubsidized operator.

To evaluate actual labor costs, an in-depth analysis of operating costs aboard several ships in the fleet of a U.S. flag unsubsidized liner operator and a domestic tanker operator was performed.

Labor Costs Aboard U.S. Flag Unsubsidized General Cargo Ships

Four different classes of general cargo ships were studied. Table I-13 shows the various classifications of the general cargo vessels. In each class the voyage data of between two and five ships was analyzed for a period of between six and twelve months, during 1969.

Table I-14 shows the manning scale, average monthly straight wages per man, and average monthly straight wages by department. In Figures I-3, 4, and 5, department manning, overall manning and straight wage cost are presented. Because the past few decades have seen the evolution of larger ships with more horsepower, the abscissa of the graphs may be assumed to represent a time scale. That is, the Class B vessels are the oldest in time. The vintage of vessels progresses to the newest vessels in the A-3 Class. It is interesting to note that the newer vessels have roughly the same total monthly straight wages as the older vessels, though they carry a substantially smaller crew. The largest differential is between the automated and unautomated vessels of the same class.

Table I-13

GENERAL CARGO SHIP CLASSIFICATION - POWER TONNAGE TABLE*

Class	Multiple Screw Power Tonnage	Class	Single Screw Power Tonnage
A4	85 United States	-	-
A3	35,001 and over	-	-
A2	28,001 to 35,000	-	-
A1	20,001 to 28,000	A1	25,001 and over
A	15,001 to 20,000	A	17,001 to 25,000
B	9,001 to 15,000	B	12,001 to 17,000
C	5,501 to 9,000	C	7,501 to 12,000
D	3,501 to 5,500	D	5,001 to 7,500
E	3,500 or under	E	5,000 or under

*Power tonnage is the total of gross tons plus horsepower as listed in Merchant Vessels of the United States, published by Bureau of Customs, Treasury Department. Note that our research included Class A vessels of both automated and unautomated design.

Table I-14

MANNING SCALES ON TYPICAL U.S. GENERAL CARGO SHIPS

Manning Scale	A-3	A-1	A (Automated)	A (Unautomated)	B
Deck Licensed	7	7	7	7	7
Deck Unlicensed	11	12	12	14	14
Engine Licensed	6	6	6	6	6
Engine Unlicensed	8	9	9	13	15
Stewards	8	9	9	11	10
Total	40	43	43	51	52
Average Monthly Straight Wages Per Man					
Deck Licensed	1,470	1,349	1,295	1,203	1,161
Deck Unlinensed	739	727	718	679	667
Engine Licensed	1,642	1,509	1,456	1,324	1,273
Engine Unlicensed	661	659	659	578	573
Stewards	667	659	659	641	648
Average Total Monthly Straight Wages by Department					
Deck Licensed	10,290	9,443	9,061	8,241	8,128
Deck Unlicensed	8,131	8,724	8,626	9,510	9,338
Engine Licensed	8,849	9,054	8,740	7,945	7,653
Engine Unlicensed	5,291	5,931	5,933	7,548	8,122
Stewards	5,340	5,931	5,931	7,059	6,486
Total	41,688	39,083	38,291	40,300	39,727

Figure I-3:

MANNING BY DEPARTMENT
U.S. Unsubsidized General Cargo Ships

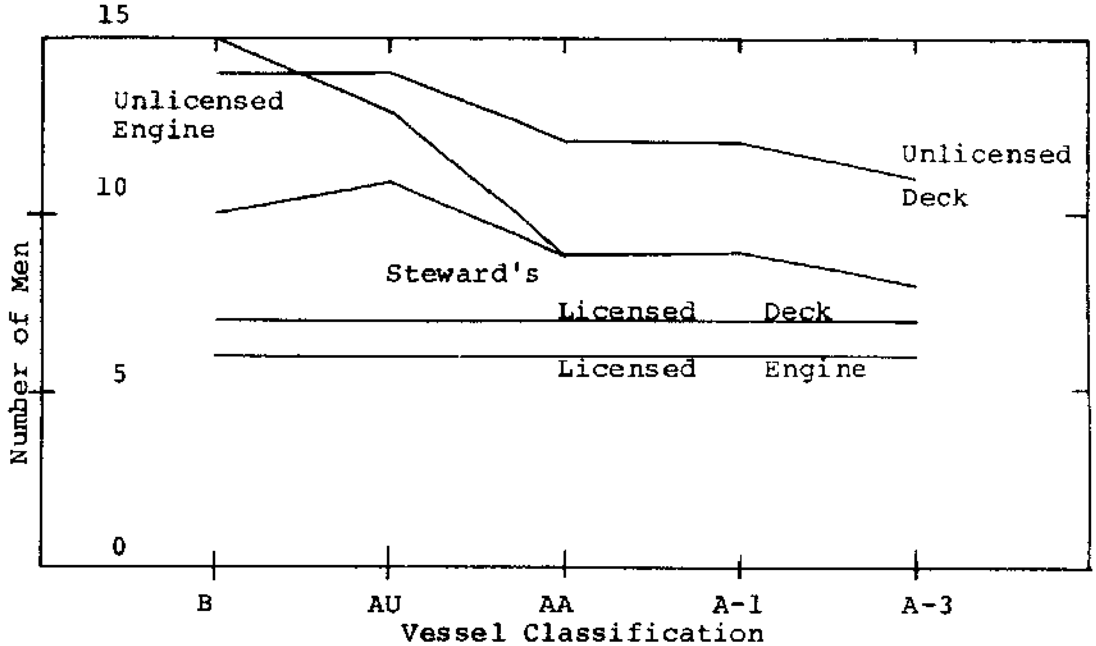


Figure I-4:

OVERALL MANNING AND STRAIGHT WAGE COSTS/MONTH
U.S. Unsubsidized General Cargo Ships

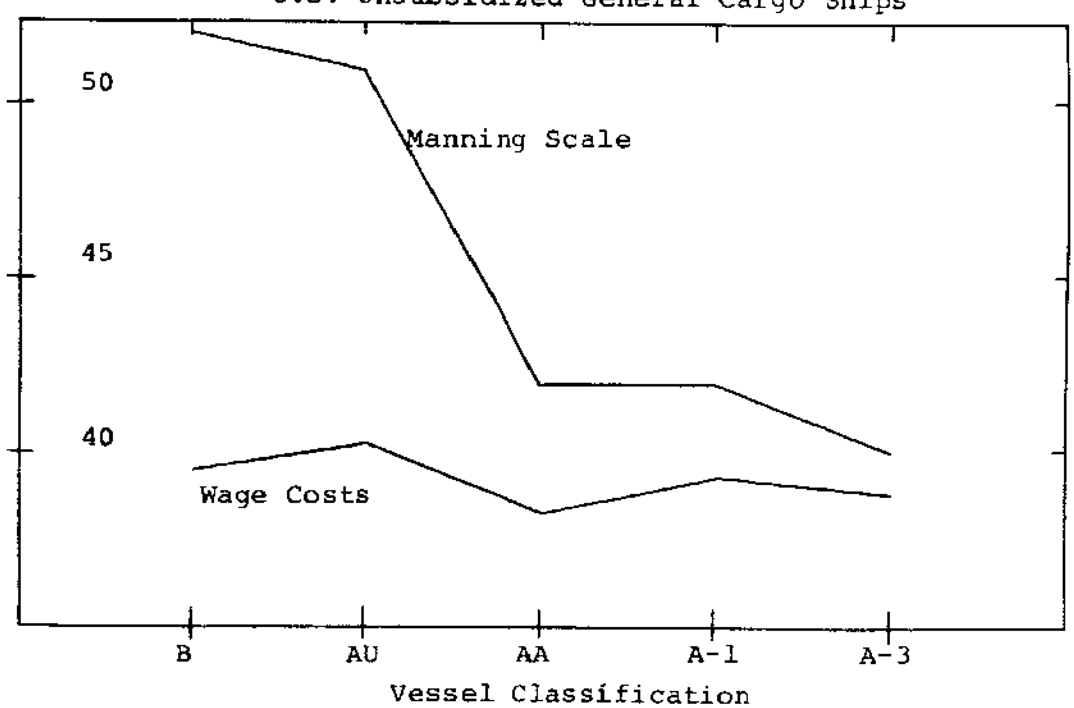
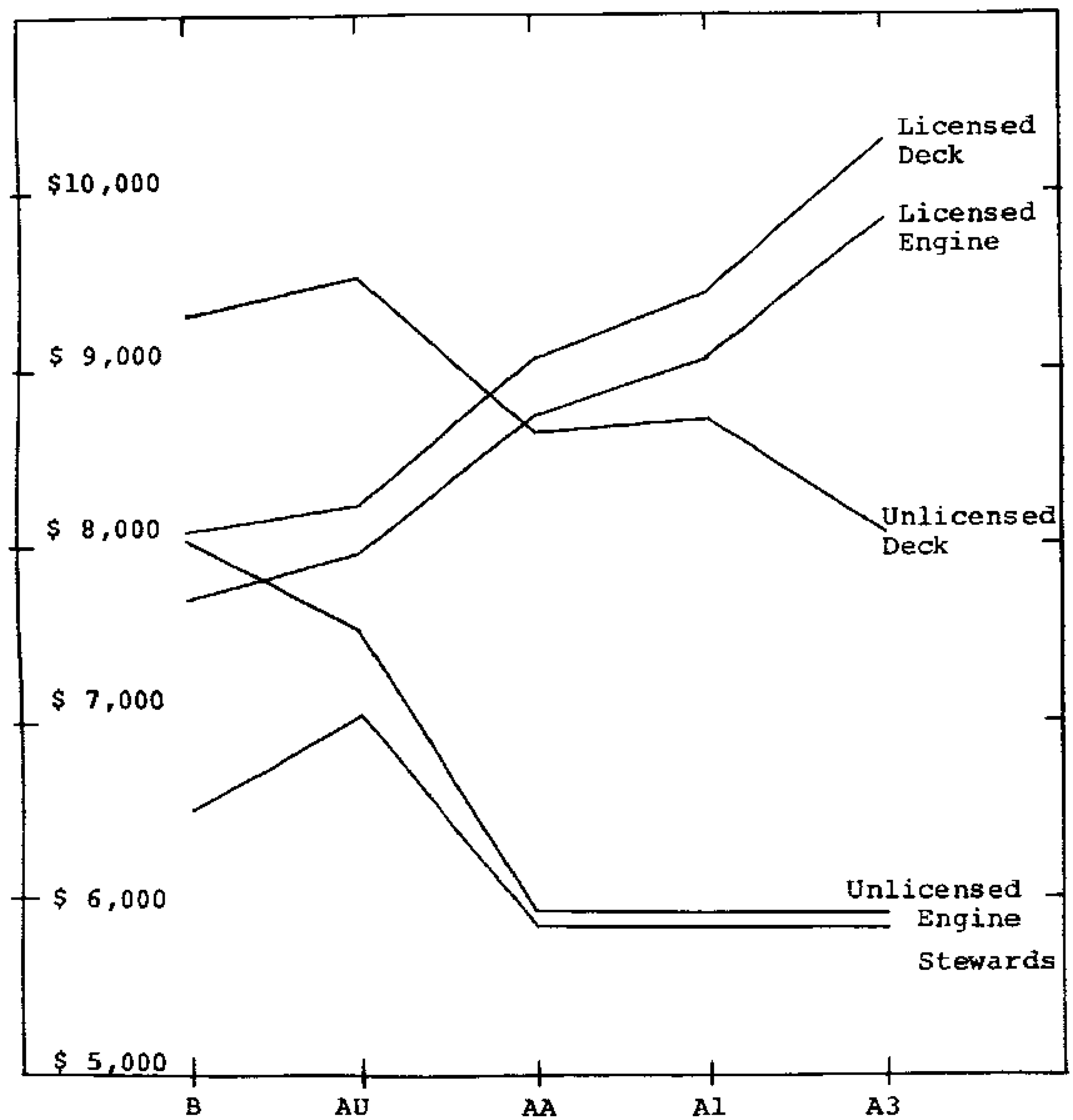


Figure I-5:

STRAIGHT WAGES/MONTH BY DEPARTMENT

For U.S. Unsubsidized General Cargo Ships



While total straight wages remain about the same, however, the make-up of the crew has changed. The number of licensed deck and engine crew has remained constant, but the number of unlicensed crew has declined, decreasing the total number of crew members. Consequently, while wages for each individual seaman has increased, the unlicensed union, as a group, have greatly suffered relative to the licensed union.

Table I-15 shows a breakdown of all monthly operating expenses.[1] Table I-16 presents the breakdown between controllable and noncontrollable wages. The "controllable" was interpreted to mean all expenses which could be theoretically avoided aboard ship. Such expenses included such factors as overtime wages because the ship came into port on a weekend. While in theory the vessel could have waited outside the harbor until Monday, overall economic factors would prevent this from happening. Consequently, the controllable wages in Table I-16 represent the maximum possible.

Table I-17 shows some interesting observations that can be made from these data. Note that straight wages are only about 36% of the total manning costs. In other words, the cost to the steamship company for each man is almost three times the straight wages paid. No matter what class of ship the total manning costs represent between 51% and 58% of total monthly costs. Varying with the class of ship the noncontrollable costs account for between 56% and 72% of the total of both noncontrollable and controllable costs.

Labor Costs Aboard U.S. Flag Domestic Tankers

While U.S. flag tankers are basically able to meet Coast Guard manning rules with crews of as few as 21 men or even less, most of these ships carry crews in excess of 30 men, even on short coastwise runs. Typical manning and wage scales for such tankers are presented in Table I-18, while Table I-19 presents the cost of vacation pay. The average crew member spends a maximum of 8 months aboard for a year's wage and fringe benefits. As a result, total labor costs to the operator are one and a half times the combined take-home pay and fringe benefit costs of the crew.

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1. The term "Chief Engineer Time Back" refers to money paid to a Chief Engineer for time when he theoretically should have been off-duty ashore but instead was working on board. An example of this situation would be shifting a ship from one dock to another. The term "Repatriation" refers to the cost of flying crew members back to their home port.

	A-3	A-3 (Totals)	A-1	A-1 (Totals)	A(Auto)	A(Auto) (Totals)	A(Unauto)	A(Unauto) (Totals)	B	B (Totals)
MANNING COSTS										
Straight Wages	$41,688	$ 41,688	$39,083	$ 39,083	$38,291	$ 38,291	$40,300	$ 40,300	$39,727	$ 39,727
Overtime Wages										
a) Watch Standing	5,063		4,893		4,783		5,193		5,099	
b) Maintenance	2,540		2,780		2,030		2,030		1,400	
c) Shiphandling	5,450		3,900		3,900		3,900		3,900	
d) Cargo Work	2,720		2,030		2,030		2,030		2,030	
e) At Sea Operation	3,240		3,240		3,240		3,240		3,240	
f) Other	3,500	22,513	3,500	20,343	3,500	19,483	3,500	19,893	3,500	19,169
Special Wages										
a) Contract Provision	$ 1,200		$ 1,200		$ 1,200		$ 1,200		$ 1,200	
b) Ch. Eng. Time Back	416	1,616	416	1,616	416	1,616	416	1,616	416	1,616
Fringe Benefits	$43,000	43,000	$40,000	40,000	$39,400	39,400	$41,500	41,500	$40,750	40,750
Subsistence	2,748	2,748	2,954	2,954	2,954	2,954	3,503	3,503	3,572	3,572
Repatriation	3,320	3,320	3,569	3,569	3,569	3,569	4,233	4,233	4,316	4,316
Total Manning Costs		$114,885		$107,565		$105,313		$111,045		$109,150
OTHER OPERATING COSTS										
a) Fuel, etc.	$31,920		$16,800		$16,100		$16,100		$11,277	
b) Shore Repairs	35,000		48,400		64,000		64,000		51,000	
c) Consumable Stores	8,916		9,830		10,183		10,183		12,641	
d) Port & Relief Officers	1,824		1,824		1,824		1,824		1,824	
e) Other Repairs (Includes Laundry)	260	77,920	260	77,114	260	92,367	260	92,367	260	77,002
Port Charges										
Tugs	$ 1,400		$ 1,400		$ 1,400		$ 1,400		$ 1,400	
Pilotage	1,600		1,600		1,600		1,600		1,600	
Customs & Clearing	1,800		1,800		1,800		1,800		1,800	
Harbor Dues	-		-		-		-		-	
Dockage	2,000	6,800	2,000	5,800	1,000	5,800	1,000	5,800	1,000	5,800
Total Monthly Costs		$199,605		$190,479		$203,480		$209,212		$191,952

COSTS PER OPERATING MONTH

Table I-15

	A-3	A-3 (Totals)	A-1	A-1 (Totals)	A (Auto)	A (Auto) (Totals)	A (Unauto)	A (Unauto) (Totals)	B	B (Totals)
NONCONTROLLABLE COSTS										
1) Straight Wages	$41,688		$37,083		$38,291		$40,300		$39,727	
2) Overtime Wages										
Watch Standing	5,063		4,893		4,783		5,193		5,099	
Ship Handling	5,450		3,900		3,900		3,900		3,900	
3) Special Wages	1,616		1,616		1,616		1,616		1,616	
4) Fringe Benefits	43,000		40,000		39,400		41,500		40,750	
5) Subsistence	3,320	$100,137	3,569	$ 91,061	3,569	$ 91,559	4,233	$ 96,742	4,316	$ 95,408
6) Fuel	$31,920		$16,800		$16,100		$16,100		$11,277	
7) Port & Relief Officers	1,824		1,824		1,824		1,824		1,824	
8) Port Charges	6,800	40,544	3,400	22,024	3,400	21,324	3,400	21,324	3,400	16,501
Noncontrollable Total		$140,681		$113,085		$112,883		$118,066		$111,909
CONTROLLABLE COSTS										
Overtime Wages										
Maintenance	$ 2,540		$ 2,780		$ 2,030		$ 2,030		$ 1,400	
Cargo Work	2,720		2,030		2,030		2,030		2,030	
At Sea Operation	3,240		3,240		3,240		3,240		3,240	
Other	3,500	$ 12,000	3,500	$ 11,550	3,500	$ 10,800	3,500	$ 10,800	3,500	$ 10,170
Shore Repairs	$35,000		$48,400		$64,000		$64,000		$51,000	
Consumable Stores	8,916		9,830		10,183		10,183		12,641	
Other Repairs	260	44,176	260	58,490	260	74,443	260	74,443	260	63,901
Controllable Total		$56,176		$ 70,040		$ 85,243		$ 85,243		$ 74,071

COSTS PER OPERATING MONTH

Table I-16

Table I-17

	A-3	A-1	A (Automated)	A (Unautomated)	B
Straight Wages As a % of Total Manning Costs	36.4	36.4	36.3	36.3	36.3
Total Manning Costs as a % of Total Monthly Costs	57.5	56.5	51.9	53.2	57.0
Noncontrollable Costs As a % of Total Controllable and Noncontrollable Costs	71.5	61.8	56.8	58.2	60.2

Table I-18

U.S. Flag Tanker Manning and Wage Scales*

(Typical Tanker of 50,000 DWT in domestic and nearby foreign service)

Deck Department	No.	Monthly Rate	Daily Rate	Overtime Per Hour	Penalty Per Hour
Master	1	$2,511.39	$83.71300	---	---
Chief Officer	1	1,587.83	52.92767	$10.74	$4.23
Second Officer	1	1,096.94	36.56467	9.49	4.23
Third Officer	2	953.40	31.78000	8.25	4.23
Radio Officer	one only[1]	1,126.77	37.55900	9.49	4.23
Radio Electronics Officer		1,239.45	41.31500	10.44	4.23
Boatswain	1	740.58	24.68600	6.41	2.86
Deck Maintenance AB	1 only	607.68	20.25600	5.26	2.80
Deck Maintenance OS		490.83	16.36100	4.25	2.18
Able Seaman	6	534.67	17.82233	4.63	2.80
Ordinary Seaman	3	423.77	14.12567	3.67	2.18
	17				
Engine Department					
Chief Engineer	1	$2,304.51	$76.81700	$15.58	$4.23
1st Asst. Engineer	1	1,587.83	52.92767	10.74	4.23
2nd Asst. Engineer	1	1,096.94	36.56467	9.49	4.23
3rd Asst. Engineer	2	953.40	31.78000	8.25	4.23
Chief Pumpman	1	747.36	24.91200	6.47	2.86
Maint. Mechanic/ 2nd Pumpman	1	747.36	24.91200	6.47	2.86
Oiler	3	534.67	17.82233	4.63	2.80
Fireman/Watertender	3	534.67	17.82233	4.63	2.80
Wiper	2	490.83	16.36100	4.25	2.18
	15				
Stewards Department					
Chief Steward	1	$ 743.53	$24.78433	$ 6.44	$2.86
Chief Cook	1	642.37	21.41233	5.56	2.86
Second Cook & Baker	1	556.22	18.54067	4.81	2.80
Galley Man	1	420.79	14.02633	3.64	2.18
Mess Man/Utility Man	4	409.63	13.65433	3.55	2.18
	8				
Total	40				

This table based on current contract agreements of MM&P, MEBA, ARA, and NMU. These agreements expire June 16, 1972.

Table I-19

RATE OF VACATION PAY ON U.S. FLAG TANKERS

(For 30 Days Vacation)

Master	$2,511.39
Chief Mate	1,587.83
Second Mate	1,404.09
Third Mate	1,220.36
Radio Officer	1,239.45
Boatswain	740.58
Deck Maintenance AB	607.68
Deck Maintenance OS	490.83
Able Seaman	534.67
Ordinary Seaman	423.77
Chief Engineer	$2,304.51
First Assistant	1,587.83
Second Assistant	1,404.09
Third Assistant	1,220.36
Chief Pumpman	747.36
Second Pumpman	747.36
Oiler	534.67
Fireman / Watertender	534.67
Wiper	490.83
Steward	$743.53
Chief Cook	642.37
Second Cook	556.22
Galley Man	420.79
Mess Man / Utility Man	409.63

Contract wages are for 8 hours a day. Anything over is overtime. Quoted wages are in effect until 16 June 1972, at which time current union contracts expire. At the present time (June 1972) only the NMU has signed a new contract. This is a three-year agreement with a 5% increase in wages each year. An increase also is included in vacation pay: Boatswain and Pumpman - $25; AB, Oiler, and Fireman - $15; and OS and Wiper - $10 for each year. There is also an increase in vacation time from 13 to 14 days for every 30 days worked. It is assumed that the MM&P, MEBA, and ARA will sign contracts with a similar increase in pay of 5%-6%. At the present time licensed officers receive 15 days vacation for every 30 days worked.

Whenever a vessel is in port between 1700-0800 Monday through Friday or anytime during Saturday, Sunday or a holiday, a night mate and night engineer must be ordered from the union. His rate of pay is approximately $9.50 an hour. Also transportation to and from the union hall must be paid. Ships also carry cadets at times whose wages and scale are:

	Monthly	Daily	Overtime
Cadet (Academy)	$208.80	$6.96000	---
Cadet (Union MEBA)	200.00	6.66667	$4.23

Overtime accrues to the crew for maintenance and repair on weekends and holidays, during docking, undocking, port watches (1700-0800), tank cleaning, etc. A watchstander works an average of about 100-110 hours overtime a month and a dayworker between 60 and 70 hours. (Deck department crew members average about 130-150 hours of additional overtime on a clean oil or chemical ship due to the Butterworthing and tank cleaning necessary on that type of vessel.)

Most shipping companies have recently attempted to cut down on maintenance overtime. The quality and amount of work performed generally does not justify the expense of having seamen do the maintenance and repair work.

<u>Other benefits</u> are:

Room and board is considered to be part of a seaman's wages and is figured at $1.60 a day per man.

Transportation for each man from the place of shipment to the vessel is paid by the company. If any man is employed aboard a vessel for 30 days or more and quits, transportation back to the original place of shipping must be paid. If the vessel goes into the shipyard and the crew is paid off, transportation back to original place of shipping is paid. To date, transportation must be first class. As of June 16, 1972, transportation for the NMU may be coach class.

Fringe benefits such as unemployment tax, medical, dental, and pension payments for union members and dependents are paid by the steamship companies. Direct contributions are paid into the pension and welfare plan of individual unions. A fixed amount is paid in for each crew member per day. The cost of these benefits varies widely.

Using this data described above it is estimated that annual manning costs on a typical U.S. flag tanker are $1,035,840 as shown in Table I-20.

Table I-20

ESTIMATED ANNUAL MANNING COSTS OF U.S. FLAG TANKERS

To man a tanker for year-round operations, an operator on the average pays one and one-half the monthly salary in straight wages because about one-half the ship's complement is always on vacation. His manning costs are therefore the sum of:

Base Wage/Month	$ 30,000
Vacation Pay/Month	14,800
Overtime Pay/Month	16,400
Transportation Costs/Month	3,200
Room and Board/Month	1,920
Fringe Benefits	18,400
Shore Staff	1,600
Total Manning Costs/Month	$ 86,320
Total Manning Costs/Annual	$1,035,840

Longshore Labor

Longshoremen in the United States are represented by the International Longshoremen's Association (ILA) on the Atlantic and Gulf Coasts and on the Great Lakes and by the International Longshoremen's and Warehousemen's Union on the Pacific Coast and in Hawaii. Table I-21 shows the number of men normally available for longshore work on the various coasts for the last two years.

Table I-21

LONGSHORE MANPOWER NORMALLY AVAILABLE AS OF APRIL 1, 1971

Total	Atlantic	Gulf	Pacific	Great Lakes
67,900	34,100	14,350	13,150	6,300

At the present time the two unions are pursuing common goals by similar methods and cooperating in areas of mutual interest. This is but a recent occurrence. For most of the years since their separation, the unions have been markedly different, even to the point of the ideologies they have expounded. More importantly, over the past ten to twenty years, the ILA and ILWU have, through different approaches to collective bargaining, negotiated contracts with their respective employer associations which contain varied approaches to common problems. Exemplary of this are the union's reactions to containerization, the revolutionary method of cargo handling that has been the primary step in the mechanization of the longshore industry in the past fifteen years. The ILA has stubbornly resisted containerization, while the ILWU has accepted it under various constraint provisions.

The ILWU - Pacific Coast Longshoring

In 1937, Harry Bridges led the West Coast locals of the International Longshoremen's Association out of the American Federation of Labor into the Committee of Industrial Organizations (later the Congress of Industrial Organizations), reorganizing them as the International Longshoremen's and Warehousemen's Union. The ILWU, now independent, is still dominated by Bridges.

The ILWU is a strong centralized union of longshoremen and warehousemen. Approximately 15,000 longshoremen belong to the union, and are represented in twenty-four ports in the states of California, Oregon and Washington. ILWU also represents longshoremen in Hawaii and at the port of Vancouver, British Columbia. Contract negotiations are held with the Pacific Maritime Association (PMA), a management organization representing passenger services, intercoastal, coastwise, Alaska, offshore, foreign lines, stevedores and terminals for the purpose of coordinating the aims and goals of the industry and negotiations with the ILWU and the various offshore unions.

Table I-22 shows West Coast wage costs from 1934-1970. The ILWU negotiated a contract in 1959 with the PMA which included very far-reaching provisions in the form of a Mechanization and Modernization (M&M) Agreement. The union agreed to a five and a half year contract, which was renewed for five years in June, 1966, to eliminate most of the inherent make-work practices that had become common to the men and to permit the shippers to introduce labor-saving machinery and other cost-saving methods. In exchange the ILWU received over five million dollars per year, which primarily provided for large increases in fringe benefits.

The M & M Agreement was costly to the employers, but it nonetheless proved quite profitable. Table I-23 shows the productivity and labor costs for the last ten years. Although the labor cost per man-hour has risen 54.7 percent from the 1960 average to the average of the four years ended June 30, 1970, the tons per man-hour increased 126 percent for a net decrease in labor cost per ton of 31 percent from \$6.26 to \$4.29.

Table I-22

LONGSHOREMEN BASE WAGE - WEST COAST

1934 - 1971

Date of Increase	Base Rate
July 31, 1934	$ .95
February 20, 1941	1.00
February 4, 1942	1.10
October 1, 1944	1.15
October 1, 1945	1.37
November 18, 1946	1.52
January 1, 1947	1.57
December 16, 1947	1.65
February 10, 1948	1.67
December 6, 1948	1.82
September 30, 1950	1.92
June 18, 1951	1.97
June 16, 1952	2.10
June 15, 1953	2.16
December 20, 1954	2.21
June 13, 1955	2.27
June 18, 1956	2.29
October 1, 1956	2.45
June 17, 1957	2.53
June 16, 1958	2.63
June 15, 1959	2.74
June 13, 1960	2.82
June 12, 1961	2.88
July 30, 1962	3.06
July 17, 1963	3.19
June 15, 1964	3.32
June 15, 1965	3.38
July 1, 1966	3.88
June 28, 1969	4.08
June 27, 1970	4.28

Source: BLS Wage Chronology
Bulletin #1568

Table I-23

Pacific Coast Longshore Productivity and Labor Cost

Year Ending June 30 of	Weighted Tonnage[1,2]	Manhours Worked[2]	Labor Cost[2]	Labor Cost Per Manhour	Tons Per Manhour	Labor Cost Per Ton
1960	19.9	29.8	$124.4	$4.17	.665	$6.26
1961	18.8	29.8	124.5	4.18	.678	6.63
1962	19.8	26.7	126.3	4.73	.742	6.39
1963	21.7	27.8	137.9	4.95	.78	6.35
1964	23.4	27.7	143.0	5.16	.844	6.11
1965	26.3	30.0	162.1	5.39	.874	6.16
1966	--	--	--	5.42	1.182	4.585
Four Years Ended						
June 30, 1970	--	--	--	$6.45	1.504	$4.287

[1]Five tons of bulk cargo are equated with 1 ton of general cargo.

[2]In millions, rounded to nearest tenth.

This decrease in labor cost per ton has been possible on the West Coast largely due to a quite substantial increase in container shipping free from almost any union-imposed restrictions. In 1970 alone, the total tons of general cargo handled in containers increased 26 per cent over 1969, from 6.9 million tons to over 8.7 million tons.

The ILA - East and Gulf Coasts Longshoring

One of the primary differences between the ILA and the ILWU is the decentralization of the power structure into various bargaining districts and strong locals. This fact has contributed to a high level of strike activity common to the ILA.

For the last twenty years, every time that a new longshore contract has been negotiated on the East Coast, the ILA has gone out on strike. The emergency dispute legislation of the Taft-Hartley Act, requiring the union to return to work for eighty days while bargaining continues, has been used against the ILA more times than for any other union.

During 1958-1970, 215 longshore stoppages occurred on the Atlantic and Gulf Coasts as opposed to only 41 on the Pacific Coast.

The Port of Greater New York, the largest port in the country, is the home port for more than 20,000 ILA members, who regularly work in excess of thirty million man-hours each year. The port of New York accounted for 41 percent of all strikes in the longshore industry during 1958-1970 and for 35.5 percent of all man-days lost in the industry during that period.

The port of New York is the pace setter for all ILA actions on the East Coast and all contract settlements. It has regularly been the port with the highest contract terms. Table I-24 shows various wage costs for New York longshoremen.

In 1966, in New York, 15.4 million tons of cargo were handled by 23,848 registered longshoremen, clerks, and checkers and in 1970, 19,500 men loaded 15.9 million tons. The total number of man-hours for the contract year ending September 30, 1971, was 30.8 million, a drop of two million man-hours over previous year.

In-Depth Analysis of the Longshore Industry

Having completed this overview of maritime labor, we are ready to begin an in-depth analysis of the U.S. longshore industry. The following chapters will provide a detailed background of the longshore industry including current contract negotiation of both coasts. The effect of longshore strikes, possible union mergers, and possible federal legislation will be analyzed. Finally, conclusions will be formed concerning future actions in the longshore industry.

Table I-24

LONGSHOREMEN BASE WAGE AND FRINGE COSTS

Port of New York

Date of Increase	Base Rate	Base Rate & Fringes
1957/1959 BASE	$2.817	$3.324
October 1, 1957	$2.73	$3.155
October 1, 1958	2.80	3.25
October 1, 1959	2.92	3.565
October 1, 1960	2.97	3.625
October 1, 1961	3.02	3.69
October 1, 1962	3.17	3.915
January 26, 1963	3.17	3.94
October 1, 1963	3.26	4.0875
October 1, 1964	3.36	4.3175
October 1, 1965	3.46	4.7045
October 1, 1966	3.54	4.871
October 1, 1967	3.62	4.941
January 1, 1968	3.62	4.961
April 1, 1968	3.62	5.031
October 1, 1968	4.00	5.731
October 1, 1969	4.25	6.618 (Excepted Commodities)
October 1, 1970	4.60	7.118 (Excepted Commodities)

Source: NYSA Research Department

Prepared: October 27, 1971

CHAPTER II

BACKGROUND ON THE LONGSHORE INDUSTRY

Nature of Longshore Employment

The nature of longshore work in all ports of the United States is fundamentally the same. The specific tasks on a particular ship may very because of cargo, terminal and mechanical differences, but the nature of the job of loading and unloading a vessel is everywhere identical. This task consists of moving cargo through the use of human power and mechanical aids from the hold of the ship to the first place of rest on the dock - or the reverse in loading. Customary longshore work also includes the rigging of ships and dock-side handling gear, covering and uncovering of hatches, movement of baggage, and the fueling and victualing of ships.

Members of longshore unions are also engaged in activities which are auxiliary to loading and unloading cargo. On the West Coast longshoremen succeeded in obtaining a contractual right, under certain conditions, to employment which custom has assigned to sailors, such as handling ship stores, hold cleaning, and lashing and securing cargo. On the East and Gulf Coasts longshoremen have acquired jurisdiction over many warehouses both portside and inland. Many union members engage in such occupations as truck driving, cargo repair, general maintenance, and carpentry. On all coasts, clerks and checkers associated with cargo movements are ordinarily members of longshore unions.

One fact dominates the employment relationship of longshoremen - the casualness and unpredictability of work. The volume of available work is tied to shipping schedules and is beyond the control of dock employers. One result follows which has had an immense impact upon labor relations: the need of employers for a labor force of sufficient size to cope with peak work periods, and the creation of surplus workers for most of the year. The special characteristics of hiring in the industry - such as the shape-up in time - are consequences of the lack of the permanent employer-employee relationship and the intermittent nature of job opportunities.

The costliness of dock delays gives waterfront unions, under certain circumstances, an exceptionally high degree of bargaining power. Considerable public concern has resulted from the strikes of pastyears and the government attempts to "clean-up" the docks and legislate control over walkouts. The weakness of the present laws and proposals for change will be discussed in a later chapter.

International Longshoremen's Association

The International Longshoremen's Association has been of major importance to the shipping and longshoring industries along the East and Gulf Coasts and to the U.S. economy in general, most notably due to the turbulence of labor relations with employers on the ILA waterfront, for which there is no industrial counterpart. Not only has there been a very large number of strikes since the end of World War II, but their magnitude and impact have been disproportionately severe. On eight consecutive occasions of contract expiration the national emergency provisions of the Taft-Hartly Act have been utilized against the ILA. It has been estimated that the 1964-1965 strike resulted in economic losses of about $77 million a day, and that the total damage to the national economy was in excess of two billion dollars. The results of the 1968-1969 strike were equally serious.

Structure of Union and Industrial Relations

The ILA's proneness to strike is basically caused by a defective bargaining relationship with deep historic roots. Symptomatic of the underlying weakness is the fact that such critical issues as seniority and the method of royalty payments for containerized cargo were determined by arbitration and not through negotiations.

The economic structure of the Atlantic and Gulf Coast longshore industry generates a wide range of issues which set off local against local and member against member. The many ports which make up the industry are largely independent product markets, and gains in one port are often made at the expense of another. A large port, such as New York, can best be understood as comprising separate, smaller ports, each with independent leadership, occasionally pursuing different goals.

The atomization of the industry creates unusual power in the hands of local officers. Evidence of this allocation lies in the prevalence of local discretion in work practices. Each port on the Atlantic and Gulf Coasts has different practices in fundamental areas, such as hiring methods, gang size, and work practices generally. Although there are many practical reasons for such variation - differences in equipment, ships, terminals, and cargo - the most important influence is the policy of a particular local union.

Since a major function of an international union is to adjust conflicts among locals, the relatively weak centralized authority vested in the ILA causes considerable disabilities in bargaining because of inability to reconcile competing local interests.

Master Contract

Because contracts are not negotiated coast-wide, the important bargaining process centers around the union locals and the individual port employer associations with the international ILA leadership as observers and contributers. It has been the custom in the past that a Master Contract, covering a limited number of items first be negotiated between the New York Shipping Association (NYSA) and the ILA locals of the Port of New York. The Master Contract would then be used as a "Standard" for negotiations in the other ports. It has been the rule of the international union that if negotiations in any port are not finalized at the time that the old contract expires, then all ILA members will walk out ("one port down, all ports down"). There has not been complete support of this rule during the past two contract strikes. In 1971 longshore locals along the west Gulf Coast refused to strike in support of contract demands in New York.

In 1971 employers in six ports (New York, Boston, Providence, Philadelphia, Baltimore and Norfolk) combined in an organization, known officially as the Council of North Atlantic Shipping Associations (CONASA), for standardizing bargaining on seven major contract terms: hours of work, basic wages; contributions, but not benefits, to the pension fund; contributions but not benefits, to the welfare fund; containerization; and LASH Ships. Settlement on these contract items became the Master Contract for negotiations in the individual ports.

Port of New York

Because contracts and hiring in the ILA are not coastwide (as they are on the West Coast), it is difficult to speak in general terms of the many facets of the longshore industry on the East and Gulf Coasts. It is perhaps easier to study the Port of New York in particular. New York, the largest port in the U.S., is complex in itself, but yet it has several characteristics that are important: several Union locals exist in the port, yet all negotiations are held with one employer association, the New York Shipping Association (NYSA), and one port wide contract exists; all hiring is supervised by one bi-state (New York and New Jersey) agency, the Waterfront Commission of the Port of New York; New York is the home of the ILA headquarters; and New York has long been the pacesetter for ports along the East and Gulf Coasts, both in the form of the Master Contract and other provisions affecting the union members.

The port of New York is 833 miles long, 578 miles of which is within the city, with the remaining 255 miles in New Jersey. The New York piers of Manhatten and Brooklyn, together with those at Port Newark and Port Elizabeth in New Jersey regularly handle 90-95 per cent of the cargo which goes through the Port of New York. Approximately 20,000 longshoremen handle more than 15 million tons of cargo per year.

The total tonnage handled in the Port of New York has remained relatively constant in the last decade, but the total manhours of longshore work has dropped drastically, due to mechanization of operating devices and modernization of cargo handling procedures. It has been the primary concern of the union to protect the job rights of its members.

Containerization

The increase in mechanization has centered around containerization, one area in which the union has fought hard to maintain jobs and to collect a share of the savings the employers were experiencing. Containerization involves the integration of transport and handling arrangements of standardized cargo units which makes possible savings in capital utilization through economies of scale, through greater capacity utilization of both ship and pier facilities, and through greater efficiency in labor utilization.

The innovations in the transport of bulk cargoes laid the foundation for subsequent developments in handling of general cargoes. The extensive growth of piggyback arrangements by truckers with railroad and water carriers for integrating van and container operations was an added stimulant.

The greatest economies promised by containerization are found in the efficiency of using a specially fitted, all-container ship. The fast turnaround time of a container ship greatly reduces the costs of dead time in port while loading and unloading, and substantially cuts the number of ships needed to handle a given volume of traffic. A container ship can unload and reload in 36-48 hours, compared to the seven or eight days required for conventional ships.

The increase in labor productivity due to containerization is astonishing. Generally, the industry considers that "it would take 120 men 84 hours each, or a total of 10,584 manhours, to discharge and load about 11,000 tons of cargo aboard a conventional ship. The same amount of cargo on a container vessel can be handled by 42 men working 13 hours each or a total of 546 manhours."[2] The fact that these savings come about as a result of a reduction in manhours

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1. Unless otherwise stated, all tonnage figures are for general cargo, and exclude cargo transported in bulk form.

2. Phillip Ross, "Waterfront, Response to Technological Change: A Tale of Two Unions," Labor Law Journal, July 1970, p. 400.

is extremely important in the issue of collective bargaining.

Although containers were first used in the 1950's, they did not become extremely important until several years later. Even by 1966, the percentage of general cargo moved by containers in New York was under three percent. Two years later it reached twelve percent, and it is estimated that by 1975, fifty percent of all general cargo will be containerized.

It is the response of the ILA to containers which sets it apart from its West Coast counterpart. In 1959 now-president Gleason told the unions' convention, "I believe that the cargo container will be forced on shipping lines through competition...I am convinced that it has got to come, and when it does come, its effects on us can be tremendous. It is not too farfetched to estimate that we stand to lose, in the full force of the container issue, 8,000 to 9,000 jobs in the New York area alone...At stake, also, is the merit of a strong union."[3]

Agreements were made in the late 1950's between the ILA and the NYSA that the use of containers would not justify reduction in gang sizes or losses of checkers and clerical jobs, that the employer would have the right to use any and all types of containers without restriction, that royalties on containers loaded or unloaded away from the pier were to be paid to the union, and that any non-NYSA container work should be performed by ILA labor.

The annual income going to the container fund was extremely small, averaging, in the first two years, slightly above $200,000, which comes to about $6.79 per employee per year. Subsequently the funds were used to support the medical claims of union members and reached $2 million by 1969.

Containerization played virtually no role in the negotiations between 1959 and 1968, basically because of the low amount of containerized cargo moving through ports in those years. The employers agressively sought basic changes in work rules. Experience had demonstrated to the rank and file, though, that their protection lay in the inflexible enforcement of rules which were understood, whose consequences were certain, and whose benefits were visible. The international union led the fight to maintain practices that to the members are obvious forms of promoting job security, such as the size of operating gangs and the restrictive practices of job assignment in the terminal.

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3. ILA Convention, July 13, 1959.

The new factor in the mid-1960's was the role of the federal government. The Labor Department conducted a study of longshore manpower utilization and job security in nine ports on the East and Gulf Coasts, which concluded that technological change must be accepted, while at the same time the burden of this change should not fall entirely upon the affected employees. The report urged that the ILA relax its resistance to flexibility in work assignments and to reduce gang size, and that the work force be reduced by restricting the supply of new entrants and by making early retirement more attractive to older employees.

1968 Contract Negotiations

The issues of all-coast bargaining and containerization dominated the negotiations that preceded the expiration of the contract in 1968 and the ritualistic pattern of events which followed: a strike, the invocation of national emergency steps by the President, a quickly imposed 80-day injunction, membership rejection of employers' last offer, and the resumption of the strike. The drastic economies accompanying containerization stimulated massive economic demands by the ILA. The union's strategy was to get the very best possible economic conditions by offering to continue containerization provided that its jurisdictional interest in the handling of containers would be preserved and its future bargaining position protected.

The initial employer strategy was to preserve the cost-saving benefits of containerization by making a substantial wage offer which was coupled with concessions on job security. The New York employers claimed, though, that they could not speak for the outports on job security; and the issue of a new container clause introduced new elements of inter-port employer rivalry. Since New York was the pre-eminent container port, many of the other ports resisted with great bitterness any agreement which they considered to be an impediment to their own traffic.

The mixture of containerization and all-cost bargaining prolonged the dispute despite a last-minute wage offer which probably exceeded the union's fondest expectations. Under strike pressure after the expiration of the eighty day injunction, and with little hope of further government intervention, the NYSA virtually capitulated to most of the unions demands. The economic package was $1.60 per hour increase over three years, up to a basic wage of $4.60, and a guarantee of 2080 hours of work a year for all regular longshoremen. An entirely new contract clause was adopted which provided that all consolidated or less-than-truck containers owned or leased by signatory employers which "either come from or are destined to any point within a 50-mile radius from the center of any North Atlantic District port shall be stuffed and stripped by ILA labor at longshore rates on a waterfront facility..."4

4. NYSA - ILA Settlement Terms, January 12, 1969, p.l.

From 1968 Until the 1971 Contract

With knowledge of the longshore situation in New York before the 1968-1969 negotiations, it is important to examine the resulting contract and the past three years of relations between the union and employers to best understand the circumstances surrounding the 1971-1972 contract negotiations.

Seniority System and Labor Mobility

Although the Port of New York is covered by one contract, the union locals still maintain their autonomy, and hiring has not become port-wide. Pier seniority, which mandates hiring according to the length of time a man has worked on a particular pier, tends to tie each worker to "his" pier. So-called industry seniority confines the longshoreman to one borough. He is ranked in one of six groups according to how long he has worked out of one particular hiring hall.

This immobility becomes critical when figures showing the shifts in flow of traffic are studied. Whereas Brooklyn in 1964 handled 40 percent of New York's water-borne domestic and foreign tonnage, that figure has now dropped to 25. The percentage for Manhattan has dropped from 17 to 3 over the same period, while the percentage for the ports in New Jersey has climbed from 38 to 64.

Manhattan longshoremen bear the brunt of this reality. In the year ending June 30, 1970, they worked 20 percent fewer days than in 1968. Of the 72 piers still standing in Manhattan, only nine are now used for ship passengers and ocean borne cargo.

Containerization has been at the heart of the shift of cargo flow. Since new breakbulk piers have failed[5] and since land is too scarce and too expensive to be devoured by such a land-hungry, traffic-engendering facility as a container terminal, it is clear that the future of Manhattan's waterfront is not with expanded cargo handling. The land alone for a single containerized general terminal in Manhattan would cost at least $65 million.[6]

Because union rules prevent men from taking advantage of many job openings by restricting the seniority to pier areas, there are frequent manpower shortages in New Jersey while men

5. In 1965 New York spent $7.3 million to develop a breakbulk pier which fell almost immediately into disuse.

6. New York City Planning Commission, Waterfront, 1970 p. 25.

remain idle in Manhattan. If a man were to leave his local in Manhattan in pursuit of more work at Port Elizabeth, he would be giving up his seniority and would not be assured of a position in the Port Elizabeth local. Consequently he might be forced to join the casual, non-union, labor force.

Guaranteed Annual Income (GAI)

The irregularities in hiring are also to a great extent due to the Guaranteed Annual Income (GAI) provision which was initiated in the contract of 1966, and extended in 1969 to the level of 2080 hours. Under the contract effective October 1, 1968, to September 30, 1971, "all regular employees presently having active seniority status would be guaranteed an annual income of 2,080 hours multiplied by the applicable basic straight-time rate..."[7]

Thus, a man is reluctant to search for work when there is a shortage of jobs available in his area due to the guarantee he has of income even if he does not work. The international union hesitates to change its policy concerning pier-seniority because of the strength it receives from the old, large New York locals.

Men need not look further than their own hiring center for work. As long as a man reports for work on any given day, he will be paid for a full day even if no work is available. Many workers have found canny ways of dodging work while collecting GAI. One technique developed because of the practice of "inverse seniority" which was established in arbitration. A longshoreman with top seniority ranking may let a job pass by to someone of lower seniority without much chance of losing a day's pay under GAI for refusing to work, if he is sure that the number of available jobs is less than the number of men below him in seniority. Some men have even managed to hold down a second regular job, to which they have reported after checking in at the hiring hall.

In the very busy days of September, 1971, when shippers were moving a great deal of freight in anticipation of the most recent dock strike, there were 13,000 men working cargo, 4,000 additional were absent while collecting GAI, and 1,000 more were sick, absent for other reasons, or on vacation (the longshoremen get up to six weeks vacation annually).[8] The employers claim that 2,000 men averaged only about one work-day a week during 1971, and that about 1,200 men took

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7. Settlement of Port of Greater New York Conditions, January 12, 1969.

8. NYSA Press Release, October 5, 1971.

their GAI and did not work a single minute. In the contract year from September 30, 1971, GAI costs soared to more than $30 million from $24.3 million the previous year and from $5.8 million in 1969.

Prior Day Order (PDO)

The ILA has admitted to abuses in the GAI system, but it had not agreed to any of the management proposed solutions. In negotiations in 1968-1969, the union demanded a hiring provision that would make daily employment more certain. The employers agreed to the provision, but the union later blocked acceptance in many areas. Called the Prior Day Order (PDO) system, it stated that "men who are on employer's list shall be available on a prior day order basis and must accept any work in their list jobs for their employer within the employee's zone, i.e., Brooklyn, Hudson County, Port Newark-Port Elizabeth area, Manhattan and Staten Island being established as the five zones."[9] Thus, many of the abuses continued through the life of the contract. Under the PDO system men receive their assignments for the following day by mid-afternoon. If they do not report to the assigned job, they are debited one day's pay from their GAI. Only "fill-ins" needed each day would still be hired in the morning at the information center. Under the PDO system most men would be able to report directly to work, rather than lose time by going through the hiring process.

In late 1971 the union permitted the PDO system to be put into effect, and it has apparently worked out fairly well for both management and longshoremen. In mid-December the Waterfront Commission reported that with a total work force of 10,629 men at work there were no shortages or job refusals. Management has been accustomed to several hundred refusals per day.

One consequence of the PDO system of hiring is the fact that it is possibly a major step toward eventual port-wide hiring in the New York area, which would greatly weaken the strength of the twenty-two ILA Locals.

Fringe Benefit Plan: "Short-Fall"

Another major provision of the 1968-1971 contract which the management did not feel was fair was the so-called "short-fall" which, along with the guaranteed annual income, resulted in a rising cost of fringe benefits. (Table I-24 shows the longshoremen base wage and fringe costs for the Port of New York.) The 1968-1971 contract provided that all contributions to the pension, welfare and clinic funds be made on the basis

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9. General Cargo Agreement, New York, October 1st, 1968 - September 30, 1971.

of 40 million manhours of work per year in the Port of New York, a number that was normal in past years. The total number of manhours of work available has decreased, though, as the volume of tonnage remains fairly constant and mechanization has resulted in an increase in productivity. The total number of manhours worked in the Port of New York in the contract year ended September 30, 1971, was 30.85 million, down more than two million manhours from just the year before. "Short-fall" is the difference between the fringe benefit level of 40 million manhours and the 30.85 million hours actually worked.

This obligation to pay pension, welfare and clinic contributions on the basis of more than nine million manhours more than are actually worked has put a heavy burden upon the employers. Along with the guaranteed annual income, short-fall has required a steady increase in the tonnage assessment for each carrier in the past few years. Since 1969 the assessment per ton has risen successively from $1.23 to $1.73 to $2.23 to the level of $3.23 per ton in fall of 1971.

International Longshoremen's and Warehousemen's Union

The International Longshoremen's and Warehousemen's Union represents approximately 15,000 longshoremen and 45,000 warehousemen along the Western Coast of the United States, but its leadership considers it to basically be a longshore union. Unlike its counter part on the East Coast, the ILWU has been noted, up until 1971, for the peaceful relations that it has maintained for more than twenty years with the management association with which coast-wide contracts are negotiated. The Pacific Maritime Association (PMA) is comprised of various groups representing passenger services, inter-coastal, coastwise, Alaska, offshore, foreign lines, stevedores and terminals for offshore labor negotiations, and negotiations with the ILWU for longshore employment in the 24 ports on the West Coast.

There are three major periods in the history of the ILWU. The union gained formal employer recognition as a result of a general strike in 1934, which followed years of exploitation and abuse of longshoremen by their employers. The bitterness which had characterized the industry carried over into the subsequent employer-union relationship. The first period, the years between 1934 and 1948, was marked by the employers' attempts to break the union, and the union's just as militant retaliation. In the fourteen year period, among the stormiest in U.S. labor history, the West Coast was the site of over 20 major port strikes, more than 300 days of coast-wide strikes, about 1,300 local "job-action" strikes, and about 250 arbitration awards.

A bitter 95-day strike in 1948 was followed by a period of relative calm in the West Coast longshore industry. There were no further major strikes up until 1971, a tribute to leaders on both sides since they were able to negotiate a radical new approach to the problem of restrictive work rules and job security without the use of the great leverage that is inherent in the costliness of dock delays.

Establishment of Restrictive Work Rules

During the period of "active warfare" between 1934 and 1948, severely restrictive work rules were developed in the industry. In this regard it is important to understand the employer-employee relationship. The ILWU has from the beginning concentrated its efforts upon regulating the labor supply through control of the hiring process. This control took the form of a union-operated hiring hall in which the critical element was not only the dispatching of members to the dock but a union-imposed restriction upon the number of union members. More than anyone else, employers of longshore labor draw the greatest benefit from a system which insures the existence of a permanent excess of labor. No longshoremen could work steadily for an employer, and the hiring hall dispatcher tried to equalize the earnings of the men by giving priority to men with low hours.

The ILWU's control of hiring was both a symbol and a cause of its formidable power. One form of the union strength was the development of a great variety of work rules which required double handling of cargo, limited sling loads, and which established gang sized frequently in excess of that actually needed. The range and magnitude of union control went beyond the enforcement of specific work practices. West Coast longshoremen were able to interpret and to change existing work practices to suit their immediate purposes by the use or threat of strike action. This was the method whereby most of the more restrictive rules were initially adopted. In the absence of sufficient cohesion among employers, these restrictions and practices became the rights of the union members.

Period of Peace and Reflection

After 1948, however, the climate changed. The union's restrictions remained in force, but the union leadership was not unmindful of the fact that high labor costs were driving a considerable volume of coastal and intercoastal cargo to other modes of transport and that slowly but surely the union was losing ground in their opposition to changes in operating procedures.

In 1957 following an extensive study of likely trends in shipping and longshoring, the initial decision was made which culminated in an agreement to permit the ship operators and stevedores to buy out the property rights of registered workers in the restrictive work rules they had achieved previously. Negotiations proceeded for three years, with interim changes in the basic workday and guarantees, with testing of the union's good faith in a conformance and performance program, and with an initial agreement in 1959 pointing toward basing the buy-out on direct employee productivity gains.

The initial understanding was that for a payment to the union of $1.5 million, the union would agree to go along with any and all mechanization during the 1959-1960 contract year, but that all restrictive work rules would remain in full effect. Also, the size of the work force was to be maintained at the 1958 level except for natural attrition. The ultimate objective was to guarantee the fully registered work force a share in the savings effected by labor-saving rules and contract restrictions resulting in reduced manpower or manhours with the same or greater productivity for an operation.

With this agreement the employers bought a year's time during which to develop a measurement system accurately determining the manhours saved so that a gain-sharing practice could be implemented which all participants in negotiations accepted as effectively measuring the gains due to present and future improvements. By 1960, though, the employers' position changed to one of "How much will it cost to get rid of the restrictive rules and to get a free hand in the running of our business?" They decided that a productivity study could not be effective enough to use as a basis for a gain-sharing program. For most of the stevedores, the required data were not readily available; the matching of longshore manhours on the dock and on the ship with the specific commodities being handled proved extremely difficult, because this required reasonably accurate timekeeping; and finally the compiling of reports involved additional cost and usually additional office staff.

Mechanization and Modernization Agreement

What finally evolved was a 5 1/2 year agreement, termed the Mechanization and Modernization (M & M) Agreement, to run separately from but concurrently with the general Pacific Coast Longshore Agreement of 1961 through 1966 between the ILWU and the PMA. Basically, the union agreed to abandon most of its restrictive practices as well as its historical resistance to mechanization. In exchange, the industry agreed to pay into a jointly managed fund a lump sum of money each year for the duration of the agreement. Multiple handling was eliminated; the limit on sling loads was modified; the four-on-four-off practice was eliminated;[10] and the specified minimum size of the gang was lowered below the prevailing practices in most ports.

The money raised by the employers was assessed on tonnage rather than on a manhour or productivity basis. In the beginning (1961) the assessment was 17.5 cents per ton for ordinary cargo and 5.5 cents per ton for bulk cargo. Under the agreement the PMA undertook to pay $5 million a year, or about four and one-half percent of the then existing payroll, to provide both a wage guarantee and retirement for older men. All fully registered longshoremen were guaranteed against layoffs which might arise because of productivity gains. A lump sum of $7,920 was provided for longshoremen who retired at age 65 with at least 25 years of service, with various provisions for early retirement and death benefits.

In the union's view, three million of the annual five million dollar trust fund was the price that the employers had to pay for the men's "share of the machine," to provide for early retirement, cash vesting, and death benefit features. The remainder was considered to be a quid pro quo for the surrender of employee's "property right" in

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10. "Four-on-four-off" refers to a contract endorsed practice whereby in handling cargo in the hold of the ship, one group of four men worked, while another four men rested. The resting foursome came to be referred to as "witnesses."

their working rules, to be used, if necessary, for the wage guarantee.

During this same period (1960-1966) basic wage rates rose from $2.82 to $3.38 per hour. (Table I-22 shows the basic wages for West Coast longshoremen for the period 1934-1971.) Pensions rose from $110 per month to $105 in June 1965. The actual average labor cost to the employer in 1959, after the inclusion of overtime and penalty pay and the cost of pension and welfare benefits, came to about $4.05 per hour.

These high labor costs, plus the total of $29 million paid into the M & M fund, look slight when compared with what the industry gained during the years 1959-1966. A spokesman for the industry estimated the gain to the industry to be $120 million net[11].

1966 Agreement Renewal

Joint satisfaction with the operation of the 1960 agreement furnished the basis for contract renewal in 1966. Under the new agreement, which extended from July 1966, until July 1971, the basic wage rose ninety cents an hour, to $4.28. Maximum normal and disability retirement benefits rose $70 to $235 per month at a reduced normal retirement age of 63. Employer contributions into the mechanization fund rose to $6.9 million per year, for a total of $63.5 million paid by the PMA members into the fund between 1959 and 1971.

Productivity Study and Evaluation of Program

The PMA made a substantial attempt to determine the cost or value of the M & M Agreement through a measuring system which could have served a variety of other useful purposes, but employers failed to maintain it at a level at which operational reports would be reliable. The PMA abandoned the reporting system altogether after three years, which was long enough for the employers to realize that they made a good deal.

The PMA Annual Report of 1965 (see Table I-23) provides the only available data for a measurement of the total accomplishment of the first half of the Mechanization and Modernization program. During the five year period tonnage increased by about 32 percent, and the manhours remained about the same. Despite an increase over the period of 56 cents per hour in the basic wage rate and liberalization of fringe benefits (the employer contribution for all ports to the welfare and pension benefits increased more than

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11. M. D. Kossoris, "1966 West Coast Longshore Negotiations," _Monthly Labor Review_, October 1966, p. 1068.

$1.10 per hour during this period), including the $5 million the employers paid into the fund, the cost per ton dropped from $6.26 to $6.16, after an initially large increase under the M & M Agreement, and a drop to $6.11 in 1964.

The 1970 PMA Annual Report includes averages for the four year period ended June 30, 1970, versus the levels of the year ended June 30, 1966, of longshore productivity and labor cost (see Table I-23). The figures show how longshore operations for the first four years of the 1966-1971 Pacific Coast Longshore Agreement compare with the last year of the preceding contract. The figures show that, for the four years in total, the increased labor cost negotiated in 1966 has been more than offset by gains in productivity, since the tons per hour increase of 30.9 percent exceeds the labor cost per hour increase of 18.9 percent, resulting in a decrease in cost per ton of 9.2 percent.

The 1970 PMA report also lists the total shoreside payrolls for the four primary areas (Washington, Oregon, Southern California, and Northern California). The total West Coast shoreside payroll was $165,547,153 for the fiscal year 1970, down more than $17 million from the year before. This figure includes vacation pay, subsistence and fares. The employer fringe benefit contributions to the ILWU-PMA funds for the year 1970 totalled $9,234,754 for welfare and training; $14,390,000 for pensions; $11,354,408 for vacations; and $4,636,226 for resting benefits, for a total of $39,615,388.

During 1970 approximately 60 million tons of dry cargo were loaded or discharged by longshoremen working under contract with PMA member employers. Of this total, nearly 8.8 million tons were moved in containers, a 26 percent increase over the year before.

Although the PMA levies its charges for contributions to the M & M fund on a tonnage basis on all ships requiring longshore operations on the West Coast, the benefits from the M & M Agreement have been far from equal for participating employers. However, the benefits have generally been positive all around. Employers who have unitized their loads, who have containers or similar devices, and who have speeded up operations through the introduction of new equipment have gained substantially more than their fellow association members.

Work-Force Size and Make-up

One provision of the M & M Agreement was a guarantee against layoffs of any of the regularly employed work force, i.e. fully registered longshoremen and ship clerks. This was to be accomplished partly by a closing of the union books in the late 1950's. It was thought that a decrease in total demand of manpower might be offset by a decrease in supply, which could be accomplished through normal attrition due to retirements and deaths. The 1960 membership total of 15,700 was little more than the 1949 amount of 15,000. This number has remained fairly stable during the 1960's, but the composition of the work force has changed substantially. The older longshoremen quickly took advantage of their newly won rights to a retirement bonus under the vesting or disability bonus provisions of the agreement, and 695 deaths had been covered by the improved death benefit provisions.

This attrition rate of approximately four percent just about off-sets the effect of the substantial increase in the tonnage handled per hour, but this was accompanied by an increase in the level of total tonnage handled. In 1964 the cargo volume was 20 to 25 percent above the 1960 level, and in 1965 about 35 percent higher. Due to the increase in productivity, a labor force about nine percent smaller than the 1960 level could have done the work level of 1964, but the registered list had shrunk 15 to 18 percent.

Thus, by the mid-sixties, even before the most substantial part of the Vietnam build-up, it became apparent to both the union and employers that many more longshoremen were needed, and in December 1962, they agreed to take on some new men. Nearly 2000 men, from a total of more than 9,000 applicants, were registered during 1963, and by the end of 1964 about one-fourth of the registered longshoremen were new, having joined the rolls after the signing of the 1960 agreement. In spite of the fact that a large number of younger men replaced many older, long-service workers, the average age of the work force only dropped slightly, from about 49.0 in 1960 to 48.6 in August 1966, while the modal age had actually increased from 48.6 to 51 years. This higher modal age was due to a large number of relatively older men added during the war years, men who would for the most part retire under the 1966 agreement.

Based on work force age distribution, Hartman predicted that 2,700 men would withdraw from the longshore work force by mid-1971 during the five-year period following the signing of the new agreement.[12] Assuming a rate of increase of productivity at a level at least as high as the 1960-1965 period, and a continuing increase in trade at a slower rate, it would follow that the size of the work force would contract a bit, but not much, as has been borne out. The median age would continue to fall in this manner, as men retired earlier under the provisions of the M & M Agreement, which has been called an "old man's contract," and younger men are added to the roll.

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12. Paul T. Hartman, Collective Bargaining and Productivity, Berkeley, University of California Press, 1969, p. 195.

Growing Discontent in the Rank-and-File

The emphasis under the mechanization fund has been on the payment of a sizeable separation benefit upon retirement after twenty-five years of service, which benefits older men. Men who were registered in the union after the signing of each agreement were not even considered to be entitled to any part of the Fund which represented the payment to the longshoremen for selling their "property rights" in certain of their working rules, since they were not a party to the bargaining on the working rules. Dissatisfaction with the M & M Agreement increased as the median age dropped, even though the value of the 1966 fund was substantially greater to the union, since the younger men would have to wait a long time for their turn to collect - and there was no assurance that there would be a "mech fund" by the time they reach retirement age.

Evidence of growing discontent can be evidenced by the results of the membership referendum following the signing of the 1960 and 1966 contracts. Bridges and the other leaders of the ILWU consider the approval of the membership to be an essential step in all negotiations. In 1960 the agreement embodying the new Mechanization and Modernization Fund concept was approved by the membership by a vote 7,882 to 3,695. A port in the Los Angeles area was the only major port to reject the agreement -- 1,864 to 1,065. In 1966 the overall vote accepting the agreement was much closer -- 6,448 to 3,985 -- with three out of the four major ports rejecting the agreement. Only San Francisco, the home of the union headquarters, supplied a lopsided vote for acceptance.

Containerization and Jurisdictional Dispute with Teamsters

The other major problem facing the union in the late sixties was its belated reaction to the growth of containerization. In the renewed contract of 1966, which ran for five years, containerization was not treated independently. With the steady increase of container traffic on the West Coast -- up to ten percent of freight cargo handled by mid-1968 -- the union began to take action to consider the situation. In the wake of mid-contract, wild cat strikes, which marred two decades of peaceful waterfront relations, Bridges notified his members that the 1966 agreement "overlooked or neglected to take into consideration the important advances and ramifications that would be made in container freight shipments."

The growth of containerization forced the ILWU to re-examine jurisdictional agreements with the Teamsters (International Brotherhood of Teamsters). As far back as 1955, the ILWU had protested a practice whereby containers on trucks were brought to the docks and loaded aboard ships by members of the Teamster union. An understanding was reached, but the Teamsters clearly made net gains, which included jurisdictional rights to all off-dock terminals and warehouses. Ambiguities in the agreement decreased the value of the understanding to the ILWU. The ambiguities centered upon the function of consolidating less-than-container-load (LTL) cargo in warehouses or freight stations and related activities. Due to the at least tacit acceptance by the ILWU, and mindful of the lower Teamster wage rate, the employers routed more and more containers to Teamster-manned warehouses away from, but sometimes adjacent to, dockside to be stuffed (act of placing cargo into a container) or stripped (act of removing cargo from a container).

The ILWU was able to persuade many employers to change their container work to longshore locations. The Teamsters' protest of this action was halted by a National Labor Relations Board ruling,[13] yet the ILWU's steps were insufficient in greatly reducing Teamster inroads into container employment. The Teamsters were restrained under the unfair labor practices provisions of the Taft-Hartley Act [Section 8(b) (4) (i) (ii) (D)] from picketing to stop all truck deliveries to the waterfront when one stevedoring firm complied with the ILWU demands to change the location of container work.

A great many meetings between the PMA and ILWU failed to produce a formal agreement, for a change by employers of their containerization practices would increase labor cost and antagonize the Teamsters. The fact that the PMA could claim that its contract agreement with the ILWU foreclosed the issue until its expiration in 1971 caused pressure to build. This pressure was intensified by the bargaining accomplishments of the ILA, the ILWU's East Coast counterpart.

After an unsuccessful longshore boycott of all containerized cargo handled by Teamster members -- a move so clearly in violation of the contract that the union did not even participate in a hearing before the industry arbitrator who quickly ordered an end to the work stoppage -- negotiations between the ILWU and the PMA were resumed, and four months of bargaining resulted in an agreement on a supplement to the existing contract. This new agreement provided for longshore jurisdiction over the consolidating of cargo containers to be accomplished in two steps. Initially all new container freight stations or consolidating points were to be manned by members of the ILWU.

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13. NLRB, "Hoffman v. Teamsters, Local 85," 59 LC, par. 13,359 (DC Cal. 1969).

It was also agreed that by the end of the current agreement all such consolidation areas were to be under the jurisdiction of the longshoremen. Until the expiration of the contract, existing arrangements under which Teamster stuffed or stripped containers could be continued.

The Teamsters' reaction to this new pact was hostile. Teamster picketing of container freight stations was halted by injunction, but the Teamster leadership continued to express determination not to surrender any of its jurisdictional interests and warned the employers that the loss of work previously held "will bring on strikes or other legal or economic action."

ILA - ILWU Comparison

In a limited sense, the varying experience of the two longshore unions can be considered to have been a product of the accuracy of estimates on the growth of containerization and other forms of mechanization. The ILA had strong foresight in this regard, and the ILWU can attribute many of its difficulties to erroneous assumptions on this growth.

Of more importance is the fact that two contrasting approaches to technological change were tried. This contrast in both style and substance has implications for other unions. For the ILWU, mechanization was to be a source of member benefits, and containerization, until very recently, was viewed not as a threat, but as a desirable end in its own right. The ILA acquiesced to the introduction of containerization, but it maintained a continual state of alert on any possible encroachment of its jurisdictional claims. While the ILWU approach can and has been described as progressive and enlightened, the ILA has been the target of attack for obstructing innovation.

Containerization was introduced at a time when the ILA was a faction-ridden union with little centralized control or direction over semi-independent locals. Its wages and other benefits were markedly inferior to that of the ILWU and, while many of its members enjoyed substantial protection on the job, this largely depended upon the agressiveness of local leaders or the willingness of the rank-and-file to engage in wildcat strikes. Retrospectively, it would appear that the ILA's opposition to containerization was a tactical maneuver to secure even greater bargaining benefits. The results to the union and its members are impressive. Substantial economic gains which surpassed those achieved by the ILWU were not the least of these. The winning of a guaranteed wage for 52 weeks a year in major ports for the life of the contract was an extreme achievement, when the inherent casuality of longshore employment is considered. These bargaining successes strengthened the ILA leadership and had favorable influence on the bargaining structure throughout the ILA.

The situation was not as fortunate for the ILWU. The erosion of jurisdictional interests and the inferiority of its wage package and other non-pension oriented terms have decreased the power of the union and have added unrest to the union rank-and-file whose instincts on job protection appear much closer to those held by the ILA.

1971 West Coast Longshore Negotiations

The kickoff to bargaining for the 1971 contract renewal occurred in October 1970, when the ILWU's longhsore caucus met for four weeks to adopt the union's goals or demands for negotiations. The ILWU and the PMA commenced negotiations in November 1970, eight months in advance of the June 30, 1971, contract expiration date in the hope of reaching an early settlement.

The longshoremen sought in their initial demands a contract of two years duration with annual straight time wage increases of one dollar an hour, ten paid holidays (vs. none under the former contract), $500 monthly pension after 25 years of service regardless of age, a work opportunity guarantee of forty hours per week for all registered men, and jurisdictional concessions, among others. The caucus also proposed the dismantling of the M & M Agreement.

On July 1, 1971, the ILWU called 12,000 of its 15,000 members at 24 ports in California, Washington, and Oregon out on strike after negotiations with the PMA were unsuccessful in reaching agreement before the former contract expired. The remaining members of the ILWU continued working to handle military cargo, passenger baggage, and mail. The ILWU also agreed to or allowed the release of perishables from strikebound docks and ships (and later all cargo from the docks) and allowed terminal grain elevators to operate at capacity.

Principal negotiations were held between the ILWU and the PMA. Employers not represented by the PMA traditionally sign collective bargaining agreements on the same terms and conditions as negotiated by the PMA.

Emergency Dispute Machinery Initiated

The Board of Inquiry, appointed by President Nixon on October 4, 1971, under the emergency dispute provisions of the Taft-Hartley Act, concluded that the dispute was uncommonly difficult. When the strike ensued, after months of negotiations, discussions were temporarily terminated. Negotiations began anew on August 25, 1971, and continued, under the professional assistance of the Federal Mediation and Conciliation Service, until October 4. While the Board of Inquiry found the parties to the negotiations "experienced and determined," and to be "negotiating earnestly and in good faith to resolve their differences," it was the judgment of the Board that "under the present circumstances resumption of normal operations on the docks is not soon to be anticipated nor, more to the point, reliably predictable."

When negotiations broke off on June 30, the union was seeking a two-year contract with an 85 cents an hour increase the first year and 75 cents an hour the second year. The Association had offered $1.00 an hour increase over a three year period. The parties were even further apart on technological factors such as containerization, and such items as the guaranteed 40-hour week for regular workers, and a guarantee of 32 hours for part-time stevedores.

By October 4, the ILWU had been out on strike for nearly 100 days, resulting in the longest dock strike in West Coast history. The union's strike of 1948 lasted 95 days. The principal issues which at that time still contributed to the impasse dealt with container handling, work guarantee, employment of steady skilled men, and wages. The parties reached a tentative agreement on a zone and tax concept similar to the East Coast method to cover the work of stuffing and unstuffing of containers by the longshore work force. The union had not agreed to a PMA proposed "royalty tax" of $.576 per ton for all containers handled within a 50-mile zone by other than the longshore work force. The major container issue which remained unresolved was a status quo arrangement for PMA companies who have collective bargaining agreements with other unions covering longshore work. There was a tentative agreement to a work guarantee of 36 hours per week for "A"-men and 18 hours per week for "B"-men, and as to rules and a formula for determination of eligibility to receive the guarantee.[1] There was a major disagreement arising out of the PMA demand for an annual ceiling on its maximum annual liability of $6 million, when the union refused to accept the concept of any ceiling whatsoever. By October 4 the parties were only ten cents apart concerning the straight time hourly wage of the second year of the contract. They agreed upon $5.00 for the first year, but were unsettled between $5.40 and $5.50 for the second year. The PMA's total wage fringe package was $2.35 an hour spread over two years, of which $1.12 would be in basic hourly wages and $1.23 in hourly fringe benefit rates.

<u>"Return-to-Work" Injunction</u>

An injunction acquired by the administration under the machinery of the Taft-Hartley Act forced the striking longshoremen back to work for a period of eighty days. Negotiations were temporarily curtailed and the ILWU president told the union members that, "The Taft-Hartley means that

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1. There are two categories of registered longshoremen on the West Coast, those "fully registered" or "A"-men, and those "partially registered," known as "B"-men, or "pool men." The fully registered men have first preference for dispatch.

every dispute issue will be continued on the job, with every dispatch, on every vessel and with every gang."

As required by law the employers submitted a "last offer" to be voted upon by the union members before the injunction expired. Once the 80 day period ends, only Congressional action can halt the resumption of the strike. By the date of the vote the parties had made little progress since October 4. They were still in disagreement over the weekly work guarantee, skilled work assignments, the hourly rate for the second year of the contract and subsidiary issues. The longshoremen rejected the offer by a vote of 10,072 to 746, a level of over 93 percent.

Negotiations continued and the union agreed to bar further walkouts until January 17, 1972, when the strike resumed after a breakdown of contract negotiations between the pier management and the union negotiators. Disagreement resulted over the financing of a fund needed in the annual wage guarantee arrangement which was agreed to in the talks. The PMA insisted that royalty based on container handling should be used to finance the guarantee while the union demanded a special fund to finance the wage guarantee.

Agreement Reached

Under the threat of special compulsory arbitration legislation, the parties announced the settlement of the waterfront contract dispute. Agreement was reached on all economic issues and a number of non-economic issues. Several items were to be referred to arbitration if further negotiation or mediation did not cause resolution by February 11. The final agreement is to be effective until June 30, 1973, retroactive to December 25, 1971, the day that the Taft-Hartley injunction expired. Terms of the contract (see Appendix 1) include a total base wage hike of $1.12 over the 17 months, a guarantee of 36 hours and 18 hours per week for the two levels of registered men, under a total liability of $5.2 million per year of contract, a royalty "tax" of $1.00 per long ton of non-ILWU handled container cargo, among others.

Strike Costs

During the West Coast strike nearly 250 ships carrying millions of tons of cargo were idled for various lengths of time. Many ships were able to channel U.S. cargo through Ensenada, Mexico, and Vancouver, British Columbia, but after the strike resumed on January 17, even the traffic of U.S. cargo through these ports was halted. In Vancouver, members of that ILWU local refused to handle U.S. cargo diverted from the West Coast ports. To halt traffic through the Mexican ports, men from the ILWU, accompanied by Teamster Union members picketed at the border to persuade drivers not to carry in their trucks cargo that was diverted because of the ILWU walkout. The White House gave this estimate of the damage done by the strike up through mid-January 1972: $1.4 billion of imports and exports lost; farm exports reduced by more than $200 million, from July to September; $41 million lost in earnings for longshoremen and $5 million for ship crews; average $17.5 million per day in cargo from California ports and $6 million from Oregon ports tied up, and 46 U.S. and 203 foreign flag ships immobilized.

1971 East Coast Longshore Negotiations

Longshore negotiations on the West Coast proved quite difficult in 1971, a fact which was predicted, but yet very uncommon to the West Coast industry. On the East and Gulf Coasts both the employers and the government expected problems with the ILA in bargaining for the new longshore contract, since the ILA had gone out on strike in support of contract demands at the time of every contract renewal for over twenty years.

Structure of Negotiations

The ILA has for some time been working toward an eventual coastwide agreement covering longshore locals and employers in all ports under ILA jurisdiction. A common contract for all locals is a source of strength and unity to an international union. The ILA has found that whenever one port or one area achieves contract gains not shared by others, the work tends to move to the area where the labor costs are lower, and pressures increase to move toward the lowest common denominator rather than the highest. Separate agreements, with some contracts less costly than others, weaken the union's position and strengthen the employers' excuses about labor costs.

The ILA's fractionalized history, which has shown that the union locals generally do the bargaining and rule interpreting, points to the difficulty of the goal of union solidarity behind a common contract. The union has pushed interdependence by use of the "one port down, all ports down" method to walkouts.

The early steps to a common coast-wide contract centered around the terms of a Master Contract, negotiated between the ILA and the New York Shipping Association (NYSA) for the port of New York, but used by the other ports of the North Atlantic and followed by the South Atlantic and Gulf ports. The employers also hoped to bring more regularity to the dock negotiations, especially by eliminating the "one port down, all ports down" concept, so they have attempted to centralize contract discussions.

In April, the NYSA announced that "a centralized bargaining unit, representing the six leading North Atlantic seaports, will negotiate the major contract items in bargaining this year with the International Longshoremen's Association." The establishment of the Council of North Atlantic Shipping Associations (CONASA) was described as an historic first in waterfront labor relations "that should remove some of the obstacles to early contract settlements that have existed in the past and consolidate management's thinking on major contract issues." Part of the negotiating structure of CONASA was the setting of a fixed period of time in which each port would negotiate local conditions between the port management and the port ILA representatives.

Initial Union Demands

At a meeting of the ILA's first National Wage Scale Conference in May, proposals for a new "national collective bargaining agreement covering all ports from Portland, Maine, to Brownsville, Texas, Puerto Rico, and eventually, the Great Lakes" was recommended. The union hoped that all local port conditions would be out of the way by September 1, 1971, so that when an offer from the employers was acceptable to the National Negotiating Committee, all ports would be in a position to ratify the agreement long before the September 30 contract expiration date. The union stated that it would rather avoid the occurrence of negotiations being broken off at the eleventh hour and the government being prepared with a Taft-Hartley injunction. The union members are left very much in the dark under such a situation.

Among the union's proposals was a straight time wage increase from $4.60 an hour to $7.50 an hour, overtime pay (time and a half) for the last two hours of work during an eight hour day (a provision of the West Coast longshore contracts for the past ten years), and double time ($15.00 per hour) for all work over eight hours. The union also proposed an increase in paid holidays from thirteen to sixteen, an increase in vacation benefits (e.g. increase of maximum vacation length from six to eight weeks), a one year term of contract, an increase in royalties for cargo handled by non-ILA personnel to $2.00 per ton for container, seabee, and Roll-on, Roll-off ships, continuance of the Guaranteed Annual Income, expansion of GAI to all ports, and various manning restrictions, among others.

Prior to the expiration of the old contract there was sporadic, intermittent negotiation by the parties. Although there were a few discussions relating to specific issues and local questions, the only discussion of all national issues was on August 18, 1971, when the ILA formally presented its demands to CONASA. A work stoppage began October 1, when the employers in the Port of New York informed the union that there would no longer be any Guaranteed Annual Income for longshore employees. The union refused to work under such conditions, and a walkout resulted.

Strike Resulting from Dispute Over GAI and Interpretation of Wage/Price Freeze

Negotiation on the East and Gulf Coasts were more strongly affected than the West Coast talks by the mechanics of the 1971 Wage/Price Freeze. The New York employers stated that they could not afford to maintain operations under provisions including a Guaranteed Annual Income (GAI) which, due to abuses by the workers, has cost more than $30 million per year. It was originally estimated that GAI would cost $13 million per year at the most. The employers felt that the GAI under the form of the 1968-1971 contract destroyed productivity in the Port of New York, and since New York moves almost half of the general cargo on the Atlantic Coast, it also affected the solvency of many U.S. flag steamship carriers as well as the continued use of New York by many foreign flag carriers.

The union agreed that abuses existed in the administration of the GAI provisions, but it desired to continue negotiation and working under the old contract until the expiration date of the Wage/Price Freeze on November 13, 1971. Mr. Gleason, president of the ILA, testified before the board of Inquiry appointed on October 4, under the emergency dispute provisions of the Taft-Hartley Act, that he believed it "was the best thing for the country" for the men to do this, but that this proposal was rejected by the employers. The union did not oppose, and actually supported, the government step of a Taft-Hartley injunction, since such a move would require that the longshoremen return to work for 80 days on a status quo arrangement under the provisions of the old contract.

Taft-Hartley Injunction Not Used

The various employer associations testified before the Board of Inquiry setting forth their reasons why no national emergency had been created by the work stoppage. They contended that the invocation of the injunction provisions of the Labor Management Relations Act of 1947 would only serve to aggravate rather than solve the bargaining impasse.

Much of the impact of a strike on the East Coast was blunted by the foresight of shippers and by the current depression of world economic activity, particularly in the U.S. Exporters to the U.S. either used an alternate route, such as through Halifax, Nova Scotia, or pushed through enough cargo before September 30, to build up a stock. Many operators took the opportunity to dry dock their ships and perform various other, usually-disruptive chores while they could. Because strikes have resulted over contract negotiations with the ILA so regularly in the past, the shippers have come to expect and plan for such an occurrence.

At the time of the Board of Inquiry investigation, only five days after work on the docks had been curtailed, the major issues were GAI, containerization and Lighter Aboard Ship (LASH) operations, and wages and working conditions during the period of the wage-price freeze. An NYSA proposal to place every eligible employee on the direct payroll of a direct employer was emphatically rejected by the union as unsound and an attempt to weaken the union. While the employee would be annually guaranteed 2080 hours of pay, he would work, within his particular craft, wherever he was needed in the port, as distinguished from the former pier seniority system.

The Board concluded that the parties had not engaged in any productive bargaining on the pending issues, and the Administration decided not to invoke an injunction at that time.

Operations Continue In Several Ports

Although an injunction was not granted, the ILA had difficulty in maintaining solidarity among its locals in shutting down operations in all East and Gulf Coast ports. The West Gulf locals made independent agreements with their employer associations to continue working at least until the end of the Wage/Price Freeze, rather than strike for the primary purpose of supporting union GAI demands in New York. The fact that the GAI provision of the New York contract was the main issue of the strike and the failure of negotiations was used by employers in many ports to obtain injunctions under the secondary boycott provisions of the Taft-Hartley Act to require longshoremen to return to work.

Taft-Hartley Injunction Used To Halt Strike

In late November 1971, after more than 45 days had elapsed since the expiration date of the old contract, the Board of Inquiry concluded that the ILA negotiations with the shipping associations had broken down over two "very sticky issues" -- minimum pension guarantees and welfare contributions -- and an injunction was granted to halt the strike. At that time the ILA had rejected two offers which were made by CONASA covering increases of $1.555 and $1.975 in wages and contributions to the Welfare and Pension Plans over a three year contract.

While negotiations continued, primarily between CONASA and the ILA, work resumed on the docks. The problem of the main item of dispute, the guaranteed wage, was meanwhile partially solved by the expansion of the Prior Day Order (PDO) system in New York. The number of men collecting GAI daily was drastically reduced, and the employers' objections to GAI and the costliness of the abuses in the system were placated.

Agreement Reached

In January 1972 the Board of Inquiry concluded that a "last offer" vote need not be conducted since the parties were close to final agreement, they had begun setting their own referenda in motion, and they had agreed to continue operations assuming ratification of the complete agreement by the union members in all ports. The Board was advised that CONASA and the ILA had agreed on all seven of the Master Contract items, and that all local issues in the Port of New York had been solved. Only the local issued in the various other ports remained.

The key element in the local dock negotiations in New York is a revision of the manner in which the guaranteed wage system will be implemented. The job categories on the New York docks have been reduced essentially to two, and if any job in a category goes unfilled during a given day, every man in that category would be denied pay for that day. Additionally, no longshoreman will qualify for guaranteed wages if he holds another job during normal working hours. Mr. Gleason insisted on the validity of the management demand regarding outside employment despite the opposition of Manhattan longshore leaders.

The money terms of the master contract settlement negotiated between CONASA and ILA are as follows for the three-year contract (in per-hour increases):[2]

	Nov.14,1971	Oct.1,1972	Oct.1,1973	Total Increase
Wages	$0.70	$0.40	$0.40	$1.50
Pensions	0.12	0.18	0.17	0.47
Welfare	0.555	0.15	0.10	0.305
			Total:	2.275

No increases were made in vacation or holiday benefits, but monthly retirement benefits to men 62 years or older were raised from $300 to $400.

The CONASA negotiated terms on the seven major contract items were used as a guide to bargaining in the South Atlantic and Gulf Coast ports, and local negotiations settled the remaining issues.

In New York a sharp reduction in the assessment rate was made for the ocean cargo handled there based on new terms of the agreement. The assessment is the major prop for the guaranteed annual income, pensions, and other benefits provided the longshore workers. The assessment rate has been dropped from the previous $3.23 per assessment ton to $1.50 per ton, effective February 15, 1972.

The use of the prior day ordering method of hiring along with increased flexibility in work assignments and reduced job classification, and the fact that the total outlay for financing the work guarantee and benefit program has been limited to $60 million per year, has apparently resulted in the lowering of the assessment rate.

[2] Wall Street Journal, January 10, 1972

CHAPTER III

CONTRACT NEGOTIATIONS 1971-1972

Negotiations for new longshore contracts for both the ILA and ILWU occurred in 1971. The ILA's three-year, 1968-1971 contract expired on September 30, while the ILWU's five-year agreement expired June 30.

The ILWU, after working under two five-year contracts during which the employers made clear gains and the union lost its contract superiority over the ILA, sought a wage-benefit package heavily weighted toward immediate cash returns. The union demanded provisions similar to those in the East and Gulf Coast contracts: guaranteed wage, royalty payments on container cargo handled by non-longshore personnel, jurisdictional concessions, and paid holidays.

The ILA sought to continue the prize provisions that it had won in New York in 1968, and expand these contract terms to other ILA ports with the goal of an eventual "national" agreement covering all ILA locals, and less union fractionalization.

Strikes on both coasts resulted in the first shutdown of all U.S. ports since 1948. The unions also began to work together to promote common interests. The government's intervention, expanded to the point of passage of emergency dispute legislation including mandatory arbitration, was influential in the obtaining of the final settlement.

Results of 1971 Negotiations

The 1971 negotiations resulted more than anything else in the total U.S. longshore industry becoming much more unified. The ILA and ILWU had generally been bitter in their relations toward each other since the split in 1937, but during their bargaining they discussed their different past agreements and bargaining practices and present goals and methods for attainment. They concurred on a mutual aid pact to strengthen their position with their employer associations and the action of the federal government. In addition, they even discussed seriously the possibility of a merger, creating again one unified union of all U.S. dock workers.

Critical to the new relations between the two unions were the ILWU's demands for and attainment of contract provisions for promoting job security similar to those on the East Coast. Both contracts are essentially the same now, or at least much closer than in the past ten years.

Two other products of the 1971-1972 negotiations were renewed efforts by the government to find some solution through legislation to the problems in collective bargaining in the transportation industry that are not covered by present laws, and the possibility of a Teamster merger with the longshore unions, particularly with the ILWU. Both of these subjects will be covered in later chapters.

After ratification of the negotiated agreements by the union members, the primary problem to be solved before the settlement is complete is that approval of the contracts must be granted by the Pay Board machinery of Phase II of the administration's economic stabilization action. The Pay Board guidelines set combined wage and benefit increases of 5.5 percent a year as the limit, with 7 percent allowable in certain "catch-up" and other circumstances. The longshore settlements are clearly in violation of these guidelines. The contracts also come at the end of long strikes and long negotiations during which the executive and legislative branches of the government intervened, so a Pay Board veto of the contracts, or an ordered lowering of the economic issues, would likely cause a return to strike activity. Because of the significant impact of the industry on the economy, the result of industrial relations is important.

The Pay Board and the West Coast Agreement

The terms of the first year of the ILWU-PMA settlement were reviewed by the Pay Board in March 1972. Both the PMA and the ILWU, supported by various other national unions, urged approval by the Board of the Pacific Coast agreement as negotiated by the union and the employers, although the terms of the contract were considered to be inflationary by most third parties. Productivity gains were cited by the ILWU and the PMA as justification for the level of increase.

The Board determined the proper base compensation rate for computing the maximum permissible aggregate annual wage and salary increase to be $7.428 per hour. The members of the Pay Board voted 8 to 5 to reject the settlement for the first year, calculated to be a raise of 20.9 percent. By a vote of 8 to 6 the Board authorized a reduced settlement of 14.9 percent.

The approved raise may be broken down into a seven percent annual aggregate wage and salary increase allowable under catch-up provisions; a 1.9 percent increase in excludable fringe benefits; an additional 3 percent in wages and includable fringe benefits; and the final three percent as an exception to the Board's regulations because of the demonstrated and unique facts of the case, including those relating to the prior Mechanization and Modernization Plan payments, involving on-going collective bargaining and pay practices, the equitable position of the employees involved, arrangements between the parties specifically designed to foster economic growth, and other factors, including productivity considerations. The Pay Board also outlined the method by which the guaranteed pay plan would be costed.

The five labor members of the Pay Board opposed the majority decision, stating that a legitimate contract arrived at through free collective bargaining between employers and their employees had been voided, and that each of the 15,000 ILWU members would as a result lose $1,150 over the 18 month period. They felt that the rising productivity on the waterfront, resulting in labor savings of more than $900 million over the ten years of the M & M Agreement, as calculated by the Pay Board staff, compensated the large wage increase.

The disagreement between the union members of the Pay Board and the public and business members over the ILWU case sparked a union walkout and a restructuring of the Pay Board mechanism.

Although Harry Bridges threatened to call another strike, possibly with the support of the ILA, if the ILWU settlement was decreased at all, the ILWU chose to at least temporarily leave the Pay Board's ruling undisputed.

On May 15, 1972, the ILWU and the PMA jointly announced acceptance of the Pay Board cutback in the new wage rates. The union and the employer association agreed that if wage or price controls were eliminated by November 30, 1972, the contract might be terminated by either party on sixty days' notice, or on twenty-four hours' notice if controls were ended after January 31, 1972.

The new wages will be paid beginning June 3, 1972. Retroactive payments to December 25, 1971 will be made by June 30, 1972.

The Pay Board and the East Coast Agreement

In actions similar to the case of the ILWU, the ILA and the various East and Gulf Coast employer associations submitted their final agreements to the Pay Board for approval. The high level of increase in base pay and fringe benefits, amounting to approximately 14.9 percent for the first year, was justified by the ILA and the employers on the basis of past and prospective productivity increases.

The case was reviewed in May 1971, and the Pay Board members determined that the settlement was inflationary, and that the rates should be decreased. It was decided that the longshoremen should be allowed increases ranging from 9.8 percent to 12 percent, varying as to the different ports.

The ILA officials later announced that the union would not strike as a result of the action of the Pay Board, but that legal means would be pursued to counter the decrease in benefits in the contract.

Chapter IV

MERGER OF UNIONS
TO INCREASE STRENGTH AND SOLVE CONFLICTS

Ever since the ILWU separated from the ILA in 1937, the U.S. longshore industry has been split between the two unions. For decades the unions have been bitter rivals, marked by opposing ideologies and methods of pursuit of similar goals and solutions to common problems. For thirty-four years there was essentially no interest expressed by either union toward the idea of establishing a communication link to work together in areas of mutual interest. Yet by 1971, the ILWU members had become unsatisfied with their contracts for the previous decade under which the union permitted the employers large gains due to their acceptance of mechanization, and the ILWU chose to bargain for contract terms which would assure the workers a larger share in the future of the industry in a style similar to that which has characterized labor relations on the East and Gulf Coasts, as covered in the previous chapters. The likely outcome of these events has been renewed relations between the ILA and the ILWU, exchange of information related to operation and bargaining practices, mutual aid in pursuit of contract demands, and discussion of formal merger.

At the same time, the plan of a merger between the Teamsters and the longshore unions, in particular the ILWU, has become more likely. A merger with the Teamsters would solve many of the jurisdictional problems that have plagued the longshoremen, and it would greatly increase the strength of these transportation industry unions.

ILA - ILWU Merger

The Pacific Coast locals of the ILA were formed into the ILWU in 1930 by Harry Bridges. Since that time the ILWU was temporarily an affiliate of the Congress of Industrial Organizations (CIO), but it is now an independent union. The ILA after 1937 remained in the American Federation of Labor (AFL), but was expelled for a while due to union corruption. Later it reaffiliated with the newly established AFL-CIO, and it has remained so.

The ILA now represents a total membership of 115,000 in longshore and related occupations in the ports of the Atlantic Coast and Gulf Coast of the U.S., the Great Lakes, Eastern Canada, and Puerto Rico, while the ILWU's representation covers the Pacific Coast of the United States, and extends to Western Canada, Alaska and Hawaii.

Chapter II described the unions' separate methods of collective bargaining for the number-one worker demand of job security in the wake of the employers' goal of more effective utilization of manpower through far-reaching technological change. In the Mechanization and Modernization Agreement of the 1960's, the ILWU attempted to share in the savings that the employers gained due to their freedom to revolutionize methods of cargo handling and to eliminate restrictive work practices. The workers received increased work guarantees and pension benefits, but their gains were small compared to the savings that the employers experienced under the two five year contracts and to the gains which the ILA received on the East and Gulf Coasts during the same ten years. By 1971 the ILWU was interested in abandoning their former approach to contract settlements, in pursuit of provisions similar to those in ILA-negotiated contracts. The ILA maintained job security for its members primarily through the Guaranteed Annual Income and rigid enforcement of jurisdictional agreements.

Until 1971 the unions did virtually nothing to promote renewed relations. In 1955 the ILWU Convention instructed the union officers to explore with the ILA the possibility of reaffiliation of the ILWU to the ILA, but nothing came of the inquiry.

At the union convention in July of 1971, ILA President Gleason was able to inform the union members that in the past year the ILA officers had renewed and strengthened their relationship with the ILWU through the exchange of visits and the sharing of information, seeking to give to each other the benefits of their different experiences and programs.

Each set of officers addressed the other's conventions in 1971, mutually pledged unity and support in their respective dealings with shipping management and openly discussed the possibility of merger. The officials stressed the fact to their members that such decision would be left to the union members.

<u>Reasons for Merger</u>

A unification of the unions would be likely to add strength to union position plus some stability to the industry. The unions feel that because they do have the same goals and similar problems, and because many of the same major operators are now common to both coasts, perhaps it is time they should join forces.

It is also possibly in the best interest of the shippers that the unions combine in a form at least for collective bargaining purposes; in this way the employers would negotiate simultaneously with the ILWU and the ILA. Through the years their separate bargaining and different contract expiration dates have contributed to the whipsawing of settlements and added to employer labor costs on both coasts.

First Mutual Aid Agreement

By October 1971, the West Coast longshoremen had been out on strike for over three months, and were forced to return to work under a Taft-Hartley Act injunction. The ILA had just begun their strike on October 27, the union leaders announced their first official action in forming a common front in their negotiations.[1] They stated that the ILWU and ILA would collaborate "to insure that gains won in collective bargaining are not taken away" either by government through its control policies or by dock employers. They also agreed to strive for a common contract expiration date and to permit either union to picket docks in the other's jurisdiction if a struck employer's ships tried to find a haven in an open port.

In the ILWU newspaper of December 22, 1971, Harry Bridges urged that the union members support their leadership in working toward an affiliation with the ILA as a means of gaining their contract demands:[2]

> We get together with the East and Gulf longshoremen and their union, the ILA, that's what. And when I say get together, as I have been urging for a long time, and I am asked do I mean affiliating our union with the ILA, therefore the AFL-CIO? I answer, "Hell, yes, if doing so we secure our container jurisdiction and win this battle." And I know damn well that without the ILA threat we can forget getting more on containers than we have now, plus doing a job for Hawaii. And finally, there is the matter of getting a contract approved by the Wage/Price Boards. Standing by ourselves, it's doubtful whether we could ever have got an okay on the last offer contract.

The ILA and the ILWU did agree to work together in pursuit of getting each of the new contracts approved by the Pay Board. The unions used the threat of total shutdown of all U.S. ports if the Pay Board did not approve completely the agreements that each had negotiated with their respective employer associations.

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1. Business Week, November 6, 1971, p. 55.

2. The Dispatcher, December 22, 1971, p. 2.

In their separate new contracts, the two unions did not bargain for a common expiration date. The new agreements are scheduled to end over a year apart, so the ILA and the ILWU will not be in a situation for several years in which they are both negotiating new contracts concurrently, as they were in 1971-1972. The unions will likely continue to work together, but only a substantial threat to their position and security will cause them to completely combine forces by a merger in the at all near future. It would be a large step for each union to abandon its autonomous position in its own jurisdiciton and affiliate with the other group. It would essentially necessitate the ILWU joining the AFL-CIO.

Teamsters - Longshore Merger

Although a combining of forces between the teamsters and the longshore unions is possible, it is not likely in the near future, and such an occurence would surely result in some form of government action. The International Brotherhood of Teamsters (IBT) is a union primarily of truck drivers and warehousemen, although its representation ranges to occupations only distantly related to transportation. It is a union of more than one and a half million members, making it the largest union in the U.S.

A merger might take place as a solution to jurisdictional problems, but the bargaining power that would result from such a collusion would have far-reaching effects on the associated industries and the U.S. economy.

Background to Problems

The history of the jurisdictional disputes between the longshoremen and the Teamsters was outlined in greater detail in Chapter I. Basically, on both the East and West Coasts, the dispute has centered around the handling of container and palletized cargo in the waterfront area and the loading and unloading of such cargo aboard the ships. Formerly all transferring of cargo between the ship and the pier was done by slings. The longshore contracts contained provisions limiting the sling load and stating that the longshoremen's jurisdiction covered the transport of the cargo between the holds of ship and the "skin of the dock".

Upon the introduction of pallets and containers to the cargo handling in the mid-1900's, restrictive work practices were developed by the longshoremen with the aim of maintaining job security. It was not uncommon for the longshoremen to remove cargo from a pallet after the pallet had been unloaded from the ship before allowing a truckdriver to remove the cargo from the dock. The union defended this practice with the "skin of the dock" contract term.

In the early days of container shipping, Teamster member trucks would often drive non-longshore loaded containers right onto the dock and hook the containers to the ship's crane, thereby eliminating the need for any longshore manpower. The original longshore reaction to this practice was to forbid the truck drivers to enter the dock area, requiring that a longshoreman drive the truck from the gate to the ship and that longshoremen handle the loading and unloading of the container aboard the ship. Also, any non-longshore loaded containers were often, upon entering the dock area, stripped and restuffed by longshore personnel, thereby requiring double-handling of the cargo and negating much of the savings inherent in container transport.

Present Status of Dispute

Symptomatic of the underlying problem in the jurisdictional dispute with the Teamsters is the unfortunate fact that most of the critical decisions relating to the problem have been determined by arbitration and not through negotiations. On the East Coast the ILA has managed to gain many concessions from employers concerning containerization which have guaranteed the longshoremen a large part of the operation. The ILA receives a royalty on all container tonnage not stuffed by ILA personnel within a 50-mile radius of the dock, thereby guaranteeing the union more work and a fund to support any decrease in the total manhours of employment available. On hte West Coast the ILWU has been slow in realizing that a severe loss of job availability can result from not fighting for their interest in the handling of containers. In 1971 the ILWU changed their approach to container bargaining and received a contract similar to that of the ILA (see Chapter II). A method of royalty payment was set up, but the prime jurisdictional dispute with the Teamsters was not settled.

The ILA has not been involved in discussions with the IBT concerning merger, except through the ILWU's independent meetings with the ILA and IBT. On the East Coast the jurisdictional roles of each union are more clearly defined than on the West Coast. The employers, through the PMA, have been caught between the two unions and have been unable to evolve a final solution. The ILWU and Teamsters, through their leaders, have attempted to solve this problem of mutual interest.

Likely Scenario of Merger

During the ILWU's contract negotiations of 1971-1972, the IBT leadership did not openly support the ILWU leadership in its demands, but some Teamster members aided longshoremen in persuading drivers not to transport U.S. cargo diverted from the West Coast to Mexican ports, and the unions worked together for each other's betterment. The Teamsters did not support the ILWU over the issue of double-handling of container cargo as a means to establish ILWU jurisdiction over this type of work, but suggested that such an issue could best be settled in the context of a merger of the two organizations.

The framework of a possible affiliation of the ILWU with the IBT would most likely be based on the following principles, as outlined in a letter to Harry Bridges from IBT President Frank Fitzsimmons:[3]

1) The International Brotherhood of Teamsters would affiliate the International Longshoremen's and Warehousemen's Union in its entirety. In so doing, the IBT would recognize the two existing divisions of the ILWU, longshore and warehouse, and other sections.

2) The IBT would protect, under the IBT constitution, the autonomy of the longshoremen, clerks and walking bosses as a proper trade division within the IBT.

3) The ILWU Local Unions which presently comprise the Warehousemen's Division would become affiliated with and a part of the existing IBT Warehouse Division.

4) Within the framework of the IBT Constitution, the Longshoremen's Division and the Local Unions comprising the ILWU Warehouse Division would have the right to determine their respective jurisdictions.

5) A joint committee would be appointed by the two International Presidents to resolve any remaining issues.

Labor Relations and Antitrust Laws

Unlike the situation in the realm of business, there are no specific laws forbidding unions from merging with other unions or affiliating with an association of unions. The present laws have been interpreted at various times to control union practices in such areas, but no clear precedent has been set.

The ILA and ILWU would be free to combine into one large, national union of all U.S. longshoremen, or to merge with the Teamsters to form a transportation union of major size and importance. The U.S. Congress is presently considering legislation (see Chapter V) that is not for the purpose of forbidding or controlling such mergers, but such a new law would influence the mergers and vice versa. The legislation deals with national emergency disputes in the transportation

3. The Dispatcher, January 28, 1972, p. 8.

industries, and it is for the purpose of assuring, so far as possible, that no strike or lockout in the transportation industry or a substantial part thereof will imperil the national health or safety. It would establish procedures to encourage the parties to a dispute to make effective use of various private collective-bargaining techniques to resolve disputes, and to both protect the public interest and recognize the interests of the parties involved in the dispute. The interest in such new legislation is a result of the concensus among many government officials and others that the present procedures for dealing with disputes in the transportation industry, in general, have proved insufficient to prevent serious disruptions of transportation services.

The legislation would not limit a union's freedom to affiliate with other unions, but the strength in bargaining that would likely result from a merger, especially one like a merger of the Teamsters with the longshoremen, would be limited by such a law. The likelihood of the legislation being adopted would be influenced by any acts of the longshoremen to unite, or combine with the large IBT, especially in the wake of the recent long and costly longshore strikes.

Present Laws

Congress created the National Labor Relations Board as the prime interpreter of national labor policy. However, there is an alternate statutory framework for regulation of collective bargaining, the Sherman Act, as amended by Section 20 of the Clayton Act and modified by the Norris-LaGuardia Act. The stability and degree of industrial peace are endangered by these overlapping sets of legal rules.

The Taft-Hartley Act of 1947, along with previous labor legislation, created specific legal obligations that restricted union activity. Because of the establishment of machinery for handling the full range of labor problems, the courts effectively lost their power to apply the antitrust laws to union action. Judicial aciton strengthened this concept. Shortly after the Supreme Court had approved the constitutionality of the Wagner Act, it virtually removed the possibility of either damage suits or criminal proceedings under the antitrust laws being applied to lawful union activities.

The application of antitrust to labor agreements or mergers must be based on the fact that a collective agreement is encroaching on product market competition, but the union's legitimate interest in wages, hours, and conditions such as jurisdictional conflicts may outweigh the unlawful aspects. Because the present legislation does not give statutory guidance, and the court interpretations have been somewhat ambiguous, the question of coverage of antitrust to labor is still in doubt.

CHAPTER V

IMPACT OF LONGSHORE STRIKES

The longshore industry, especially in the wake of the 1971-1972 contract negotiations, is most noted for its propensity to cause a major shutdown of dock operations in support of collective bargaining demands and to use wildcat strikes to press correction of grievances.

Except for the recent difficulty, the West Coast has not had a major strike in over twenty years; however, industrial relations between the ILWU and the PMA have not been completely peaceful during this period, as longshoremen there have struck occasionally in small numbers. The majority have been portwide wildcats over such contract provisions as jurisdiction of container handling.

On the East and Gulf Coasts coast-wide strikes have been much more common. The ILA has struck after the time of every contract expiration since 1948 when the union received an increase in wages of 13 cents an hour after returning to walkout when the 80-day injunction ended. The ILA has also experienced a large number of wildcat strikes due to the lack of central structure in the union and due to the fact that several major issues have not been settled through contract bargaining, but through arbitration. Industrial relations have become on the whole more satisfactory over the past decade. A joint Labor Relations Committee, established in New York in 1956 to hear grievances,has been very successful in reducing the number of wildcat strikes. Before 1956 there were as many as 60 such strikes each year, but this number has been reduced to an average of less than 10 during recent years.

National Emergency Disputes

Under the terms of the Labor Management Relations (Taft-Hartley) Act of 1947, an emergency dispute is defined as "a threatened or actual strike or lockout affecting an entire industry or substantial part thereof," engaged in interstate commerce or in production of goods for commerce, which will, in the opinion of the President, "if permitted to occur or to continue, imperil the national health or safety." In other sections and chapters, the terms of the Taft-Hartley Act as they apply to longshore strikes will be studies; shortcomings in the law as it has been used for injunctions in the past will be evaluated and proposals for new legislation will be recommended.

Since 1947, the Taft-Hartley Act has been used 31 times to halt strikes considered to be national emergency disputes by the President. Ten of the granted injunctions were applied to the longshore unions. Eight were used to halt strikes solely involving the ILA; the other two concerned the ILWU with one of these two injunctions involving certain other seafaring unions in 1948.

Strike Statistics

In Table V-1 the statistics are listed for all work stoppages in the longshore industry for the period of 1958 to 1970. All measures of strike activity were significantly higher for the Atlantic and Gulf Coasts than for the Pacific sector during this period since there were no major ILWU strikes; in contrast, the ILA struck along the entire East and Gulf Coasts four times during this 13-year period in support of contract demands. Also, much of the substantial differences in strike activity between the two coasts reflects to some extent the fact that there are far more longshoremen working on the Atlantic and Gulf docks than on the Pacific docks. There were only 41 stoppages on the Pacific Coasts compared to the 215 that occurred on the Atlantic and Gulf Coasts.

Man-days of strike-caused idleness provide as good an indication of the totality of a strike just as man-hours of employment give an indication of the amount of work available to longshore labor. The average for the Pacific Coast was 3,400 man-days idle, which resulted from an average of 900 workers involved in an average of 3.1 strikes per year over the 1958-1970 period. At the remaining U.S. ports, represented by the ILA, an average of 453,800 man-days were lost each year during the 13-year period, resulting from an average of 28,900 dockworkers involved in an average of 16.5 strikes each year. The Port of New York, which employs approximately 30% of all U.S. longshoremen, accounted for 35.5% of all man-days lost in the industry during the period, and 41% of all strikes. Excluding the Pacific Coast, New York accounted for 35.7% of the average man-days of idleness.

Impact of Longshore Strikes

During and following each of the East Coast longshore strikes there have been attempts to analyze the impact of the strike on the employers, the union, the shipping industry, and the national economy in general. The estimates of strike-caused damages are usually higher during the strike, which contributes to the generation of political pressure. The disputes are highly visible, and the dramatic potential for claiming danger to public health or safety inevitably results in government intervention. There is no doubt that a longshore strike is costly to the U.S. economy, but part of the cost is simply the price which must be paid for free collective

Table V-1

WORK STOPPAGES IN THE LONGSHORE INDUSTRY, 1958-70
Nationwide

Year	Number of Strikes	Workers Number (000's)	Involved[1] per Stoppage (000's)	Idle (000's)	Man-Days per Worker Involved (000's)	Contract Expiration Pac.	Atlan
1958	8	3.7	0.5	16.4	4.4	X	
1959	18	66.0	3.7	393.4	5.9	X	X
1960	36	13.3	.4	65.0	4.9	Reopen.	
1961	22	31.1	1.4	40.7	1.3		
1962	18	56.2	3.1	521.8	9.3	X	X
1963[4]	22	5.8	.3	924.2	159.3		
1964	18	71.7	3.9	141.2	1.9		X
1965[4]	16	3.3	.2	1,184.3	358.9		
1966	21	8.4	.4	35.7	4.3	X	
1967	28	21.9	.8	108.2	4.9		
1968	16	80.3	5.0	623.9	7.8		X
1969[4]	20	8.1	.4	1,853.2	228.8		
1970	13	17.8	1.4	36.1	2.0		
Mean:	19.7	29.8	1.5	457.2	15.3		

1. Workers are counted more than once if involved in more than one stoppage during a year.

Note: These data include only stoppages lasting one full day or shift or longer and involving six workers or more. The number of stoppages and workers relate to those stoppages that began in a year; man-days of idleness are derived from all stoppages in effect in a year.

Table V-1 (Cont.)

WORK STOPPAGES IN THE LONGSHORE INDUSTRY, 1958-70
Pacific Coast

Year	Number of Strikes	Workers Involved (000's)	Man-Days idle (000's)	Contract Expiration
1958				X
1959	1	.4	.4	X
1960	6	2.3	3.2	reopening
1961	6	4.0	10.9	
1962	2	.4	1.3	X
1963	4	.2	.5	
1964	4	.1	.2	
1965	5	.9	1.7	
1966	4	.6	1.5	X
1967	6	.6	1.0	
1968	1	2.0	22.1	
1969	1	( )[2]	.8	
1970	1	.2	.8	
Mean:	3.1	.9	3.4	

2. Fewer than 100.

Table V-1 (Cont.)

WORK STOPPAGES IN THE LONGSHORE INDUSTRY, 1958-70
Atlantic, Gulf, Inland and Great Lakes

	All Ports[3]			Port of New York			
Year	Number of Strikes	Workers Involved (000's)	Man-Days Idle (000's)	Number of Strikes	Workers Involved	Man-Days Idle (000's)	Con-tract Expir.
1958	8	3.7	16.4	3	0.1	0.2	
1959	17	65.6	393.0	8	25.9	128.1	X
1960	30	11.1	61.8	17	5.2	12.2	
1961	16	27.1	29.7	9	26.5	26.7	
1962	16	55.9	520.5	7	23.1	209.9	X
1963[4]	18	5.6	923.7	3	.7	361.8	
1964	14	71.6	141.0	8	27.3	43.6	X
1965[4]	11	2.4	1,182.6	5	1.8	449.3	
1966	17	7.7	34.2	9	3.9	13.8	
1967	22	21.3	107.1	13	13.9	92.8	
1968	15	78.3	601.8	9	37.4	291.7	X
1969[4]	19	8.1	1,852.4	8	1.9	457.4	
1970	12	17.6	35.4	6	14.4	24.0	
Mean:	16.5	28.9	453.8	8.1	14.0	162.1	

3. Includes strikes in the Port of New York

4. High man-days idle figures due to stoppage beginning in the previous year.

Source: U.S. Department of Labor
Bureau of Labor Statistics

bargaining, so that the parties to the agreement may assume the responsibility for the results of their efforts.

In 1969 a joint Task Force of the Departments of Labor and Transportation was established to "determine the full economic effects of recent national emergency strikes and, more importantly, to develop an analysis system or methodology which will give policy-makers basic economic information to be used in deciding which situations merit federal concern and involvement." The report was confined to analysis of economic impact, and it did not attempt to measure the impact of the strikes on either "health" or "safety".

Analysis was made of the three major East and Gulf Coasts longshore strikes of the 1960's, for which Taft-Hartley Act emergency procedures were used. These strikes were the ones of 1962-1963, 1965, and 1968-1969.

No long-run effects on the U.S. foreign trade patterns during the periods could be directly attributed to the strikes. The strikes were found to have no visible impact on the economy as a whole as determined by such indicators as industrial production, retail sales, national income or total employment. Although the immediate impact of a dock tie-up is partially to halt both imports and exports, this may be offset to some extent by advance shipments and receipts in anticipation of the strike, by diversions of traffic to ports not affected by the strike or to other transportation systems, and by above normal shipments and receipts after the strike has ended, so the strikes are not as severe as might be believed. Also, dock strikes do not usually result in the shutdown of all import and export operations. Military cargo, passenger ships, and perishable goods are usually allowed to continue in transport.

Estimates of average daily net loss in the U.S. trade balance attributable to the strike are about $9-10 million per day in the 1962-1963 and 1965 strikes and roughly $3-5 million per day in the 1968-1969 strike. The estimates of the total net loss in the U.S. trade balance are approximately $350 million in 1962-1963, about $400-500 million in 1965, and roughly $250-300 million in 1968-1969. The total U.S. foreign trade for the years 1963, 1965 and 1969 were $41 billion, $49 billion, and $70 billion respectively.

No evidence of permanent loss of export markets, which would be traceable through a slowdown in the rate of growth of either exports or imports not directly traceable to other causes, was found to be attributable to the strikes. The greatest losses resulted for commercial agricultural products, such as soybean or wheat, which are normally sold on a strictly competitive basis involving price and delivery schedules.

Domestic Economy

In the domestic economy, with few exceptions, such as sugar cane or parts for some foreign vehicles, the strikes did not appear to generate shortages of materials or components in this country. Major manufacturing firms with significant export markets or reliance on imports were generally well prepared and in a position to sit the strike out.

Although the national economic impact of a prolonged strike appears to have been minimal, the strikes have severe or even disastrous impacts on some small immediate port neighborhoods and businesses, and on many individuals. The halt in port activity adversely affected small truckers, importers and exporters whose livelihood depends on a steady flow of merchandise, small retail establishments featuring imported products, and many of the port-supporting groups such as restaurants and bars.

The most visible impact of a longshore strike is on the oceangoing fleet and its workers. The operating costs do not decrease substantially when a ship is tied up during a strike, so a per diem cost of over $5000 per vessel is lost, and at the peak of the 1969 strike, 650 vessels including 185 U.S. ships were tied up in ports. Some of the costs are made up before and after the strike by higher revenues from greater ship utilization.

Overview of Strike Impact

Based on the findings of the Task Force, many government officials feel that in longshore disputes, as in strikes in other industries, the status of a national emergency rarely actually exists, because most critical trade is maintained during the strike, and substitute products may be used, or cargo may be diverted to open ports. The rising level of government action has resulted in quicker and less costly shutdowns, but there has been less satisfaction among the parties to the dispute.

The Task Force study was conducted during the first year of the Nixon administration, and partly based on the report, no requests were made for Taft-Hartley injunctions for almost three years, until October 1971, when an injunction was granted requiring the West Coast longshoremen to return to work, but only after they had been out on strike for over three months. On the East Coast, rather than use the injunction immediately after the contract expiration, the administration allowed the strike to continue for almost two months, partly based on the employers' statements that due to pre-strike stockpiling, a national emergency would not result, at least in the early days of the strike, so the employers and union should be free to bargain without government action. The New York employers felt that due primarily to the abuses in the system by which the dock workers received a guaranteed income, they should not continue operations under the former contract terms, but be permitted to continue bargaining on such items. The President requested an injunction in October also to force Chicago grain elevator operators, who were ILA members, to return to work, but a federal judge denied the injunction because their strike did not imperil the national health or safety and because it was not industry-wide. It was the first decision of a U.S. District Court denying an injunction under the Taft-Hartley Act.

The report of the Task Force has been widely criticized since it was announced, but especially during the 1971-1972 strikes, when an end to the shutdowns was sought through public and political pressure by enactment of special legislation. One of the most common criticisms is that the Task Force performed only a statistical exercise which brushed aside as side-effects the strike costs felt by people, jobs and businesses.

The report did not attempt to explicitly measure the effect of the strike on national health and safety but only as these aspects are intertwined with the national economy, since one of its major goals was to determine whether the strikes could be considered true national emergencies.

1971-1972 Strikes

It is not possible to accurately determine the costs of a major strike until some time after the strike is completely settled, when a better perspective can be obtained. One criticism of the Task Force study is that it is difficult for a study completed less than a year after a strike is over to conclude with any degree of finality that the "long-run impact" is "small".

Some figures are unquestionable, such as the number of ships idle at struck piers, but other numbers related to the recent dock strikes, such as daily state-wide losses and total value of permanently lost foreign markets, can be questioned at this time. The 1969 study was a useful corrective for some such exaggerated notions concerning strike costs.

The major differences between the strikes of 1971-1972 and the ones of the years before are the fact that the West Coast, which had not been shut down in over twenty years, was also out on strike--for a while at the same time as the East Coast--and the fact that the President waited eight weeks before imposing a Taft-Hartley injunction on the ILA-struck docks. The ILWU was on strike for 100 days before returning to work under injunction, and they struck again in January and

February of 1972 for five weeks, amounting to the longest dock strike in U.S. history. The two unions were on strike at the same time only during the first eight days of October, 1971, but even at that time not all ports in the U.S. were closed to cargo traffic. The ILA-represented dockworkers in the ports of the West Gulf Coast agreed with employers to extend the expiration date of the former contract from September 30 to November 14, the expiration date of the Wage/Price Freeze.

At the peak of the East and Gulf Coasts strike, there were approximately 240 ships idle at their piers, but trade was not hurt nearly as much as it might have been due to the pre-strike stockpiling, the failure of the ILA to maintain a complete shutdown of all affected ports, and the success of several port employer associations in obtaining return to work injunctions against their employees under secondary boycott rulings.

West Coast Dispute

Although it is too soon to determine the total cost of the West Coast strike, there are many figures available pertaining to the 100 days of the strike from July 1 until October 9, 1971, released by the President.

When the former five-year contract expired, the ILWU went out on strike in July after eight months of negotiating for a new contract. Although there had not been such a strike on the West Coast in over 22 years, the strike was not totally unexpected by West Coast shippers. Also, the ILWU permitted military and emergency relief cargo to be moved uninterrupted, allowed grain elevators to operate at capacity, and serviced passenger ships. The ports of Vancouver, British Columbia, and Ensenada, Mexico, remained open to many ships diverted from struck ports.

During the strike, though, there were 46 U.S. ships and 203 foreign flag ships immobilized. It is estimated that American exports would have been $600 million higher during the 100 day period except for the work stoppage. Farm exports from the West Coast dropped from $288 million for the June-September period of 1970 to $73 million for the same period in 1971. It is thought that the wheat farmers suffered the worst of all, as their sales to major Far Eastern markets fell off drastically. Japan, for instance, purchases over 50% of its wheat from the United States, and in the last 8 months of 1971 the U.S. lost sales to Japan of at least 25 million bushels of wheat valued at $40 million. In January of 1972, soon after the West Coast strike resumed, the Japanese purchased 8.7 million bushels of wheat for a spring delivery, but only 1.6 million bushels were bought from the U.S.

CHAPTER VI

FEDERAL LEGISLATION PERTAINING TO LONGSHORE STRIKES

At the present time the Federal Government is fairly limited in the degree of power that it can exert upon unions and their employer counterparts during contract negotiations and strikes to protect the interests of the general public. It is not the desire of the government to completely control the bargaining process, for industrial relations are jeopardized in proportion to the level of contraints. However, in certain industries, such as in longshoring and other transportation industries, the economic and social costs of a strike can be so large that some limits must be imposed upon the negotiating parties.

The Taft-Hartley Act, or the Labor Management Relations Act (LMRA) of 1947, is the sole legislation now used in disputes arising in the longshore industry. Chapter 2 reports the case of the application of the Taft-Hartley provisions in the longshore strikes of 1971-72, the reasoning expressed by the government to justify its use, and the resulting action of and effect on the various parties to the disputes. Chapter 4 deals more with an analysis of the cost of such strikes and a determination of whether a national emergency usually exists in such situations.

Emergency Strikes

Strikes of such a proportion as to justify government intervention to avert or settle them are ones that cause serious economic damage, or result in a national emergency. Strikes that effect a major part of the longshore industry are usually considered as national emergency proportions, as are those in the maritime, steel, trucking, coal, aircraft, and railroad industries.

An "emergency" strike is usually considered to be one that causes dangerous curtailment of a necessary service, but such a definition provides too much opportunity for subjective argument. The Railway Labor Act defines an emergency dispute to be one which, in the judgment of the National Mediation Board "threaten(s) substantially to interrupt interstate commerce to a degree such as to deprive any section of the country of essential transportation service," and presently applies to the rail and air transportation industries. As defined in the LMRA, an emergency dispute is "a threatened or actual strike or lockout affecting an entire industry or substantial part thereof, engaged in interstate commerce or in production of goods for commerce, which will, in the opinion of the President, if permitted to occur or continue, imperil the national health or safety."

The emergency dispute provisions of the Taft-Hartley Act have now been invoked thirty-one times since the law originated. Thirteen of these cases involved direct defense industries: atomic energy, aerospace aircraft and aircraft engines, and shipbuilding; another twelve involved longshoring or merchant shipping; and the other six involved bituminous coal, basic steel, telephone service, and meat packing.

A common feature of all such disputes is that they generate political pressure. If the dispute has high visibility, either because it causes widespread inconvenience or because there is a dramatic potential for claiming danger to public health or safety, pressure will inevitably build for government intervention. The longshore strikes have been found to cause limited economic hardships, yet they cause inconvenience among the public. In addition the strikes are so visible and dramatic that strike costs can easily be blown out of proportion. The appeal for government intervention marks a shift of the dispute from the economic to the political arena.

Present Settlement Mechanics

The Taft-Hartley Act provides a special procedure for the President to use when he feels that a present or threatened strike imperils the national health or safety. In such cases the President, after preliminary investigation by a board of inquiry, may ask the Attorney General to seek an injunction against the strike. If the injunction is granted, strike action becomes unlawful for an eighty day period during which the parties may continue to negotiate. If no agreement is reached by the end of the period, the injunction is dissolved and the strike may proceed.

The board of inquiry is a purely investigative body. It issues a report of its findings before an injunction may be sought, and again after the injunction has been in effect for sixty days. The second report includes a final offer submitted by the employers and offered to the union members for possible acceptance. The board is not permitted to recommend terms of a settlement. It is felt that neither party is thus tempted to delay an agreement in the hope that the board's recommendations will strengthen its hand.

The report tends to focus public opinion, generate pressure on both parties to accept terms recommended by mediation, and lays a foundation for such further executive action as may be required.

The Taft-Hartley Act in the twenty-five years of its existence has not been considered to be an ideal solution to the problem that it is used to attack, but no other, let alone better, legislation has yet been passed. There are many new proposals now being considered by Congress, and they will be discussed later in this chapter.

As has been mentioned, the Taft-Hartley injunction may only be used in strikes of national emergency proportions. Whether a strike causes enough economic damage or adversely affects a large enough part of the populace are decisions that must be made by the courts that grant the injunctions.

Other criticisms of the present law deal with the effectiveness of the eighty-day injunctions, the influence upon the negotiations, the effect on the employer's and union's positions, and the limits on the law once the injunction expires.

The primary reason that new legislation is being proposed is the fact that the eighty-day injunction, essentially the sole element of controlling the public costs of a major strike, has not been successful in bringing about an end to disagreements.

The Taft-Hartley procedures have now been used twenty times in strikes that had already begun, and the other eleven times to divert threatened strikes. Four disputes were settled before an injunction was issued. Fourteen of the remaining twenty-seven were settled within the eighty-day "cooling-off" period, but the other thirteen were settled after the injunctions expired. Of those settled after the cooling-off period, five were settled without a strike, while eight ended only after further walkouts of varying duration. Seven of the eight strikes occurred in the longshore industry; the other one was in another sector of the maritime industry.

The history of the Taft-Hartley Act shows that its provisions seem to work fairly adequately, except for in longshoring. It can be accredited with preventing many potential work stoppages, some of which could have had a deleterious effect on the health and safety of the country.

The degree of unrest in the longshore industry and the apparent weaknesses of the injunction procedures upon strikes by dockworkers have been highlighted in Chapter 4.

<u>Temporary Strike Legislation - 1972</u>

Although the present labor laws are considered by most people to be insufficient in providing curbs on strikes that are of national emergency proportions, because of the limited scope offered to the government, new legislation has not yet been acted upon. Consequently, the President had no power in the longshore strikes of 1971-1972 once the eighty-day injunctions expired. The only course of action left to the President to legally intervene in the disputes was to request special temporary legislation from the Congress, as President Nixon did in January 1972, for the case of the ILWU-PMA dispute.

As has already been stated, the present laws restricting strike actions in collective bargaining situations are limited in the powers that it grants to the executive branch of the government. Several times the Congress has felt it necessary to act upon legislation to constrain the effect of particular strikes, but not in the longshore industry. A major reason for passing a law that is less limiting than the present Taft-Hartley Act is to avoid leaving final action on individual disputes, such as in the case of the ILWU, to the Congress. A great deal of time is necessary for the members of Congress to acquaint themselves with the details of contract negotiations.

After the Taft-Hartley injunction requiring the ILWU to return to work on October 9, 1971, expired on December 25, the union and the employer association agreed to continue working and negotiating voluntarily until at least January 17, 1972. On January 17, when the negotiators failed to conclude agreements on all contract items, the ILWU again called its members out on strike. On January 21, the President requested special legislation from Congress that would settle all terms. The President cited the strike as being threatening to the Nation's health and safety, and the parties to the negotiations as insensitive to the harm inflicted upon others not connected to the walkouts.

The President proposed special legislation to establish a three-member arbitration board, appointed by the Secretary of Labor, which would hear and settle all issues in the ILWU-PMA dispute. During the time that the arbitration board was making its determinations no strike or lockout would be permitted, and the decision, to be reached within forty days of enactment of the legislation, would be binding upon the parties for a definite period of time of at least eighteen months.

To justify the special legislation, the President referred to the economic effects of the West Coast longshore strike, as outlined in Chapter 4. He does believe that government intervention is not generally a satisfactory method of resolving labor disputes. However, under the circumstances of the ILWU strike, he felt that there was no other alternative. In over a year of negotiations the PMA and the ILWU had been unable to reach agreement, even with the assistance of the Director of the Federal Mediation and Conciliation Service.

The special legislation included Teamsters locals in ports on the West Coast, Hawaii, and Alaska as subject to the resolution as well as the ILWU and employers. The arbitration board was to make the final decision on all contract terms, plus settle the jurisdictional disputes. Even items already agreed upon by the PMA and the ILWU were to be decided by the board, since no terms of a contract are final in bargaining until the total contract is settled.

The board's decision was to be final and total to the point that it would not be reviewed by the Pay Board.

Results of Special Legislation

The President's legislative proposal provided that the Secretary of Labor might terminate the procedures of the resolution before issuance of a determination by the arbitration board if he found that all the labor organizations and employers involved in the dispute had reached complete agreement on all the issues. Based on this provision, the special legislation was not used, since it was not passed by the Congress and signed by the President until February 11, and the ILWU and the PMA announced that they had reached agreement on February 8 on all major items, and that any remaining unresolved items would be left to arbitration.

Thus, the special legislation enacted on account of the national emergency that resulted due to the West Coast longshore dispute was not used, but it no doubt influenced the negotiations. The threat of the special legislation affected the discussions concerning contract strikes of major proportions and protection of the national interest while at the same time not jeopardizing labor-industry relations through too great a level of government intervention.

The PMA, representing the West Coast employers, supported the administration's efforts to have the temporary legislation enacted. The PMA in testimony before the Congress, cited the fact that 90 bargaining sessions during 15 months had been unsuccessful in producing an agreement. The PMA felt that compulsory arbitration would not destroy free collective bargaining, but that the availability of a tribunal to settle the dispute would be essential to the free collective bargaining system.[1] The employers urged passage as a substitute for collective bargaining because of the union's imposition of "widespread financial and human disasters upon helpless third parties that have been fomented by this dispute."

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1. Daily Labor Report, February 4, 1972, p. 6-3.

The ILWU, represented by Harry Bridges at the Congressional hearings, bitterly opposed compulsory arbitration, but offered to enter into voluntary arbitration on the money issues remaining as of February 4, 1972. Bridges stated that compulsory arbitration legislation would likely not be obeyed by the dockworkers, possibly through use of a work slowdown, and that dockworkers in other parts of the world might act in support of the ILWU's demands.

Compulsory Arbitration

The use of compulsory arbitration as a means of settling a labor dispute is usually not desirable, since although a solution is reached for a present problem, the solution is generally temporary and sometimes results in an overall damaging effect. It is difficult for the union and employers to live peacefully with a settlement which they did not decide upon through agreement.

Compulsory arbitration is not a frequently suggested option in the permanent legislation proposed to deal with national emergency disputes in the transportation industry. When compulsory arbitration is a likely tool to be used by the government in a negotiation impasse, the positions of the parties generally stay at extreme distances from common ground. The general expectation is that the arbitrator tends to split the difference between the parties, so most bargainers are tempted to build a case for their own positions, rather than endeavor to bargain out a settlement. It thus tends to supplant and eliminate any genuine bargaining. Compulsory arbitration is a legal procedure, or a special kind of court trial. The outcome of this or any such trail is a victory. The outcome of bargaining is an agreement.

The President did not feel that the options of his proposed permanent legislation (to be discussed later in this chapter) could be effectively used in the ILWU-PMA case since these options were not available and visible throughout the whole period of negotiations.

Legislation Proposed To Deal With Emergency Disputes

The Taft-Hartley Act and the Railway Labor Act, which deals only with rail and air transport disputes, have been found to be inadequate to control the problem of major strikes. It is inherently difficult to draft legislation which deals with labor-management dispute situations, because the two major objectives of shaping approaches to emergency labor disputes, as outlined by the President, are mutually inconsistent. The first objective is that the health and safety of the nation should be protected against damaging work stoppages. The second is that collective bargaining should be as free as possible from government interference.

Past and present legislation has attempted to balance partial achievement of both objectives and to maximize the total outcome. In some industries, it is felt that the public interest has not been protected well enough and that more restrictions should be put upon the privileges of parties to negotiations. The longshore industry has been the outstanding example used to show abuse of the public well-being and weaknesses in the present laws. Most suggestions for new legislation concern all major parts of the transportation industry, though, including railroads, airlines, seafaring, longshore, and trucking.

The primary legislation now before Congress is that drafted by the executive branch and first submitted to Congress on February 27, 1970, under the title "Emergency Public Interest Protection Act of 1970." The bill was again submitted on February 3, 1971, to the new session of Congress, and then renamed "The Crippling Strikes Prevention Act" on January 21, 1972, by the President. There are in addition more than a dozen other legislative proposals before both houses of the Congress dealing with similar matters. These bills vary in scope, applicability, and options for settling strikes.

In the bill supported by the President, it is recommended that the emergency strike provisions of the Railway Labor Act be discontinued and that railroad and airline strikes and lockouts be subject to a new law which draws upon the experience of the Taft-Hartley Act. The Railway Labor Act is generally considered to discourage genuine bargaining. Since its passage 45 years ago, the emergency provisions have been invoked 180 times, and work stoppages at the end of the sixty-day return-to-work period have occurred at a rate of more than one per year since 1947.

The primary proposal is to broaden the President's options at the point in the dispute when the eighty-day injunction expires. At present there are no options available to the President at this point in the dispute other than to request special temporary legislation as President Nixon did in 1972.

The most commonly proposed program is to offer several options, or an "arsenal of weapons," of which the President can choose only one, if at the end of the regular Taft-Hartley injunction the dispute has not been settled and another strike or lockout is likely. The President has proposed three options: extension of the injunction for a period of up to 30 days; partial operation of the troubled industry; or invocation of the procedure of "final offer selection." Other proposed options are compulsory arbitration, seizure, and indefinite extension of the injunction.

An extension of the injunction for a short period of time would be most attractive if the President believed the dispute was very close to settlement, but would likely not be used very often if the President is limited to a choice of just one of the prescribed alternatives.

Under partial operation the major part of the lockout or strike would be allowed to continue, but essential segments of the industry crucial to the national health or safety would remain in operation for a period of up to six months. The practical problems of implementing this proposal are enormous and difficult to manage fairly by any board. The longshore strikes have usually continued in partial operation, permitting military and other critical cargo to be handled by the dockworkers, but a larger part of the operation would certainly be maintained under this proposal.

Under the "final offer selection" procedure, each of the parties would be given three days to submit either one or two final offers to the Secretary of Labor, and each offer submitted "must constitute a complete collective bargaining agreement and resolve all of the issues involved in the dispute." The parties would then have an additional five days to meet and bargain over these final proposals for settlement. If no agreement emerged from those meetings, a final offer selection group of three neutral members would be appointed by the disputants or, if they could not agree on its membership, by the President. This group would choose one of the final offers as the final and binding settlement.

The selection of the final offers would be made after formal hearings had been held, but the board would be explicitely forbidden to modify any of the submitted terms or to attempt any form of mediation.

The "final offer selection" is an essentially untried method of settling major disputes. It would guarantee a conclusive settlement without a dangerous work stoppage, but, unlike arbitration, it would also likely provide a strong incentive for labor and management to reach their own accommodation at an earlier stage in the bargaining, by encouraging the disputants to come together toward more reasonable and realistic final offers. In short, while the present prospect of government arbitration tends to widen the gap between bargaining positions and thus invite intervention, the possibility of final offer selection would work to narrow that gap and make the need for intervention less likely.

The final offer procedure was not requested by the President in the temporary legislation sought to halt the ILWU strike in January 1972, because it was not an alternative available to the President and visible to the union and the management association during the total time of the negotations.

The practical effect of plant or industry seizure depands on what the government does during the seizure period. Unfortunately it has been shown that both management and labor have often benefited economically from seizure, while the public footed the bill.[2] That situation leaves little incentive to resolve hard issues.

Extending the work injunction indefinitely is essentially requiring mediation to finality, which is much the same as compulsory arbitration, which has been previously discussed.

In the longshore industry especially there is no "final solution" to the problem of free collective bargaining and protection of the national health and safety. Although there are many shortcomings in our present statutory procedures, the number of disputes in the general economy causing serious disruptions in operations and services essential to the health and safety of significant numbers of teh population has been minimal. However, special legislation, or a commission for the purpose of developing agreed plans for eliminating or minimizing the danger of strikes or lockouts might be established specifically for the longshore industry.

The atmosphere is ripe for new legislation restricting unions and union activities. There has been in the past several years a sharp increase in the rate of price inflation, and an increase in strike activity; moreover, it has been over twenty years since such legislation has been emended. The Wage/Price procedures of the Economic Stabilization Act, though, might be sufficient to placate the need for new legislation.

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2. Balckman, Presidential Seizure in Labor Disputes, 1967.

CHAPTER VII

CONCLUSION

This report has studied the longshore industry in its present state, the actions related to the recent contract negotiations and strikes, and the impact of longshore strikes on the economy, as well as analyzed alternatives in the form of mergers or new federal legislation that are highly relevent to the longshore industry at this time.

The past twelve month period, beginning in the spring of 1971, has been an especially unique period of time for the longshore industry, and will no doubt stand out in the years to come as somewhat of a turning point, particularly for the two unions. Major points are notable at this time:

1) Incomplete control by the national ILA of all strike and collective bargaining activity in the ports of the East and Gulf Coasts.

2) Settlement in the Port of New York, including the Prior Day Order method of hiring, that has resulted in a substantial decrease in the local tonnage assessment rate, and will lower cargo handling costs, adding to New York's competitive position.

3) The ILWU's strike, their first major one in over twenty-three years, lasting 134 days and resulting in government action in the form of an injunction requiring a temporary return-to-work and special temporary legislation passed by Congress.

4) The ILWU's abandonment of former peaceful negotiating techniques and provisions for a new contract similar to the one that has evolved on the East Coast, which is more restrictive towards mechanization and jurisdictional encroachments, and not as heavily pension-oriented.

5) The ILA and ILWU were both negotiating new contracts in 1971, and for a short while, they were both out on strike at the same time, shutting down most of the major U.S. ports.

6) Discussion and action between the two longshore unions concerning a possible merger, the first such serious steps since the ILWU split from the ILA in 1937.

7) The possible merger between the ILWU and the Teamsters as a means of settling the jurisdictional dispute which had resulted in bad industrial relations over some of the dock area cargo handling.

8) Concern for an increasing amount of U.S. cargo being handled through Canadian ports and the reasons for such diversions.

9) Special temporary legislative action taken by the Congress to halt the 134 day West Coast strike in an attempt to protect the overall public interest.

10) Hearings and discussions by Congress concerning possible new permanent legislation to provide more effective means for protecting the public interest in national emergency disputes involving the transportation industry.

The events related to the longshore industry this past year have been dramatic and significant in their impact, but it appears that their consequences on a longer-range time scale will be minor compared to the temporary impact. The jurisdictional problem on the West Coast is temporarily placated, so the ILWU and the Teamsters are not as motivated to merge. The ILA and ILWU have settled on agreements of different lengths, and the termination dates of the new contracts are far enough apart that the unified bargaining power that would be one of the major causes and benefits of a merger would not be very effective.

New emergency dispute legislation is likely to be passed in the next few years because of the weaknesses in the present laws, but it is doubtful that new legislation will be passed during this year of Congress, partly due to the 1972 elections. After this year, the impact of the recent problems in the longshore industry will have decreasing influence upon such legislative action.

The coming years will bring changes to the longshore industry. The public and the government are not likely to stand for a dispute again of the proportions that took place in 1971-1972, and the unions will not both be bargaining for new contracts at the same time for at least several years. The ILWU strike was extremely costly compared to the peaceful negotiations of former years, but it is not an action that the union can afford very often. The atmosphere surrounding the dispute on the East and Gulf Coasts was actually more peaceful and less costly than those before, as the ILA and the management associations have attempted to stabilize relations.

The unions have been fighting the job cut-backs due to mechanization and general decreases in tonnage handled, attempting to provide security in the jobs of the men who have been on the docks and the unions for many years. Mechanization advances have caused a substantial increase in longshore productivity over the past ten years, but the gains in productivity will not keep up at such a high rate. Maritime activities have in general been quite low in the past few years, due to a low in economic activity, resulting in a lower amount of manhours available to the dockworkers. This decrease will not continue, so that the longshore will not be as active in fighting for positions they fear they will lose.

The two primary dock leaders, Harry Bridges of the ILWU and Teddy Gleason of the ILA are both over seventy years old, and likely to retire in the next few years, probably at the time of the next union conventions. The change in union leadership will provide the opportunity for hopefully improving industrial relations with the employers while at the same time maintaining the needs of the union members.

APPENDIX

SUMMARY OF WEST COAST DOCK CONTRACT

February 1972

International Longshoremen's and Warehousemen's Union

and

Pacific Maritime Association

Source: The Dispatcher
February 11, 1972

DISPATCHER Page 4 February 11, 1972

DISPATCHER Supplement

Summary of Dock Contract

The following is a summary of the changes and improvements in the Pacific Coast Longshore and Clerks Agreement. For your convenience the summary is divided into two sections: (1) Economic issues; (2) Non-Economic issues. The Coast Negotiating Committee is recommending a "YES" vote to the Coast Caucus.

I. ECONOMIC ISSUES

1. WAGES

LONGSHORE

	PER HOUR Straight Time	Over-Time
Effective December 25, 1971 72c per hour increase	$5.00	$ 7.50
Effective 8 a.m. July 1, 1972 40c per hour increase	$5.40	$ 8.10
For longshoremen historically on an 8-hour basis, straight time, the increase will be	.81	Dec. 25, 1971
	.45	July 1, 1972

CLERKS

	Straight Time	Over-Time
Base Rate, 81c per hour increase effective December 25, 1971	$5.625	$ 8.44
Clerk Supervisors effective December 25, 1971	$6.19	$ 9.285
Chief Supervisors/Supercargoes effective December 25, 1971	$6.87	$10.305
Container Freight Station Parity		
Wages in CFS shall be brought up to parity. Effective Dec. 25, 1971, a wage increase of $1.125 per hour	$5.625	$ 8.44
Effective July 1, 1972, an increase of $1.5725 per hour	$6.075	$ 9.11
Supervisory clerk, 12/25/71 (CFS)	$6.19	$ 9.285
7/1/72	$6.68	$10.07

CFS Shift differentials remain unchanged

2. SKILL RATES

15c per hour rates increased to 25c
20c per hour rates increased to 35c
30c per hour rates increased to 50c
40c per hour rates increased to 70c
All increases in skill rates effective upon ratification.

In the closing hours of negotiations, the employers moved away from their position that the second wage increase would be effective October 1, 1972, and mainly to meet union's demand for retroactivity agreed with the union position that the effective date of the wage increase would be July 1, 1972.

The first increase is retroactive to December 25, 1971 and the second increase will be effective in about five months (July 1, 1972).

In the closing hours of negotiations the union's demands on skill rates were met. The increase in skill rates is an additional increase for approximately 28 percent of the longshore workforce. During the life of this agreement this percentage will increase substantially.

3. MEAL ALLOWANCE

Meal allowance is increased from $2 to $3 per meal for longshoremen and clerks.

4. LODGING

Lodging for longshoremen is increased from $5 per night to $8. For clerks, the increase is from $6.50 to $9.50.

5. GUARANTEE

For A men: 36 hours at the straight time rate
For B men: 18 hours at the straight time rate
(Averaged over a 26-week period)

Eligibility. Eighty percent of average hours. No rules to prevent A-men from working all they wish. Rules to prevent gimmicking to be negotiated or arbitrated.

Liability. $5,200,000 liability per year of the contract.

The employers provide $100,000 per week for a total of $5.2 million per year, and in the event there are insufficient funds because of technological change resulting in lost work opportunity to pay the guarantee at any time during the life of the contract, the union has the right to arbitrate the issue. The arbitrator has the right to increase the employer's maximum liability where lack of work is due to technological improvements.

Container tax funds are applied against the cost of the guarantee, and if any tax funds remain, these funds will be applied against the unfunded liability of the pension plans.

The employer proposal for a 52-week average was reduced to a 26-week average. This reduces the possibility of high earnings in a peak period causing a reduction of guarantees in a slow period. All guarantee hours for B men will apply toward welfare.

Complete rules and regulations on the guarantee will have to be worked out within 10 days, and if no agreement is reached the rules will go to coastwise arbitration.

6. CONTAINERS

All containers stuffed or stripped within a 50-mile zone in each port shall be stuffed or stripped by ILWU longshoremen or taxed $1 per long ton (2,240 pounds).

Except:

(1) Those containers stuffed or stripped at retail or wholesale warehouses, factories or processing plants;
(2) Household goods stuffed or stripped by a moving company;
(3) Containers moving in the coastwise or intercoastal trade;
(4) Containers stuffed or stripped in the "store door" method in the domestic trade. Domestic trade includes intercoastal, West Coast of the continental United States including Alaska, Hawaii, Guam, Puerto Rico, and any other U.S. insular possession.

All containers originating outside of, or delivered outside of the 50-mile zone are not taxed.

Sea Land containers not stuffed or stripped by longshoremen, not covered by other exceptions, shall be taxed at $1 per long ton rate.

The provisions of these amendments to the CFS Supplement are intended to protect and preserve the established work of employees covered by the ILWU/PMA Pacific Coast Longshore and Clerks Agreement at docks or areas adjacent thereto.

7. WELFARE

All improved welfare benefits will become effective not later than one month after date of ratification of the agreement.

(a) Hospital and medical benefits in small ports will be brought up to a level or as close as possible to major port plans.
(b) Prescription Drugs. Prescription drugs (Kaiser Plan IV or comparable) for welfare eligible retirees, eligible employees and dependents, subject to a $1 deductible for each prescription.
(c) Dental Program. Dental care for eligible men and for dependents based on 73% of the agreed schedule.
(d) M&M Deficit. The employers agreed that approximately $800,000 would be paid out to those who did not receive full M&M death and disability benefits.

8. LIFE INSURANCE

$10,000 life insurance, $10,000 Accidental D&D to fully registered longshoremen and clerks with five years of qualifying time, and whose survivors are not eligible for any pension on date of death.

9. INDEMNITY

Longshoremen and clerks who were eligible for welfare benefits injured in the course of their work, will receive the difference between workmen's compensation and $125 per week. Rules will be established within 30 days of ratification.

10. PAID HOLIDAYS

The union receded from its demands for paid holidays as part of the negotiating package.

11. PENSIONS

There is agreement on the following:

$500 benefit from age 62 to 65 with 25 years of service

Basic benefit is $350 per month with a bridge of $150 per month from age 62-65. The basic benefit ($350) continues after age 65

New disability and pro-rata benefits to be based on the $350 basic benefit.

Early Retirement

Early retirement provisions at age 59 with 25 years of service with an actuarially reduced basic benefit and bridge otherwise payable at age 62. Early retirement benefits would be as follows, and include welfare coverage:

AGE	BASIC BENEFIT	BRIDGE	TOTAL
62	$350.00	$150.00	$500.00
61	317.59	108.52	426.11
60	289.00	83.78	372.78
59	263.70	67.40	331.00

At age 55, with 25 years of service, men may retire with the basic $350 deferred until age 65, or with an immediate pension having an actuarial reduced value equal to the amount of the basic benefit payable at age 65.

Men may leave the industry at age 55 with 13 to 24 years of service with pension benefits accrued to date, and payment deferred until age 65.

Compulsory retirement is reduced from age 68 to 65, effective January 1, 1972.

Present pensioners who retired prior to July 1, 1966 will receive a basic benefit of $300 effective July 1, 1971; and those who retired between June 30, 1966 and July 1, 1971 will receive the $300 benefit 63 months after date of retirement.

PAY BOARD APPROVAL OF ECONOMIC ITEMS

In the event that the Wage and Price Board approvals are not granted within 30 days after filing of applications, either party may give notice of cancellation and the proposed contract and local agreements shall expire and the union shall be free to take such action, including strike action, as may be necessary to force implementation of the proposed agreement.

II. NON-ECONOMIC ISSUES

9.43

The union wrote into the contract the provisions of Caucus Resolution No. 9-4, which provides that steady skilled men cannot operate winches or fork lifts up to 5-ton capacity, except to fill out the 8-hour guarantee and to move equipment around incidental to their other duties.

Equalization of hours and methods of dispatching shall be worked out at the local level, or settled by coast arbitrator no later than five days after adjournment of the coast caucus, providing coast caucus recommends approval of the entire settlement.

Clerks Demands

Following clerk demands were agreed to:

1) Safety and first aid training provided to supervisors and supercargoes who wish to qualify, subject to negotiating at the local level.

2) The union is submitting a list of locations where shelters are required for clerks. If an agreement cannot be reached, the matter is referred to the coast arbitrator.

3) Supercargoes. At those locations and under those conditions where a PMA vessel is required to employ a supercargo, a nonmember vessel will not be worked by a PMA member unless the nonmember vessel employs a supercargo.

The following items are settled as indicated:

1. Travel Time. The employers have the right to request further discussion on the subject of existing travel time and pay.
2. All PMA lawsuits against the ILWU and any of its locals, and all lawsuits of the ILWU and any of its locals against the PMA, are dropped.

Items Referred to Mediation/Arbitration

If the Parties are unable to resolve by February 11, 1972, the following items by further negotiation or mediation, they shall be submitted for resolution to the Coast Arbitrator whose decision shall be final and binding:

ILWU	PMA
HOURS	
Elimination of all extended shifts.	Present shifts. Extended hours to continue in effect. Allow men to be ordered for lashing, lining, store, baggage, to work beyond existing hours.
GRIEVANCE MACHINERY	
Revised to provide for quick settlement of on-job discharge, define assault, no penalty on union officials, time limit on length of time on non-dispatch list.	Deregistration for bad conduct on work; additional penalties for certain offenses. Expedite grievance machinery.
STOP-WORK MEETING	
Same as present.	One meeting per month between 7 p.m. and 3 a.m. Other meetings by mutual agreement on one week's notice, no more than one special stop-work meeting a month.
HIGH PILING	
Same as present.	Eliminate sling load limits. Allow teamster to high-pile two-high and to break down piles not exceeding 12 feet.
SCOPE OF WORK	
Contract to apply on certain industrial docks. Limit teamster unloading trucks on dock. Log assembly by longshoremen.	Same as present.
MANNING	
Lash-Bolts-Sanfloo: East Coast manning to be negotiated by the Coast Negotiating Committee.	PMA disagrees. However, there is agreement on eliminating T-letter procedure.
CLERKS JURISDICTION	
New tools and equipment to be manned by clerks and training provided by employer.	PMA disagreement. No substitute offered.

LOCAL NEGOTIATIONS

At the time the Dispatcher went to press the parties had not arrived at their respective positions regarding local negotiations.

ILWU	PMA
PENALTY-HEALTH-SAFETY	
New hazardous cargo list. Minimum standard for shippers, pallets, regulations, of use of special equipment — lifts, reefers, etc.	Subcommittee to work out differences in six months.
TRAINING	
All men trained in all categories.	Training as in present agreement.
CRANE SUPPLEMENT	
No gear men as crane operators. No extensions beyond 22 days.	No change as required in context of basic agreement.

10. PMA DEMANDS

ILWU	PMA
a) Union demands all nonmember contributions be accepted.	a) Eliminate nonmember participation.
b) Union disagrees.	b) Protection against dispatch hall lawsuits.
c) Union disagrees.	c) Gear Priority
d) Union disagrees.	d) Skill Rate Application.

Referendum Procedure

Re: Veto Power on New Agreement

Any Pacific Coast longshore contract approved by the negotiating committee appointed by the Longshore and Clerks' Caucus shall not become effective until submitted to the longshore and clerks' rank and file for referendum.

The longshore and clerks' Pacific Coast membership shall be divided into voting units as follows:

Seattle	Local 19	1 unit
Portland	Local 8	1 unit
San Francisco	Local 10	1 unit
Wilmington	Local 13	1 unit
Clerks	Locals 34, 40, 52 and 63	1 unit
Small Ports:		
Oregon	Locals 4, 12, 21, 31, 49, 50, 53	1 unit
Washington	Locals 1, 7, 23, 24, 25, 27, 32, 47, 51	1 unit
California	Locals 14, 18, 29, 46, 54	1 unit

Any one voting unit as above shall be accorded veto power over the contract. If in any one unit a majority votes against the proposition, the vote shall kill the proposition.

If the proposition is vetoed a second coastwise referendum must be taken in which a two-thirds (2/3) majority must be cast to override a veto and ratify the supplement.

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PART 7

FINANCING OF U.S. SHIPPING

by

S. G. Buttner

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INTRODUCTION

Prior to 1960, the United States had historically maintained one of the most significant merchant fleets in the world. During the past 10 years, however, the U.S. flag fleet has declined in number and carrying capacity to the point where today less than 5% of all U.S.-foreign trade is carried in U.S. bottoms. This decline has been brought about largely by the relatively high cost of U.S. labor which severely affects the purchase cost of American-built ships as well as the cost of operating them. Both construction and operating costs have been government subsidized in the past for certain segments of the U.S. fleet. Even this, however, has not been an effective means of maintaining the size of our merchant marine. Recently, the 1970 Merchant Marine Act was passed which attempted to alleviate the problem. A ten-year program with the construction of thirty ships per year was planned and construction subsidy (CDS) as well as operating subsidy (ODS) was extended to the U.S.-flag bulk trade. Thus far, even this stimulus has been less than successful as witnessed by the large sums of CDS which remained unused after the first year of the construction program. There is evidence to suggest that this was brought about to a great extent by financing difficulties. The development of a modern U.S. fleet requires modern financing techniques and a thorough understanding of the important points of the government programs which aid U.S. companies in their financial affairs.

The problem addressed in this study is that of defining and developing the relevant decision areas with respect to the financing of vessels of U.S. shipping companies. To do this, first, the financial position of U.S. shipping companies is analyzed including the areas of corporate capital structure, liquidity, and profitability. Debt and equity instruments available to U.S. shipping companies are described as well as the tax environment in which these companies operate. Major Federal Programs relevant to vessel financing are covered which include TITLE XI Mortgage & Loan Insurance, Tax Deferred Reserve Funds, Operating Subsidy and Construction Subsidy. A frame work drawing together all pertinent factors is developed for making the vessel financing decision including the important technique of vessel leasing. It is hoped that this comprehensive study of financing alternatives for U.S. shipping companies will provide the necessary information and insights required by shipowners, bankers, and other financial institutions to overcome some of the financing problems encountered in the past.

CHAPTER I

FINANCIAL ANALYSIS OF U. S. SHIPPING COMPANIES

A. General Background

In beginning a study of the financing practices and alternatives of United States shipping companies, it is important to gain an overview of the financial position of the industry in general. To obtain this overview, the major financial statements issued by several companies in the industry are analyzed. Values from balance sheets and income statements are compiled and various important ratios are calculated from them. It must be recognized, however, that this type of analysis is open to several problems in that the values are obtained from records which result from business accounting practices. As such, they might not be entirely consistent among companies and their preparation is always subject to "creative" accounting. Nonetheless, this information is the best and most consistent available for the purpose of this chapter. The data, therefore, are analyzed more on a qualitative than a strictly quantitative basis.

Three basic areas will be covered: (1) debt measurement and leverage, (2) liquidity and (3) profitability. In each of these sections, time plots of appropriate ratios are used. The supporting data and calculations appear in the appendix to this chapter. Six data sets were obtained as listed below:

Maritime Administration Aggregate Data:

(1) All Subsidized Lines[1]

(2) Selected Non-Subsidized[2] Tanker Companies

(3) Selected Non-Subsidized Cargo Companies

Data from Annual Reports of Individual Companies:

(4) Company A - a subsidized cargo line

(5) Company B - a non-subsidized bulk company

(6) Company C - a non-subsidized bulk and cargo company

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[1]Subsidized Line: defined in the classical sense of a U.S. shipping company which receives direct operating differential subsidy. In addition, prior to 1971, these were the only companies who received construction differential subsidy.

[2]Non-Subsidized Company: these include all U.S. flag shipping companies which are not subsidized as defined above. However, these companies do receive, in many cases, indirect subsidies from preference cargo, protected domestic trade cargo and other sources

Before proceeding with the analysis, the data terms are specifically defined below followed by a sample balance sheet and income statement similar to those from which the data were obtained.

(1) Total Assets - the total book value of all valuable resources owned by the company. (equal to Total Liabilities)

(2) Current Assets - a subset of total assets which can or will be marketed or used in business within one year.

(3) Total Debt - Current liabilities plus long term debt plus other liabilities.

(4) Current Liabilities - a subset of total debt; considered a claim on the assets of the business which will be liquidated within a year.

(5) Long Term Debt - another subset of total debt usually made up of long term notes and bonds.

(6) Net Worth - considered owner's EQUITY; this type of liability is the owner's claim on the value of the business.

(7) Net Profit After Taxes - the yearly business profit after all expenses and payment of taxes.

(8) Revenue - defined here as vessel revenue resulting from ship operations (before expenses).

To make these terms more explicit, Figures I-1 and I-2 are examples of a balance sheet and income statement for a typical U. S. shipping company. Each term is referenced by a circled number.

Figure I-1

Typical Shipping Company Balance Sheet
(Simplified)

ASSETS		LIABILITIES	
2 Total Current Assets (cash, marketable securities, accounts receivable, etc.)	______	4 Total Current Liabilities (short term debt, current long term debt, accounts payable, etc.)	______
Fixed and Other Assets	______	5 Long Term Debt (all bonds and long term notes)	______
		Other Liabilities	______
		3 Total Debt	______
		6 Total Net Worth (Owner's equity stock and surplus)	______
1 TOTAL ASSETS	______	= TOTAL LIABILITIES	______

Figure I-2

Typical Shipping Company Income Statement (Simplified)

TOTAL REVENUE		
Voyage Revenue	________	
Interest & Other	________	
TOTAL		________
EXPENSES		
Voyage Expenses (less operating differential subsidy, if any)	________	
Overhead	________	
Depreciation	________	
Interest Payments	________	
Lease Payments	________	
TOTAL		________
Profit before Taxes (revenue-expenses)		________
Taxes		________
Profit after Taxes		________

B. Debt Measurement and Financial Leverage

The "liabilities" side of a balance sheet shows the claims on the assets of a business. These claims fall into two major categories: (1) debt which is characterized by funds invested in the business to which a constant rate of interest is paid for each debt category; (2) equity or net worth which consists of funds invested in the business by its "owners" who receive returns on their investment which vary with the profitability of the company. There are other liability forms which can be considered a hybrid of debt and equity and will be further discussed in Chapter II. In general, the relative balance between instruments of debt and equity is called capital structure. The make-up of capital structure has important implications on risk associate with the firm, rates of return, tax shelters, and credit availability. Therefore, it is an important consideration in decisions relating to financing and capital budgeting.

1. Capital Structure Ratio Plots: Figures I-3, I-4 and I-5 are time plots of important ratios to show the basic capital structure of selected U. S. shipping companies. The ratios shown are as follows:

Figure	Ratio	Explanation
I-3	Debt / Total Assets	This is a ratio which shows the proportion of the assets of the company claimed by debt. It is generally considered the measurement of a firm's "leverage".
I-4	Long Term Debt / Total Debt	This ratio further breaks down the debt portion of capital structure; it shows the extent to which the firm uses long-term financing of debt.

2. Analysis of Capital Structure Ratios: In general, the transportation industries are characterized by relatively high debt in their capital structures. The shipping industry is no exception, yet within itself there are marked variations. This is expecially true in comparing the subsidized to non-subsidized firms. For reasons mostly connected with government subsidy programs and resulting regulation, the subsidized lines show debt ratios considerably lower than non-subsidized firms. Referring now to Figure I-3, this fact becomes apparent. The non-subsidized lines (tankers and cargo) have an average Total Debt/Total Assets ratio of about .72 from the most recent data available. Subsidized lines, however, show about .49 for this same ratio, yet this has grown steadily over the past five years.

The case of the subsidized lines produces some interesting observations. Through various requirements, such as a minimum of 25% equity in each vessel and statutory reserve funds, these companies have been strongly influenced toward lower debt levels than might have come about without regulation. In the past several years, with the shrinking of reserve funds, higher vessel costs, and an imminent need to replace aging fleets, these companies are financing through the use of more debt. In addition, the Maritime Administration is acting less to influence their capital structure. The author expects this trend to continue in the future which might give rise to higher returns on investment through increased leverage, that is, assuming no drastic fluctuations in shipping demand and more management flexibility due to less government regulation. More will be said about returns later in the chapter.

As a basis of comparison, data were gathered on the capital structure of other businesses. First, five transportation companies were examined for the year 1970. This information appears in Table I-1. Second, several non-transportation industries' Debt/Equity ratios are listed in Table I-2 for 1968. It should be noted that Total Debt/Total Asset ratios

Fig. I-3
Total Debt/Total Assets for U.S. Shipping Companies

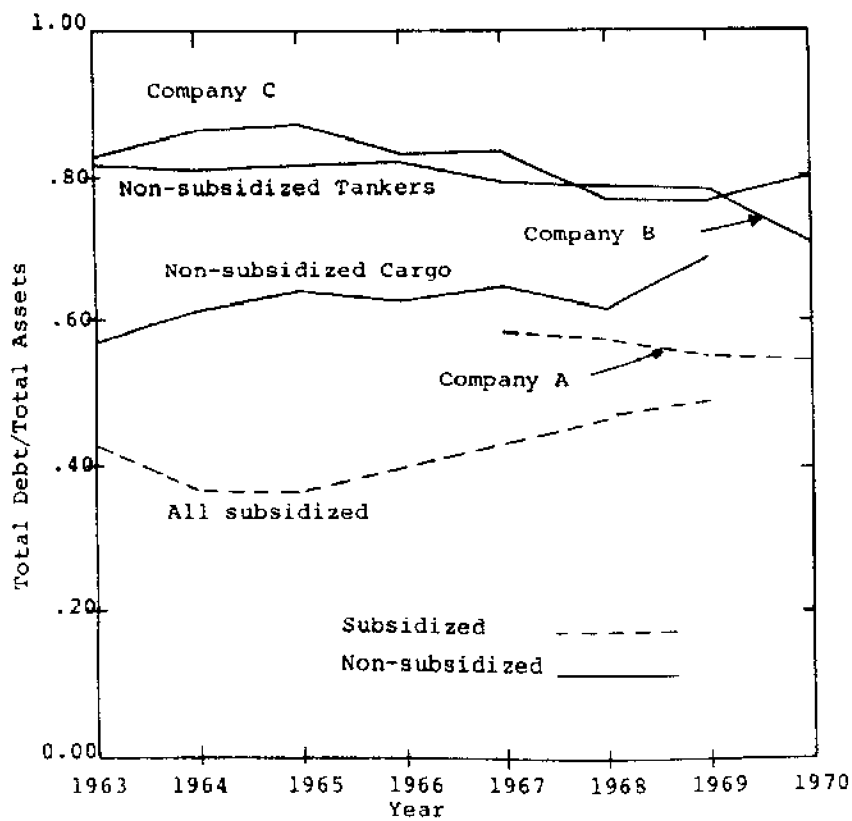


Fig. I-4
Total Debt/Equity for U.S. Shipping Companies

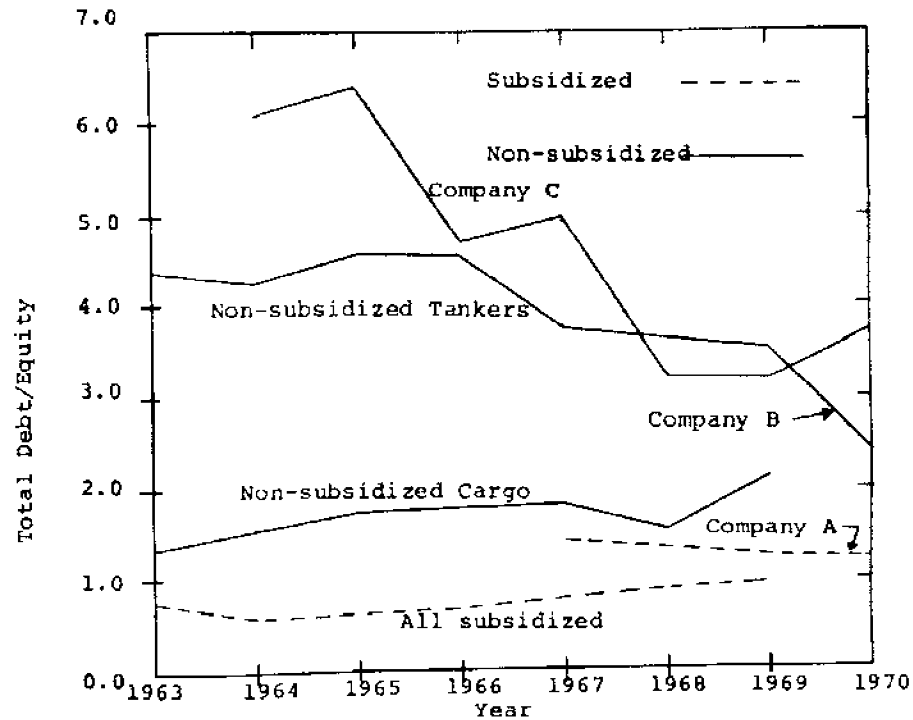


Table I-1

CAPITAL STRUCTURE RATIOS FOR SELECTED AIRLINE AND TRUCKING COMPANIES - 1970

COMPANY	TOTAL DEBT / TOTAL ASSETS	TOTAL DEBT / EQUITY	LONG-TERM DEBT / TOTAL DEBT
Airline "A"	.883	7.56	.722
Airline "B"	.775	3.22	.615
Airline "C"	.797	4.10	.772
Trucking "A"	.670	2.02	.493
Trucking "B"	.661	1.96	.593

SOURCE: See Appendix to Chapter I.

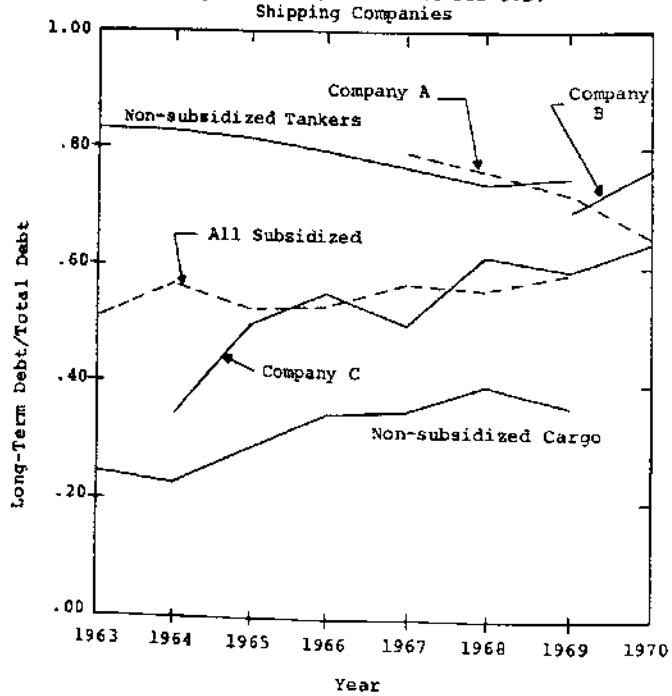
Table I-2

TOTAL DEBT/EQUITY RATIOS FOR SELECTED NON-TRANSPORTATION INDUSTRIES - 1968

INDUSTRY	TOTAL DEBT/EQUITY
Electronic Component Mfg.	.845
Electrical Contracting	1.04
Airplane Parts Mfg.	.853
Farm Machinery Mfg.	.877
Automotive Equipment Wholesaling	.99
Commercial Machines and Equipment Wholesaling	1.33
Motor Vehicle Retailing	1.69
Farm Equipment Retailing	1.67

SOURCE: Dun and Bradstreet's "Key Business Ratios in 125 Lines" - 1968

Fig. I-5
Long-Term Debt/Total Debt for U.S. Shipping Companies



for non-subsidized companies correspond closely to those calculated for sample airline and trucking companies. Again, subsidized lines show much lower Total Debt/Total Asset ratios. The same conclusion is reached by comparing Total Debt/Equity ratios from Figure I-4 and Table I-1. Examination of Total Debt/Equity ratios for non-transportation companies (Table I-2) reveals significantly lower use of debt for manufacturing firms than for non-subsidized shipping companies. The manufacturing firms are close to subsidized lines, however, in their use of debt.

A more theoretical treatment of optimal capital structure is presented in the next section, explaining what factors should be considered in making this decision. The major conclusion to be derived from the foregoing analysis is that Total Debt/Total Assets and Total Debt/Equity ratios for subsidized lines are well below other transportation industry values and non-subsidized shipping company values as well.

The information included in Figure I-5 shows a wide disparity in the proportion of Long Term Debt/Total Debt. This disparity generally is caused by differences in a firm's dependence on accounts payable and short-term lending notes as forms of short-term debt financing. These ratios for airline and trucking companies fall in the .5 - .8 area as do most U. S. shipping companies. The exception is the aggregate data on non-subsidized cargo companies who have a large dependence upon accounts payable as a short-term financing option.

3. Financial Leverage and Optimal Capital Structure

Throughout this chapter, the use of debt in financing U. S. shipping companies has been discussed as well as the "financial leverage" it brings to the firm. In this section the author will attempt to show the effects of debt financing and present a framework for determining the optimal capital structure of a shipping company. The objective will be to maximize the value of the firm.

a) Rates of Return and Risk: To demonstrate the effect of leverage on rate of return, a simple example will be used. Consider three firms with everything identical except the amount of debt employed in their capital structures. Leverage is defined as DEBT/TOTAL ASSETS and we assume no income tax. The three companies have capital structures as shown in Table I-3:

Table I-3

Three Sample Companies

Company	Leverage %	Total Assets (millions)	Total Liabilities ($ millions) Debt (8% Int.)	Equity
A	0%	100	0	100
B	50%	100	50	50
C	75%	100	75	25

Table I-4

Effect of Leverage on % Return to Equity

Under Various Levels of Earnings Before Interest and Taxes

Company A

Earnings Before Interest and Taxes	2	4	6	8	10	15
Interest Expense	0	0	0	0	0	0
Gross Profit	2	4	6	8	10	15
Taxes (0%)	0	0	0	0	0	0
Profit Available to Equity Holders	2	4	6	8	10	15
% Return to Equity	2%	4%	6%	8%	10%	15%

Company B

Earnings Before Interest and Taxes	2	4	6	8	10	15
Interest Expense (8% of $50M)	4	4	4	4	4	4
Gross Profit	(2)	0	2	4	6	11
Taxes (0%)	0	0	0	0	0	0
Profit Available to Equity Holders	(2)	0	2	4	6	11
% Return to Equity	-4%	0%	4%	8%	12%	22%

Company C

Earnings Before Interest and Taxes	2	4	6	8	10	15
Interest Expense (8% of $75M)	6	6	6	6	6	6
Gross Profit	(4)	(2)	0	2	4	9
Taxes(0%)	0	0	0	0	0	0
Profit Available to Equity Holders	(4)	(2)	0	2	4	9
% Return to Equity	-16%	-8%	0%	8%	16%	36%

Fig. I-6

Plot of Results from Table I-4

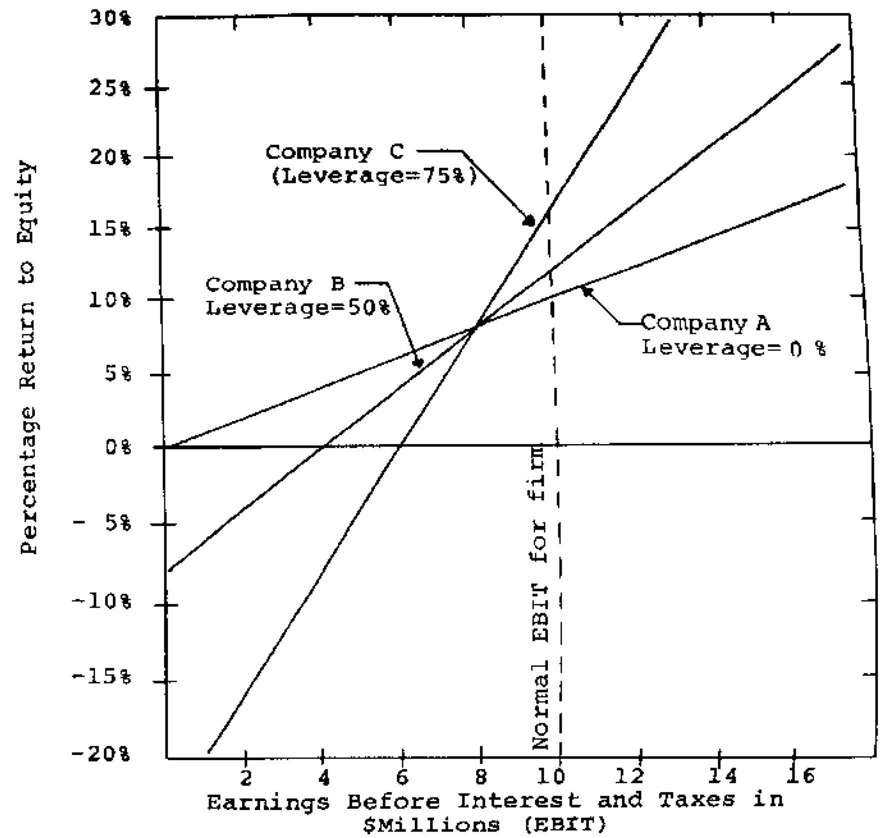
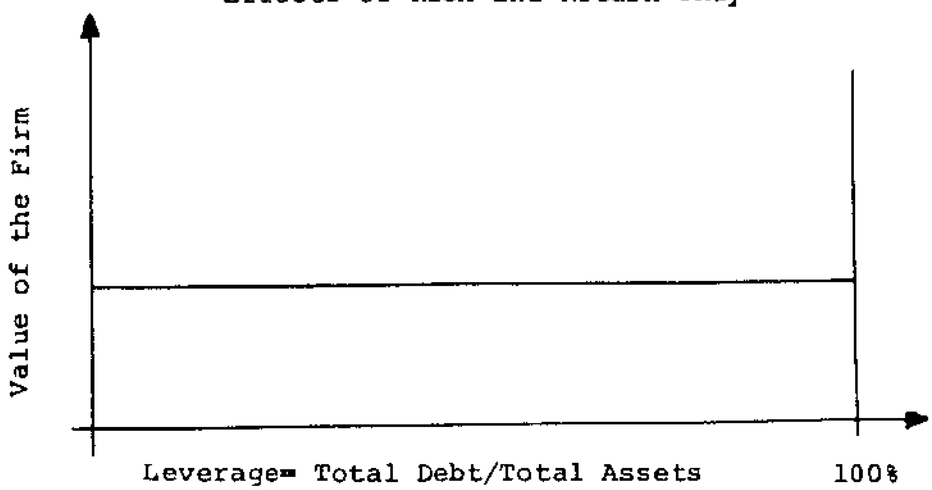


Figure I-6 shows the significant change in the rate of return possibility plots for similar firms with different degrees of debt in their capital structure. Simply stated, the higher leveraged firm experiences a magnification of unleveraged rates of return. They are magnified upwards for EBIT higher than $8 million and downwards for EBIT lower. Under favorable economic conditions leverage provides higher returns yet, these returns tend to fluctuate more drastically than under the unleveraged condition. These fluctuations imply greater risk associated with the potential higher returns. It can be proven that, in theory, the magnification effect of leverage is equally offset by greater riskiness and that leverage alone does not increase the value of the firm. Therefore, assuming no tax effects or bankruptcy costs, the value of the firm is as shown in Figure I-7.

Fig. I-7

Value of the Firm Plot Showing the Leverage Effects of Risk and Return Only



b) Tax Shelters: If we introduce a 50% income tax into our example we see that there is a significant tax shelter created by debt in a shipping company's capital structure. This is because all interest payments are deductible from the tax base whereas, stock dividends and capital gains are not. To see how much this tax savings is and how much the value of the firm is increased, we shall analyze the situation for Companies A and B in Table I-5.

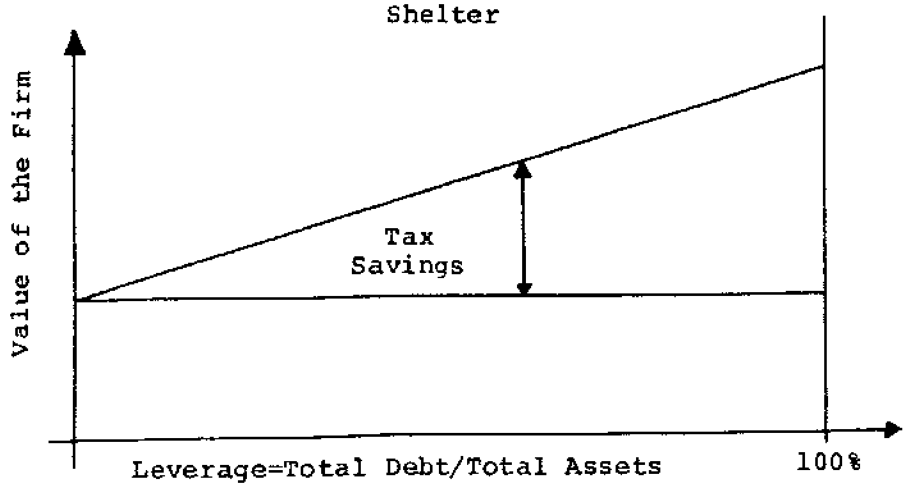
Table I-5

Tax Savings Due to Leverage

(Leverage = 0%) Company A	(Leverage = 50%) Company B
Assets = \$100M Debt = \$0M Equity = \$100M	Assets = \$100M Debt = \$50M Equity = \$50M
Tax Savings/year = \$0M	Tax Savings/year = yearly interest payment x tax rate
	Tax Savings/year = (.08) (50) (.5) = \$2M
	Present value of future tax savings:
	P.V. = $\frac{\$2M}{.08}$ = \$25M
	= present value of a perpetuity of \$2M at 8% discount
Value of Firm A = \$100M	Value of Firm B = \$125M

Fig. I-8

Value of the Firm Plot Showing the Leverage Effects of Risk, Return, and Income Tax Shelter



Assume that we take unleveraged Company A and transform \$50M of equity into \$50M in debt at an 8% interest rate. This would create the situation of Company B. The resultant tax saving per year due to this new debt is \$2M. The present value of all future tax savings is, then, \$25M. The difference in the value of the firm in going to higher leverage is therefore significant, as firm B's value is 25% greater than that of firm A. The plot of value of firm vs. leverage is now as shown in Figure I-8, having taken into account risk, return, and tax shelter.

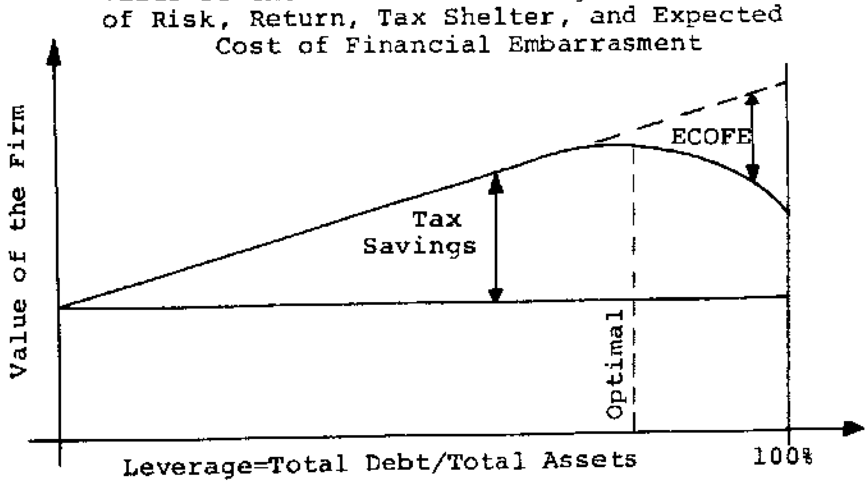
c) <u>Cost of Financial Embarrassment (COFE):</u> As leverage is increased, it was shown how return to equity will experience greater variation over time. Indeed, this variation may be so great that the firm is unable to meet its high fixed interest costs and is forced into bankruptcy. The cost of bankruptcy include legal service, administrative costs, disruption of service costs, customer ill-will, etc. As leverage is increased the probability of bankruptcy becomes greater so we must take into account the expected cost of financial embarrassment (ECOFE), defined as:

$$\text{ECOFE} = (\text{probability of bankruptcy}) \times \Sigma\text{bankruptcy costs}$$

We have now examined all the major effects of financial leverage and the final value of firm plot is as shown in Figure I-9.

Fig. I-9

Value of the Firm Plot Showing the Effects of Risk, Return, Tax Shelter, and Expected Cost of Financial Embarrasment



Clearly, there is a maximum value of the firm and, therefore, an optimal debt structure. That is not to say that this plot could be exactly calculated for an actual firm, but it illustrates the important effects of debt of which the decision-maker should be aware. It is interesting to note that a former financial manager of a subsidized steamship company felt that his firm attempted to issue as much debt as possible subject to limitations from the Maritime Administration and private capital markets. ECOFE was not an issue in the decision-making process as the other limitations on debt were overriding factors.

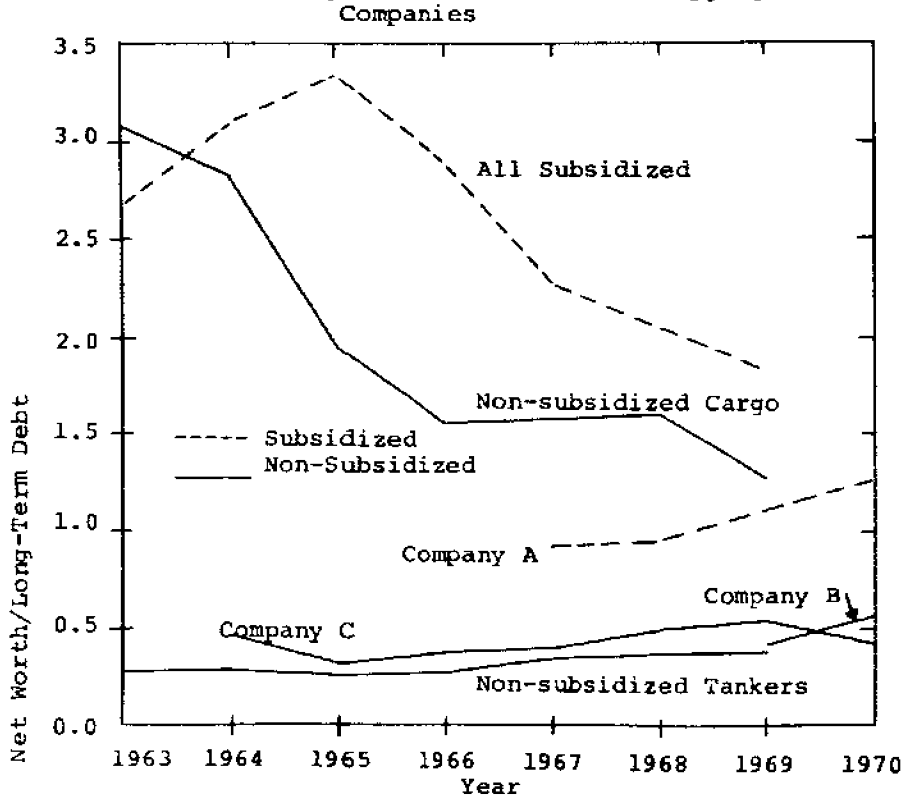
4. Net Worth/Long-Term Debt: The Maritime Administration's Measure of Financial Strength: As will be shown in Chapter IV, MARAD measures the financial strength of a company be the above ratio for purposes of setting Title XI premiums. To provide background for Chapter IV, this measure of capital structure is plotted in Figure I-10 for shipping companies. For comparison, Table I-6 shows Net Worth/Long-Term Debt for selected companies engaged in other modes of transportation.

C. Liquidity and Working Capital

One of the major concerns of the financial manager of any corporation is the ability to meet short-term obligations. These are represented as current liabilities on the balance sheet. They are placed in this "current" category because it is expected or known that they must be disposed of within one year. Liquidity, then, is a measure of how easily the firm can dispose of these liabilities when the need arises. Although the notion of liquidity requires careful attention and cash flow analysis, a quick measure of a corporation's liquidity is the ratio of its current assets (gross working capital) to current liabilities. This ratio shows the extent to which short-term creditors are covered by the short-term assets of the firm.

Fig. I-10

Net Worth/Long Term Debt for U.S. Shipping Companies



Source: See Appendix to Chapter I

Table I-6

NET WORTH/LONG-TERM DEBT

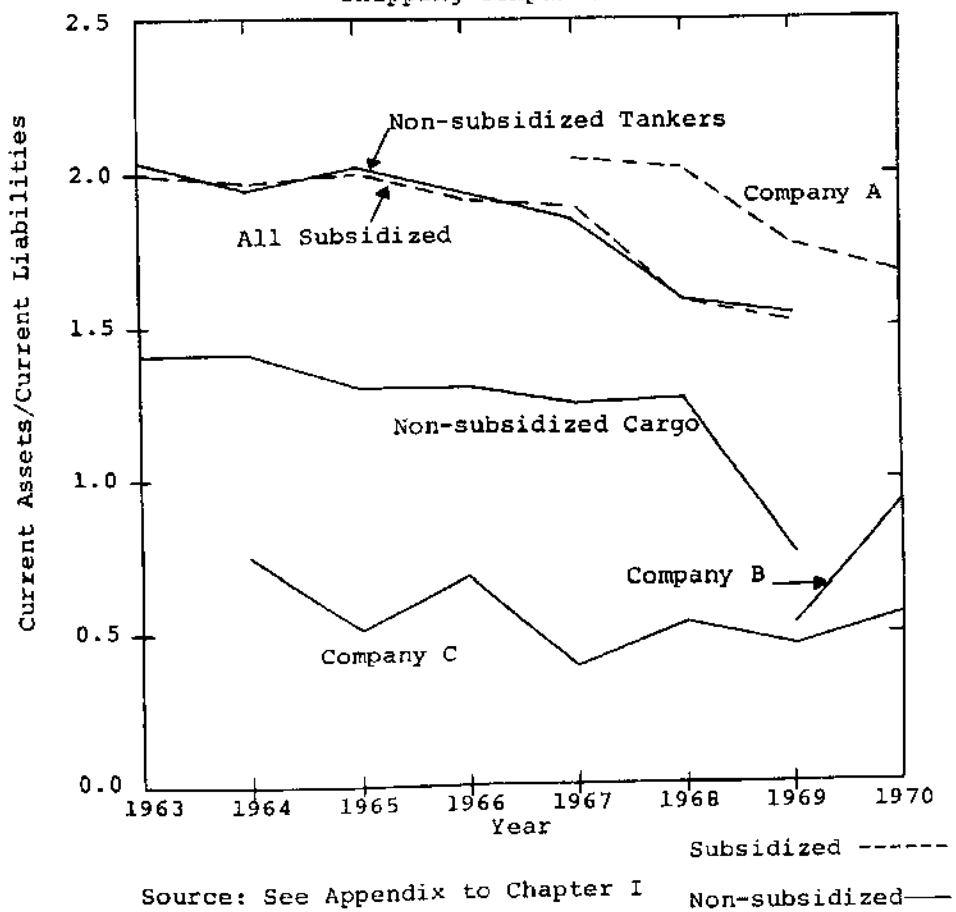
FOR SELECTED AIRLINE AND TRUCKING COMPANIES -- 1970

Company	Net Worth/ Long-term Debt
Airline "A"	.182
Airline "B"	.506
Airline "C"	.331
Trucking "A"	1.01
Trucking "B"	.950

Source: See Appendix to Chapter I.

Fig. I-11

Current Assets/Current Liabilities for U.S. Shipping Companies



Source: See Appendix to Chapter I

Table I-7

CURRENT RATIOS FOR SELECTED

AIRLINE AND TRUCKING COMPANIES -- 1970

Company	Current Assets/ Current Liabilities
Airline "A"	1.07
Airline "B"	1.02
Airline "C"	1.15
Trucking "A"	1.15
Trucking "B"	1.22

Source: See Appendix to Chapter I.

Table I-8

CURRENT RATIOS FOR SELECTED

NON-TRANSPORTATION INDUSTRIES -- 1968

Industry	Current Assets/ Current Liabilities
Electronic Component Mfg.	2.71
Electrical Contracting	2.11
Airplane Parts Mfg.	1.94
Farm Machinery Mfg.	2.50
Automotive Equipment Wholesaling	2.62
Commercial Machines and Equipment Wholesaling	2.23
Motor Vehicles Retailing	1.65
Farm Equipment Retailing	1.70

Source: Dun and Bradstreet, "Key Business Ratios in 125 Lines," 1968.

Figure I-11 is a time trend analysis of the current ratio (current assets/current liabilities) for U. S. shipping companies. For comparison, Table I-7 shows the current ratios of airline and trucking companies while Table I-8 shows this ratio for selected non-transportation industries. They show that non-subsidized cargo shipping companies have current ratios close to airline and trucking companies while non-subsidized tankers and subsidized lines are more conservative with higher ratios. It is interesting to note that Company C, a very profitable non-subsidized bulk and cargo shipping company, has enjoyed success in its short-term finance, with a current ratio significantly lower than 1.0. This would seem to indicate that the degree of working capital alone is not an absolute measure of the firm's ability to manage its short-term obligations. Sophisticated and well-planned refinancing on a short-term basis can make up for a low current ratio. The fact remains, however, that many creditors as well as the Maritime Administration keep a close eye on working capital and thus, it is included in this chapter. More is said about MARAD's working capital requirement in Chapter IV.

D. Profitability

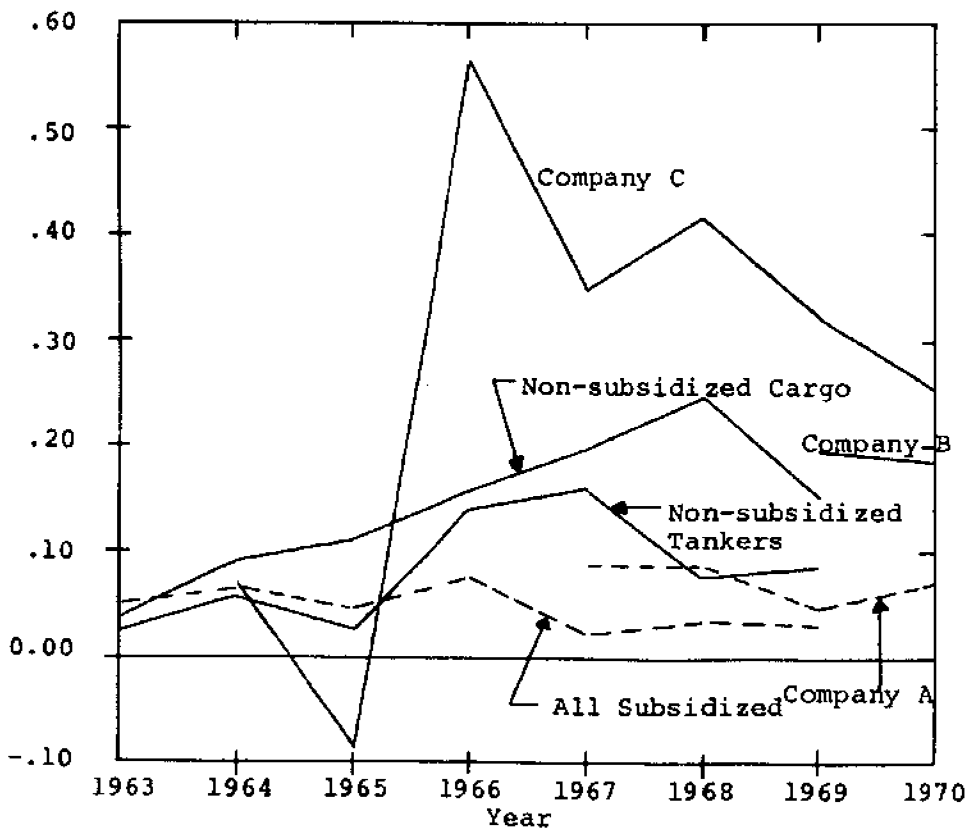
The ultimate test of a shipping company's health or success is the measurement of its profitability. There are several practical ways to make this measure from the accounting records of a firm. These measures are widely used yet, they possess inherent inaccuracies due basically to generally accepted accounting procedures. It is important to keep this problem in mind. Profitability will be calculated in terms of ratios of net profit to net worth (equity capital), to net assets, and to operating revenue. These values are necessarily dependent upon the following accounting variables: (1) expensing policy, (2) depreciation policy, (3) average asset life, (4) fraction of working capital to total capital, and (5) timing of cash flows. The alternative to accounting profitability is to use discounted cash flow principals and determine $\underline{r}$, the required rate of return of all funds invested in the firm. This is often impractical or impossible and therefore, accounting measures are used to make general comparisons.

1. Profitability Ratio Plots: Figure I-12, I-13 and I-14 are time plots of important ratios which measure the profitability of selected U. S. Shipping companies. In addition, these same ratios are shown in Tables I-9 and I-10 for other industries. They are included here for reference in interpreting the plots for shipping companies. The ratios used are defined as follows:

Figure	Ratio	Explanation
I-12	Net Profit / Net Worth	This ratio measures the return on the book value of stockholders' investment. Note that it does not necessarily indicate stockholder returns since book value may not equal market value.
I-13	Net Profit / Total Assets	This ratio measures the return on the book value of total assets or total invested capital. Note that, again, the book value concept may cause erroneous results.
I-14	Net Profit / Operating Revenue	This ratio shows the net profit a firm derives per dollar of freight revenue it takes in.

Fig. I-12

Return to Net Worth (Equity) for U.S. Shipping Companies

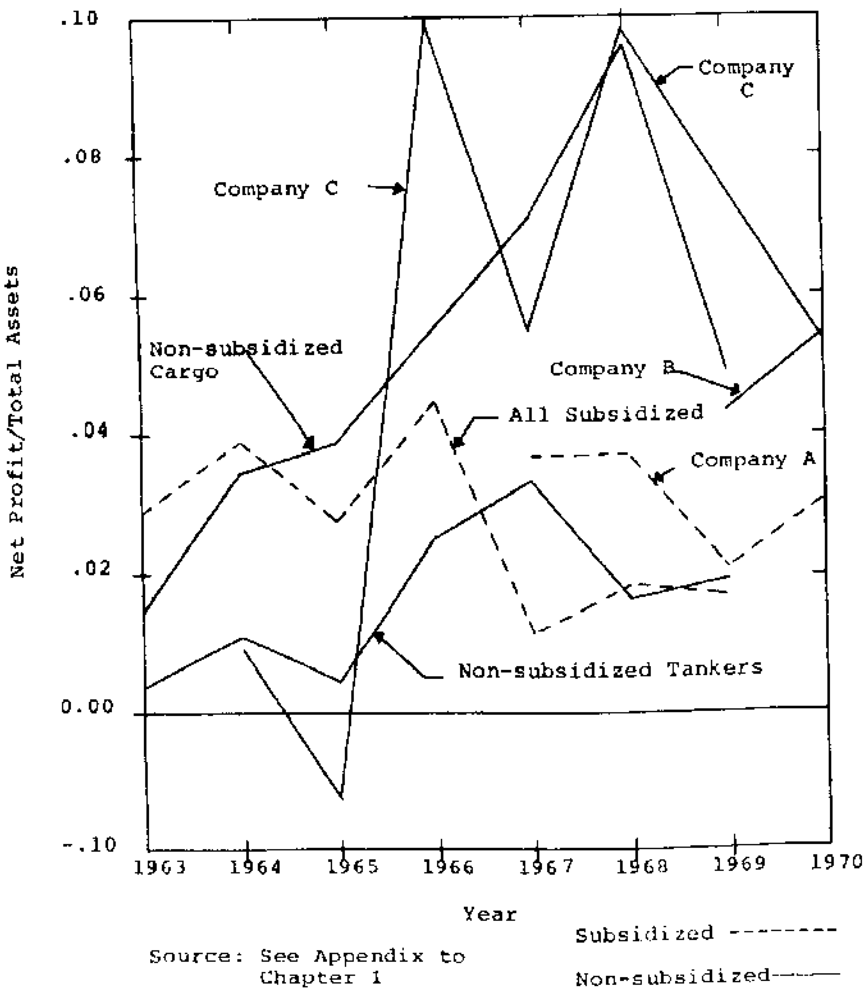


Source: See Appendix to Chapter I

Subsidized -----
Non-subsidized——

Fig. I-13

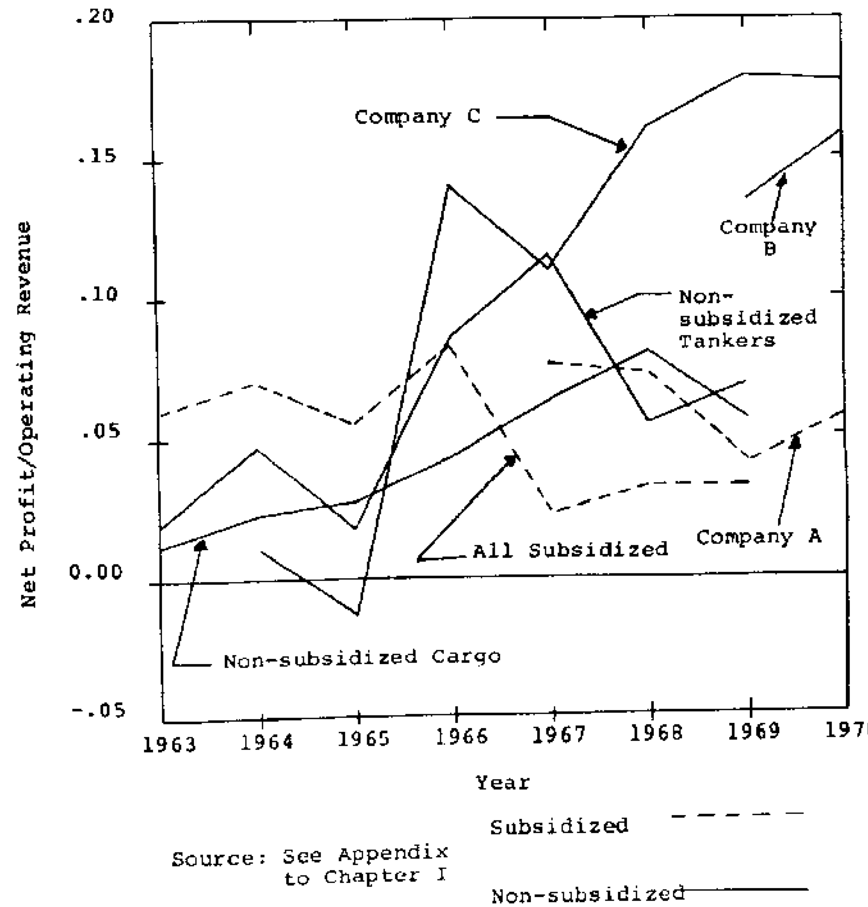
Return to Total Assets for U.S. Shipping Companies



Source: See Appendix to Chapter 1

Fig. I-14

Return to Operating Revenue for U.S. Shipping Companies



Source: See Appendix to Chapter I

Table I-9

PROFITABILITY MEASURES

FOR SELECTED AIRLINE AND TRUCKING COMPANIES

Company	Net Profit/ Net Worth	Net Profit/ Total Assets	Net Profit/ Oper. Revenue
Airline "A"	.0284	.0033	.0037
Airline "B"	-.073	-.0173	-.0234
Airline "C"	.0239	.0049	.0056
Trucking "A"	.0927	.0307	.0284
Trucking "B"	.131	.0445	.0256

Source: See Appendix to Chapter I.

Table I-10

PROFITABILITY MEASURES

FOR SELECTED NON-TRANSPORTATION INDUSTRIES -- 1968

Industry	Net Profits/ Net Worth	Net Profits/ Net Sales
Electric Component Mfg.	.1027	.0357
Electrical Contracting	.1329	.0229
Airplane Parts Mfg.	.1378	.0414
Farm Machinery Mfg.	.0847	.0286
Automatic Equipment Wholesaling	.0760	.0183
Commercial Machines and Equipment Wholesaling	.0741	.0162
Motor Vehicle Retailing	.0917	.0108
Farm Equipment Retailing	.0761	.0163

Source: Dun and Bradstreet, "Key Business Ratios in 125 Lines," 1968.

2. Analysis of Profitability Ratios: It is difficult to make an exact quantitative study of true profitability from balance sheet methods. However, comparisons can be made assuming consistent accounting methods.

a) Net Profit/Net Worth: Figure I-12 shows return to net worth or the return to book equity capital invested in the company. The average return for subsidized lines was between 2% and 8% for the time period shown. It should be noted, however, that during this same time period the Maritime Administration recaptured one-half of all profits in excess of 10% return to equity for lines receiving operating subsidy. Not all companies made profits high enough to have these recapture expenses, yet, the overall effect helped in keeping subsidized lines' profits below the 8% level as shown in Figure I-12. The 1970 Merchant Marine Act repealed the recapture provision. The implications of this action will be discussed in Chapter VI. The non-subsidized companies have shown significantly better returns to equity capital than subsidized lines. This is partly explained by their advantage of not being subject to recapture, yet still enjoying significant indirect subsidy. Another explanation is the possible existence of more innovative management in non-subsidized companies due to greater freedom from government controls and less certainty about how much subsidy (indirect) they will be able to enjoy. The extent to which this is true should become apparent as MARAD continues to exercise less control on the traditional subsidized fleet. It should also be noted that return to equity for non-subsidized (high leveraged) companies is much more erratic through higher than that of subsidized (low leveraged) lines. This further verifies the risk-return effects of leverage as presented in Section 3a.

b) Net Profits/Total Assets: Figure I-13 shows return to total assets for various companies. It demonstrates again that subsidized line profitability is lower than that of non-subsidized companies. Note also that the return to assets for shipping companies is, in general, equal to or better than the 1968 returns for selected airline and trucking firms.

c) Net Profits/Operating Revenue: It is difficult to draw any significant conclusions from Figure I-14, the plot of profit per dollar of operating revenue. There is an indication that this measure is significantly higher for shipping as opposed to air transport or trucking.

3. Profitability Measurement and Discounted Cash Flows:

It is not surprising that profitability as measured by ratios is difficult to analyze effectively. It is not the purpose of this study, however, to carry out an elaborate analysis of profitability. This section is meant only to supply background. In looking at the financing decision, we are interested in how to come upon the proper discount factor used in evaluating alternatives. Discount factor is used here in connection with calculation of the "present value" for a particular investment as employed in capital budgeting analysis. The present value of an investment such as a new ship is defined as:

$$\text{Present Value} = \sum_{n=1}^{n} \frac{Ft}{(1+r)^t} - Io$$

where n = life of investment

Ft = net cash flows from the ship in year t (revenues - expenses)

r = discount rate or hurdle rate

Io = original investment outlay

Generally, projects with the highest positive present value are accepted up to the financing limitations of the firm. The discount rate used is the firm's cost of capital, a weighted average of debt and equity financing. If this rate, r, could be accurately determined, the true profitability of the firm would then be defined. Due to market imperfections insufficient data, and unknown factors such as future earnings growth, r is difficult to determine in most cases. As a result, present value should be calculated over a range of values for r to show how it varies with r. Management decisions must then be made as to the lowest value of r that could be accepted in the best interest of stockholders.

E. Summary

In this chapter, the important concepts associated with capital structure, liquidity and profitability were presented. Data pertaining to these subjects were included for the shipping industry and general conclusions were drawn. With this as background, the author will attempt to show the major alternatives of obtaining capital open to U. S. shipping companies. Important government programs affecting these financing alternatives will be described in detail and projections of future financing methods will be made.

Table A-1-1

RATIO ANALYSIS -- U.S. SUBSIDIZED LINES, AGGREGATE (DATA GIVEN IN $000,000's)

	1963	1964	1965	1966	1967	1968	1969
Data							
Total Assets	1466	1400	1451	1592	1702	1679	1797
Current Assets	252	262	258	299	319	296	304
Total Debt	621	510	530	629	735	783	870
Current Liabilities	126	133	129	157	170	188	200
Long-Term Debt	317	291	278	334	419	439	510
Net Worth (Equity)	845	890	921	963	967	897	927
Net Profit After Taxes	41.5	5416	39.8	71.0	20.0	30.4	29.5
Total Operating Revenue	723	790	734	852	889	947	886
Ratios							
Total Debt/Total Assets	.424	.364	.364	.394	.431	.466	.484
Total Debt/Equity	.735	.573	.597	.652	.756	.873	.938
Long-Term Debt/Total Debt	.510	.570	.525	.531	.570	.560	.586
Current Assets/Current Liabilities	2.00	1.97	2.00	1.91	1.88	1.58	1.52
Net Profit/Net Worth	.0491	.0614	.0432	.0736	.0206	.0339	.0318
Net Profit/Total Assets	.0284	.0390	.0274	.0445	.0117	.0181	.0164
Net Profit/Operating Revenue	.0575	.0692	.0542	.0832	.0225	.0321	.0324
Breakdown							
# Companies Represented	15	15	15	14	14	14	14
# Ships Represented	304	321	322	322	323	310	290

Source: Maritime Administration Annual Reports, 1964-1970

Table A-1-2

RATIO ANALYSIS -- U.S. NON-SUBSIDIZED CARGO SHIPPING COMPANIES (DATA GIVEN IN $000,000's)

	1963	1964	1965	1966	1967	1968	1969
Data							
Total Assets	350	319	330	414	497	573	795
Current Assets	133	127	128	152	177	190	217
Total Debt	200	194	211	269	320	349	544
Current Liabilities	94.6	90.3	98.1	117	143	151	288
Long-Term Debt	48.7	44.0	60.6	93.7	113	140	196
Net Worth (Equity)	150	124	119	145	177	223	251
Net Profit After Taxes	5.11	10.9	12.9	22.7	35.1	54.7	38.6
Total Operating Revenue	483	489	479	532	568	687	682
Ratios							
Total Debt/Total Assets	.571	.607	.640	.625	.643	.609	.684
Total Debt/Equity	1.33	1.56	1.77	1.79	1.81	1.56	2.16
Long-Term Debt/Total Debt	.244	.226	.288	.348	.354	.400	.361
Current Assets/Current Liabilities	1.40	1.41	1.30	1.30	1.24	1.26	.751
Net Profit/Net Worth	.0341	.0878	.108	.157	.198	.246	.154
Net Profit/Total Assets	.0146	.0342	.0390	.0548	.0706	.0955	.0486
Net Profit/Operating REvenue	.0106	.0223	.0269	.0426	.0618	.0795	.0566
Net Worth/Long-Term Debt	3.08	2.82	1.96	1.55	1.57	1.60	1.28
Breakdown							
# Companies Represented	26	22	21	19	18	17	16
# Ships Represented	191	177	126	124	124	114	115

Source: Maritime Administration Annual Reports, 1964-1970

Table A-1-3

RATIO ANALYSIS - U.S. NON-SUBSIDIZED TANKER SHIPPING COMPANIES (DATA GIVEN IN $000,000's)

	1963	1964	1965	1966	1967	1968	1969
Data							
Total Assets	351	348	253	277	274	276	280
Current Assets	46.3	48.7	36.6	43.3	46.9	46.5	46.4
Total Debt	286	282	207	227	217	217	219
Current Liabilities	22.7	25.0	18.1	22.4	25.3	29.4	30.3
Long-Term Debt	237	233	169	181	166	161	164
Net Worth (Equity)	65.2	66.8	45.3	49.9	57.7	59.3	61.3
Net Profit After Taxes	1.39	3.92	1.06	6.95	9.23	4.63	5.5
Total Operating Revenue	79.2	83.8	61.7	82.5	80.4	85.0	81.1
Ratios							
Total Debt/Total Assets	.815	.810	.817	.819	.793	.786	.782
Total Debt/Equity	4.38	4.21	4.56	4.55	3.76	3.66	3.58
Long-Term Debt/Total Debt	.830	.827	.815	.796	.765	.740	.749
CurrentAssets/Current Liabilities	2.04	1.95	2.02	1.93	1.85	1.58	1.53
Net Profit/Net Worth	.0213	.0586	.0234	.139	.160	.0780	.0898
Net Profit/Total Assets	.00396	.0113	.0042	.0250	.0337	.0168	.0197
Net Worth/Long-Term Debt	.275	.286	.268	.276	.348	.368	.374
Breakdown							
# Companies Represented	25	27	19	21	20	20	18
# Ships Represented	26	25	24	25	21	33	30

Source: Maritime Administration Annual Reports, 1964-1970

Table A-1-4

RATIO ANALYSIS - COMPANY A (SUBSIDIZED LINE)
(DATA GIVEN IN $000,000's)

	1967	1968	1969	1970
Data				
Total Assets	232	242	239	255
Current Assets	42.6	47.8	46.3	70.6
Total Debt	135	139	132	140
Current Liabilities	20.9	23.8	26.3	42.2
Long-Term Debt	107	107	96.2	90.3
Net Worth (Equity)	97	103	107	115
Net Profit After Taxes	8.57	8.95	5.09	8.01
Total Operating Revenue	113	123	126	141
Ratios				
Total Debt/Total Assets	.582	.574	.552	.549
Total Debt/Equity	1.43	1.35	1.23	1.22
Long-Term Debt/Total Debt	.792	.760	.721	.645
Current Assets/Current Liabilities	2.04	2.01	1.76	1.67
Net Profit/Net Worth	.0883	.0869	.0475	.0696
Net Profit/Total Assets	.0369	.0370	.0212	.0314
Net Profit/Operating Revenue	.0758	.0727	.0403	.0569
Net Worth/Long-Term Debt	.905	.965	1.11	1.27
Breakdown				
# Ships Represented:				
Cargo		24	33	32
Passenger		3	3	2

Source: Annual Reports of Company A, 1968-1970

Table A-1-5

RATIO ANALYSIS OF COMPANY B (NON-SUBSIDIZED)
(DATA GIVEN IN $000,000's)

	1966	1967	1968	1969	1970
Data					
Total Assets				163	186
Current Assets				17.5	22.1
Total Debt				127	131
Current Liabilities				32.5	23.7
Long-Term Debt				88.0	97.8
Net Worth (Equity)				36.2	54.8
Net Profit After Taxes	5.33	3.99	6.67	7.04	10.1
Total Operating Revenue	38	39	44	52.4	64.0
Ratios					
Total Debt/Total Assets				.778	.704
Total Debt/Equity				3.51	2.40
Long-Term Debt/Total Debt				.694	.746
Current Assets/Current Liabilities				.538	.933
Net Profit/Net Worth				.194	.184
Net Profit/Total Assets				.0431	.0542
Net Profit/Operating Revenue				.134	.158
Net Worth/Long-Term Debt				.412	.560
Breakdown					
U.S. Flag — Tankers					9
U.S. Flag — Dry Bulk					4
U.S. Flag — General Cargo					4
Foreign Flag — Tanker and OBO					3
Foreign Flag — Dry Bulk					9
Foreign Flag — Ore					4
Total					33

Source: Annual Report of Company B, 1970

Table A-1-6: RATIO ANALYSIS - COMPANY C (NON SUBSIDIZED) (DATA GIVEN IN $000,000's)

	*1964	*1965	1966	1967	1968	1969	1970
Data							
Total Assets	43.3	41.5	71.7	117	144	223	333
Current Assets	7.86	6.59	14.4	16.7	18.4	28.2	44.8
Total Debt	37.2	35.9	59.1	97.5	110	170	263
Current Liabilities	10.4	12.8	21.0	43.6	34.4	61.7	80.1
Long-Term Debt	12.7	17.8	32.7	48.6	67.8	101	168
Net Worth (Equity)	6.11	5.61	12.6	19.5	33.8	52.5	69.9
Net Profit After Taxes	.396	(.50)	7.10	6.75	14.0	16.9	17.4
Total Operating Revenue	38.5	40.5	50.6	61.1	87.3	94.9	99.0
Ratios							
Total Debt/Total Assets	.860	.865	.825	.833	.765	.763	.789
Total Debt/Equity	6.08	6.40	4.70	5.00	3.26	3.24	3.78
Long-Term Debt/Total Debt	.342	.496	.552	.499	.616	.594	.638
Current Assets/Current Liabilities	.756	.515	.687	.382	.534	.457	.559
Net Profit/Net Worth	.0646	(.089)	.563	.346	.415	.322	.250
Net Profit/Total Assets	.0092	(.0120)	.0990	.0566	.0971	.0758	.0523
Net Profit/Operating Revenue	.0103	(.0123)	.140	.110	.160	.178	.176
Net Worth/Long-Term Debt	.482	.316	.386	.400	.498	.520	.416

Table A-1-6 (continued)

Breakdown	*1964	*1965	1966	1967	1968	1969	1970
Military Cargo					12	12	7
Tankers					21	18	15
Ro/Ro					1	1	1
Heavy Lift					2	2	2
Container					3	10	14
Dry Cargo					5	2	2
Total					44	45	42

Source: Annual Reports of Company C, 1966-1970

*Consolidated figures before merger of two companies in 1966.

Table A-1-7

RATIO ANALYSIS - SELECTED AIRLINE AND TRUCKING COMPANIES FOR 1971 YEAR (DATA GIVEN IN $000's)

	Airline "A"	Airline "B"	Airline "C"	Trucking "A"	Trucking "B"
Data					
Total Assets	171,302	1,524,946	1,128,559	254,602	83,714
Current Assets	44,765	284,428	222,215	81,897	26,420
Total Debt	151,365	1,164,268	898,986	170,374	55,416
Current Liabilities	41,770	277,611	192,673	71,018	21,637
Long-Term Debt	109,235	713,070	693,922	83,666	29,817
Net Worth (Equity)	19,937	360,678	229,573	84,278	28,298
Net Profit After Taxes	565	(26,398)	5,461	7,808	3,721
Total Operating Revenue	154,635	1,125,632	971,050	274,921	146,710
Ratios					
Total Debt/Total Assets	.883	.775	.797	.670	.661
Total Debt/Equity	7.56	3.22	4.10	2.02	1.96
Long-Term Debt/Total Debt	.722	.615	.772	.493	.539
Current Assets/Current Liabilities	1.07	1.02	1.15	1.15	1.22
Net Profit/Net Worth	.0284	-.073	.0239	.0927	.131
Net Profit/Total Assets	.0033	-.0173	.0049	.0307	.0445
Net Profit/Operating Revenue	.0037	-.0234	.0056	.0284	.0256
Net Worth/Long-Term Debt	.182	.506	.331	1.01	.950

Source: Moody's Transportation Manual - 1971, pp. 1302-1328, 1603-1625.

CHAPTER II

INSTRUMENTS OF DEBT AND EQUITY

A. Introduction

In Chapter I, the important notion of capital structure was introduced and examined for various segments of the U. S. shipping industry. In this chapter, the major instruments by which a company obtains capital within this structure are investigated. Long-term debt and equity financing options are described and implications of their use are demonstrated. A framework for determining the cost of these instruments is developed and it is shown how to extimate the firm's overall cost of capital. Finally, the very important "off-balance sheet" financing method of leasing is analyzed in some detail.

B. Long-Term Debt and Equity Financing

1. Long-term debt: The implications of using debt in a shipping company's capital structure were discussed in Chapter I. Debt is a source of capital which has a fixed yearly tax deductible cost to the issuing corporation in the form of interest payments. The creditors holding the debt instrument cannot, in general, exert influence on the operations of the company but are entitled to fixed payment before those who hold equity claims to the same company. The shipping industry employs the use of debt to a great degree. The major reasons for this are a high degree of tangible, easily mortgagable property (ships) and a government program called "Title XI Federal Ship Mortgage Insurance." The most widely used pure debt instrument of U. S. shipping companies is the mortgage bond although, in some cases, unsecured debentures have been employed.

a) Bonds: A bond is the general term for a corporate debt instrument. The face value of a bond is usually $1,000. Also, specified is the interest rate on this $1,000 which the company promises to pay in each interest period. Bonds are generally sold near face value so that the stated interest rate closely approximates the true interest rate to the creditor. However, there are floatation costs from underwriting syndicates which reduce the net bond proceeds to the issuing company. For example, assume a $1,000, 8% bond is sold in the market at face value, but the underwriter's fee is $15 per bond (1.5%). The effective interest rate to the issuing company is as follows:

$$\text{Yearly interest payment} = (.80)(1000) = \$80$$

$$\text{Net bond proceeds to company} = \$1000 - \$15 = \$985$$

$$\text{Effective interest rate paid by company} = \frac{80}{985} = 8.12\%$$

The effect of these fees and others on issues of debt are discussed later in this study.

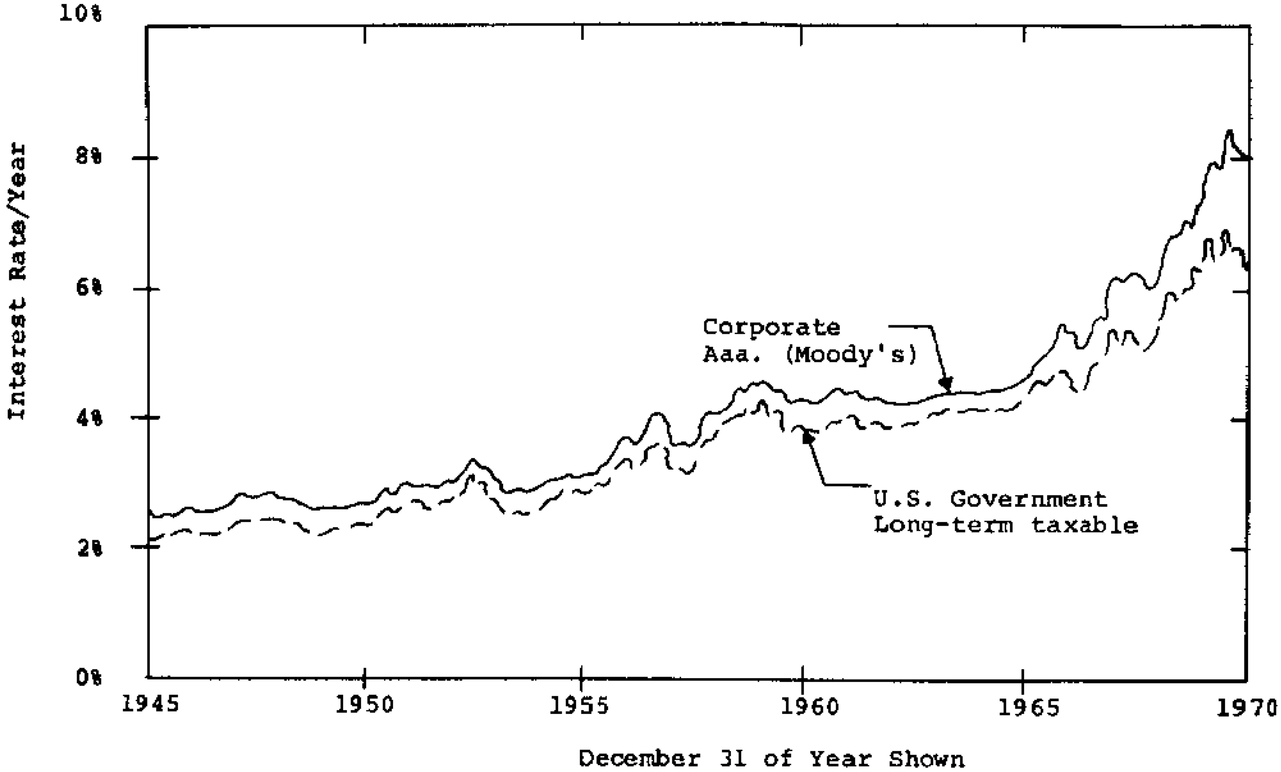
The interest rate a company is required to pay for debt financing is known as its pre-tax cost of debt. This rate is a function of several factors. First, the "risk-free" interest rate, r_f, is the general basis for the cost of capital for a corporation. This is the interest rate which a borrower is absolutely certain of receiving on certain borrowed money. For practical purposes, r_f is considered equal to the interest rate on government bonds.[f] This rate, r_f, is a function of the supply and demand for money in our economy and includes the market's expectation of inflation. In addition, there is a risk premium, that is, an additional cost to offset the risk characteristics of a particular security and firm. The risk premium will be denoted r_r. The pre-tax cost of debt then becomes $r_d = r_f + r_r$.

To aid the investor in evaluating the risk factor of a firm, several companies continuously rate new bond issues. Such a rating organization is known as "Moody's Bond Ratings." Their evaluation of a new issue of bonds is based on financial strength, profitability, capital structure, past performance, and the specific terms of the issue. There are nine categories into which these securities are placed, ranging from Aaa (lowest risk) to C (highest risk). Figure II-1 shows, by category, bond interest rates (before any fees, etc.) for the past twenty-five years. Market fluctuations among categories are highly correlated reflecting fluctuations in the risk-free rate, r_f. The absolute differences between categories show differences in risk and, therefore, differences in the risk premium, r_r.

b) Mortgage Bonds: Mortgage bonds are debt instruments secured by a lien on specific assets of the corporation, usually fixed assets. The shipping industry relies heavily on mortgage bonds as a source of capital secured by the vessels it owns. The market value of the vessels should always exceed, in theory, the market value of outstanding debt secured by them. Due to the relatively long economic life of a ship, companies which own such assets desire equally long-term debt. It is the problem of the uncertainty of a ship's market value over this time period as well as the high-leverage position of most shipping companies which makes the risk of such secured debt high. In addition, the profitability of shipping companies is subject to major fluctuations. To offset this uncertainty, the U. S. Government has instituted a program of insuring mortgages on U. S. flag vessels. This program, which has no net cost to the government in direct or indirect outlays, has been of major importance to the financing of many such ships. Title XI Federal Ship Mortgage Insurance is discussed in great detail in Chapter IV for this reason. Bonds, so insured, are rated Aaa by Moody's and receive interest rates close to those shown in Figure II-1.

Fig. II-1

Bond Yields



Source: The Federal Reserve Chartbook, 1971.

c) Debentures: A debenture is generally an unsecured bond of a corporation. In the event of liquidation, the holder of a debenture has claim only on property not previously pledged or mortgaged. The lender looks to the financial strength, earning power, and credit rating of the company as his security. Debentures are not widely used in the shipping industry. The only case the author has found was an issue in 1969 of $50M in 25 years, B-rated convertible sinking fund debentures. The issuing company was highly profitable at the time and sold them with an interest rate of only 6%. However, they were not pure debt in that they could be converted, if called, into common stock at $27.50 per share. The high growth rate and profitability of the company at the time made this conversion price quite attractive, which explains the low interest rate of 6%. Within a year, profits and stock prices fell making the debentures unlikely candidates for conversion and therefore, the value of these bonds fell drastically. Occurrences such as this demonstrate the risky characteristics of this type of security when used in the shipping industry.

2. Equity Financing: The equity financed portion of a corporation represents capital invested by the owners of a company. Usually these investors (holders of common stock) exert influence on the operations of the business through voting rights proportional to the amount of common stock of each owner. As was demonstrated in Chapter I, their earnings are closely tied to the yearly profitability of the company. The net income of the corporation (after interest

payments and income taxes) is distributed among stockholders in several ways. First, preferred stockholders must receive dividends up to the amount specified on their certificates. Preferred stock is not a true form of equity since it has no voting rights and has an upward limit on income. It is, rather, a combination of debt and equity type financing and is not used to a great extent in the shipping industry. The funds available to common stockholders (Net Profit - Preferred Dividends) can be either distributed to stockholders as cash dividends and/or retained by the business and reinvested if suitable projects can be initiated with this new capital. Any capital retained in the business in this manner is considered internal equity financing and will be reflected theoretically as an increase in the market value of each share of common stock giving the stockholder a capital gain.

The other method of obtaining equity financing is through a new stock issue, although this generally gives rise to significant floatation costs. Due to the high volatility of stock prices, floatation costs are much higher than for bonds. For good sized issues (greater than $10M), these costs may be as high as 5-10%. However, through the use of "rights" these floatation costs can be reduced or eliminated. By this method, each stockholder is issued a number of "rights" to buy a share of new stock at a price below that of market value. The number of rights a shareholder receives is proportional to the stock he already owns. Since the rights are to purchase stock below market value, the rights themselves have a value so they may be either exercised or sold to another party who will exercise them. In this manner a large issue of stock can be sold without any underwriting fees.

The cost of equity capital to the company is quite difficult to measure exactly. In making an estimate it is best to take the stockholder's view: What is his required rate of return on the equity of a particular corporation? We know it must be higher that r_d, the pre-tax cost of debt since it is inherently more risky. Return on common stock can be expressed as dividend yield plus capital gains yield. To estimate r_e, the cost of equity, we shall use the expression:

$$r_e = \text{Dividend Yield} + \text{Capital Gains Yield}$$

$$r_e = D/Po + G$$

where

D_1 = expected dividend in next period

Po = current market price of stock

G = expected growth (expected price increase/current price)

This relation may appear to be quite simple, yet G, or expected growth, is a very difficult value to determine. It can be estimated by observed past growth in dividends or past return to book equity multiplied by the past retention rate (retention rate is Retained Earnings/Total Earnings). These estimates should be used with caution, however, since it is very difficult to determine exactly what the stockholders' expectation of growth is.

It should be mentioned that the shipping industry has available to it a unique method of equity financing for new equipment. A federal program allows shipowners to deposit earnings in a special fund before paying any taxes on them. If this money is later used in the form of equity in a ship, it remains tax exempt, however, the depreciation base is reduced. This method of obtaining equity internally yields large tax savings if kept in motion. Due to its sizable importance to the equity financing of U. S. shipping companies, all of Chapter V is devoted to tax-deferred capital construction funds.

3. Weighted Cost of Capital: In evaluating investment proposals the method of present valuing future cash flows is employed. This necessarily means that a reasonable discount rate be determined. In most cases this discount rate is the firm's cost of capital. This can be measured as the expected return on a portfolio of all the firm's financing instruments while adjusting the return on debt by the corporate tax rate. The weighted overall cost of capital, r_t, is expressed as:

$$r_t = r_d(1-T)\frac{D}{V} + r_e\frac{E}{V}$$

where

r_t = total weighted cost of capital

r_d = pretax cost of debt

r_e = cost of equity

D = market value of outstanding debt

E = market value of outstanding equity

V = market value of the fim = D + E

T = corporate tax rate

C. Lease Financing and Hidden Debt

Throughout U. S. industry, leasing has become an important form of financing in the past 15-20 years. In the shipping industry a form of leasing called chartering has been widely used in the dry and liquid bulk trades for many years. These charters are of three basic types:

Single Voyage Charter: The owner agrees to ship a certain amount of oil from A to B. The price charged is in \$/Ton Delivered as the owner bears all voyage costs (ship, crew, fuel, port, etc.). This type of charter is not a true form of leasing.

Time Charter: The owner leases the ship to a shipper for a specified period (usually 6 months to 15 years). The owner supplies the crew, but the lessee pays other costs. Again, this is not true leasing in that the owner has the responsibility for the ship's operation and maintenance.

Bareboat Charter: The owner leases the ship only to the shipper. The lessee usually pays all voyage costs and is responsible for maintenance. This form of leasing has spread to other than bulk trades and is becoming increasingly employed by steamship operators leasing ships from leasing companies such as banks and special "dummy" corporations. It is this leasing method which we shall call financial leasing.

A financial lease is a long-term legal contract which, like a long-term loan, requires the ship operator (lessee) to make periodic payments. In return, the lessee receives full use of the ship or other equipment owned by the lessor. Therefore, lease financing and debt financing are similar in that the firm must be able to service long-term obligations usually lasting a major portion of the life of the asset. It is different, however, in that the lessee does not legally own the asset at any time and generally has no claim on its residual or salvage value at the end of the lease period. The lease contract between lessee and lessor usually specifies such items as (1) the lease period, (2) timing and amounts of payments, (3) renewal and/or purchase options, and (4) miscellaneous costs associated with the asset.

1. Types of Financial Leasing Arrangements:

a) Sale and Leaseback: One type of leasing arrangement which has been used by shippers is that of sale and leaseback. To do this, a ship operator purchases a ship, sells it to a leasing company and then leases it back on a long-term basis.

b) Direct Leasing: This is the case where a ship operator may lease a ship he has never previously owned. Both lessee and lessor negotiate with the shipyard for the construction of the ship, but the leasing company pays the construction cost and leases the vessel to the operator.

c) Implications: Under both direct and indirect leasing arrangements, the payment schedule for the lessee is designed so as to pay off the original cost of the vessel during the initial lease period. In addition, an interest payment is charged on any outstanding principal approximating the firm's cost of debt. Both arrangements have, however, certain implications toward "innovative" financing:

i) The ship operator may extract lower lease rates from the lessor through certain contracted an uncontracted agreements. For example, Ajax Lines may sell and lease back vessels from F.B.N. Industries who has large interests in a certain shipyard. Ajax may agree to purchase new ships from this yard in the future or, perhaps, agree to lease them from F.B.N. at a specified rate.

ii) Although the author has not found any examples of this, a ship operator might lease its ships from a non-profit organization or local government. Non-profit organizations pay no income tax and therefore can offer the lessee a lower lease rate. Local governments can issue tax-exempt bonds with very low interest rates and thereby pass the savings onto the lessee. These methods of reducing financing cost through tax shelters are of questionable legality, however, but they have been used in other industries for assets other than ships.

iii) For purposes of limiting liability and financial insulation, dummy leasing corporations are sometimes created to act as lessors. These may be set up by either the lessee or the manufacturer of a particular asset. Recently, several such dummy corporations have been created by shipyards to finance the ships they build for their customers. The dummy is maintained by a trustee who makes sure that regular interest is paid to the investors.

2. Advantages to Lease Financing: When evaluating the advantages to lease financing, it is logical to compare it to the other major alternative, which is owning the asset of interest. Ships are usually heavily debt financed, when owned, which is another important consideration to keep in mind. The following is a list of the more obvious advantages connected with lease financing:

a) Accelerated Depreciation: When a vessel is owned, the owner must capitalize this asset. He can then depreciate this capital cost over its economic life and deduct a prescribed depreciation expense from taxable income each year. U. S. tax law, as explained in Chapter III, allows for faster depreciation in the early years of a vessel's life. This is advantageous in that tax shelters realized earlier are more valuable than those taken in the future due to the time value of money. If vessel acquisition cannot be evenly timed, however, "too much" accelerated depreciation expense may be available at one time and the vessel owner cannot take full advantage of the resulting tax shelter due to insufficient profits. A leasing company, however, might have more control over its timing of asset acquisition in order to take full advantage of accelerated depreciation. This tax saving can then be passed onto the lessee in the form of lower lease payments. The lessee, otherwise, could not have realized any savings through accelerated depreciation. The implications of the tax environment are more fully discussed in Chapter III. It should also be noted that lease payments are fully deductible from federal income tax, but are generally level over the lease period.

b) Investment Tax Credit: Vessels purchased for transportation are eligible for investment tax credit. For reasons similar to those stated under accelerated depreciation, leasing is a method of having this credit passed onto the lessee through lower lease payments. Again, it is more fully explained in Chapter III.

c) Hidden Debt: When assets are "acquired" through leasing, they rarely show up on balance sheets as capitalized equipment. As a result, the financial ratios important to creditors are favorably affected by leasing as opposed to owning a ship. Table II-1 shows the fictional balance sheet of a typical shipping company. It was assumed that straight line depreciation is employed and the ships would be purchased through straight debt. Two $15M ships are to be acquired by the fictional company. In Case I the ships are purchased and capitalized; in Case II the ships are leased. The resulting financial ratios are shown at the bottom of Table II-1 for each alternative. There is a marked improvement in each ratio for leasing as opposed to buying. In reality, these improvements are purely an illusion. The lease payments hold just as much obligation to the operating company as outstanding debt of the same amount. As a result, there is a "hidden leverage" effect since the lease or hidden debt never appears in the form of assets and liabilities on the balance sheet. The company has, in reality, much higher debt than the financial ratios show. Similarly, book return to total assets is improved through leasing since the leased equipment is never capitalized. It is true that many investors are becoming increasingly aware of this fallacy; yet, there are still many who do not recognize it fully. Therefore, the ability of a shipping company is less hampered by leasing than by issuing an equal amount of debt.

d) 100% "Debt" Financing: Through leasing, a shipping company can obtain, in effect, 100% debt financing for the acquired vessel. It must put up no equity funds to have the full use of this asset. There is no other way to obtain such leverage on any particular ship. Therefore, leasing becomes a very attractive method, if not, the only method in some cases, to acquire the use of additional ships.

e) Cash Flow Timing: Leasing arrangements are usually quite flexible in the rate at which the lessee pays off the principal amount of the leased ship. Recently it has become very popular to employ step leasing techniques whereby the lessee covers only the interest payments during the early periods of the lease as shown in Figure II-2. In this way, an operator can smooth his internal cash flows through proper timing and thereby, adjust the profits he shows.

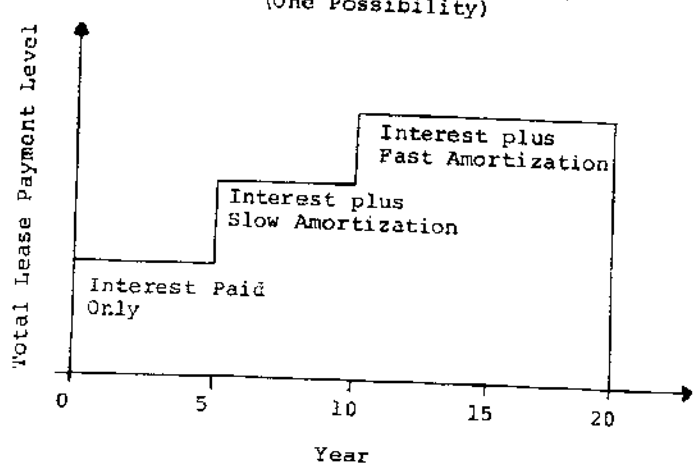
Table II-1

Effect of Buying Vs. Leasing Two
$15M Ships on the Financial Statements of the Ship Operators

(figures given in $000s)

	Case I BUY	Case II LEASE
Balance Sheet		
Current Assets	$ 50,000	$ 50,000
Fixed Assets (net)	130,000	100,000
Total Assets	$180,000	$150,000
Current Liabilities	$ 30,000	$ 30,000
Long Term Debt	100,000	70,000
Total Debt	$130,000	$100,000
Net Worth (Equity)	50,000	50,000
Total Liabilities	$180,000	$150,000
Income Statement		
Operating Revenue	$ 50,000	$ 50,000
Operating Expense	$ 18,500	$ 18,500
Depreciation Expense (St. Line)	8,500	7,000
Interest on Long Term Debt (8%)	8,000	5,600
Lease Payment Expense	--	3,900
Total Expense	$ 35,000	$ 35,000
Income before Taxes	$ 15,000	$ 15,000
Taxes	(7,500)	(7,500)
Net Profit	$ 7,500	$ 7,500
Ratios		
Net Profit/Total Assets	4.17%	5.0%
Total Debt/Total Assets	72.2%	66.7%
Total Debt/Equity	260.0%	200.0%

Fig. II-2
Illustration of Step Leasing
(One Possibility)



3. <u>Disadvantages to Leasing:</u> Certain obvious disadvantages may arise when lease financing is employed:

a) <u>Residual Value:</u> Most leases stipulate that the lessee pay off the entire initial cost of the ship plus appropriate interest on the amount outstanding. If the lease runs for 15-20 years, the ship may have considerable residual value at the time the lease is terminated. The lessee, in general, has no claim on this value even though he has essentially paid for the ship in full.

b) <u>Higher Interest Cost:</u> The lessor is usually interested in making a profit and will generally charge the lessee a higher interest rate than he is paying on debt and equity invested in the ship. Hopefully the lessor's savings in accelerated depreciation and investment credit which the lessee could not have realized will have an offsetting effect on the interest charged to the lessee. Usually, however, the total dollar cost of leasing is higher than the cost of buying.

4. <u>Leasing - Summary</u>: For each alternative, buying and leasing, the following costs must be considered:

EXPLICIT BENEFITS OR COSTS	The net present value of buying cash flows vs. leasing cash flows
IMPLICIT BENEFITS OR COSTS	Credit rating, leverage, balance sheet effects, cash flow flexibility, and specific commitments made or not made due to the lease

The explicit costs of buying vs. leasing are treated in more detail in Chapter VII. Leasing under Title XI is discussed in Chapter IV.

CHAPTER III

THE TAX ENVIRONMENT FOR U.S. SHIPPING COMPANIES

A. Introduction

When considering any financing alternative it is of paramount importance to be aware of the implications it has on taxation to the shipping company. In most instances the tax laws that apply to any corporation are those which are applied to the shipping company. Due to the international nature of the business, however, certain rules in considering foreign source income can have major effects on financing alternatives open to the U.S. shipowner. In addition, there is a special program for owners of U.S. flag vessels allowing them to place certain company cash flows in a special account which gives rise to deferral of federal income taxes. The author feels that this program is of such importance to financing U.S. flag ships that all of Chapter V will be devoted to it. This chapter will include the following points with respect to taxation of steamship companies: (1) Federal taxation of ordinary income, (2) capital gains taxation, (3) property taxes, and (4) foreign tax credits.

B. Federal Income Tax

In general, steamship companies, as most corporations, keep two sets of books: one for business accounting and another for purposes of calculating income tax liability. Recognizing the time value of money, the corporation will postpone gross income for as long as is legally possible for tax purposes. Similarly, expenses are written off against this gross income as soon as possible. The effect is to defer payment of tax for the longest possible time. The following paragraphs attempt to describe the major considerations concerning income tax for steamship companies, but it should be recognized that specific taxation problems require the analysis of an expert on Federal income tax law.

1) Tax Rates and Taxable Income: The "tax base" upon which a company's tax liability is calculated is net income defined as gross income (less) business operating expenses (less) depreciation. As mentioned earlier, exact definitions as to what can be legally considered gross income or business expense requires the careful analysis of an expert. More will be said about depreciation later. Once a company has figured its tax base for a given year, it is subject to a simple percentage of this as Federal tax liability. Presently, this rate is 22% on the first $25,000 plus 48% on any net income in excess of $25,000. These percentages are, therefore, marginal tax rates. Since the income magnitude of most shipping companies is well in excess of $25,000 (in profitable years), the average tax rate approaches 48%. For instance, the average tax rate on $55,000 is 46.7%, and on $5,000,000 is 47.9%. Therefore, for any capital budgeting or financing decisions, an appropriate tax rate estimate is 48%. The

federal government may, at any time, alter this rate in carrying out fiscal policy and any insights into the nature of this change may be important to financing and business decisions in general.

2) Depreciation: Section 167 of the Internal Revenue Code of 1954 allows a company to deduct reasonable depreciation of certain property from gross income in computing taxable income (tax base). This property must be used in trade or business or held for the production of income. The purpose is to allow businesses to recover, through annual deductions, the cost of the property over its useful economic life. In the case of steamship companies, a minimum economic life is clearly defined for the largest portion of its total depreciable assets; the guideline economic life for vessels, barges, tugs and similar water transportation equipment is 18 years. The only exception to this rule is the case where a vessel is utilized exclusively in marine contract construction (pile driving barges, workboats, floating cranes, etc.). In this case, the minimum depreciable life is 12 years. Of all the general classes of transportation, water transportation equipment is considered by the IRS to have the longest "life". In comparison, equipment used in other modes of transport have the following minimum lives:

Railroad cars	15 years
Buses	9 years
Aircraft	6 years
Heavy Trucks	6 years
Trailers and Trailer-Mounted Containers*	6 years
Tractor units	4 years

As to the method of calculating yearly depreciation, the IRS allows three methods which steamship companies can employ. The following is a summary of these methods where

V_D = original depreciable value (capitalizable cost) of vessel in dollars

V_S = salvage value of vessel (usually about 2-1/2% of V_D) in dollars

L = economic life of vessel - 18 years minimum

n = "year number" of depreciation (i.e., first year, second year, ... 18th year)

D_n = depreciation to be taken in year n (D_o = 0, always)

*These containers include the type carried aboard ship and, to some steamship companies, can represent significant depreciation cash flow.

a) Straight Line: This method allows for an equal depreciation writeoff each year.

$$D_n = (\frac{1}{L})(V_D - V_S), \qquad n = 1,2,\ldots,L$$

b) Double Declining Balance: This method is one of the "accelerated" variety. That is, it allows for a more rapid depreciation in early years yielding a higher net present value of total tax shelter. Simply stated, depreciation each year is equal to twice the straight line rate applied to the remaining depreciable value of the asset. This method will not allow, however, for full depreciation of the asset if used indefinitely. Therefore, U.S. tax law allows for a switch to straight line at any time. The optimum time to switch is when the straight line depreciation rate exceeds the rate allowable under the following D.D.B. formula.

$$D_n = (\frac{2}{L}) \times (V_D - V_S - \sum_{n=0}^{n-1} D_n)$$

$n = 1,2,\ldots,$ "switchover" year

c) Sum of Years Digits: This method is the "most accelerated" allowed under U.S. tax law. That is, it has the highest present value of total tax shelter. The formula is

$$D_n = \frac{(L-n+1)}{S}(V_D - V_S), \quad n=1,2,\ldots,L$$

where S = sum of years digits = $L(\frac{L+1}{2})$.

It should be clear, at this point, that accelerated methods are of great financial advantage if asset acquisition is properly timed. Many companies cannot, however, take full advantage of this tax shelter due to insufficient income in a given year to cover the depreciation writeoff. This gives rise to the leasing alternative whereby a financially strong corporation will own the vessel and take advantage of the rapid depreciation while leasing it to a responsible operator. A portion of this tax saving will be passed on in the form of reduced lease payments by the lessor (operator) who otherwise could not have received such tax shelter. This subject is discussed in more detail in Chapter IV and the actual cash flows are calculated in Chapter VII.

3. Interest and Lease Payments: For purposes of completeness in discussing taxable income, it is important to include the other major sources of tax writeoff connected with real and hidden debt. Simply, all interest payments on company debt as well as lease payments on leased equipment are tax deductible. As was shown in Chapter I, this form of tax shelter is the major justification for partial debt financing of U.S. corporations.

4. Investment Tax Credit: U.S. tax law provides that a steamship company can take as a direct deduction from its income tax liability a fixed percentage of the acquisition cost of a new asset. This credit is only valid for the year in which an asset is acquired, yet certain amounts can be carried forward. It should also be noted that the nature of the credit or even its very existence is subject to U.S. fiscal policy since it is designed to stimulate investment. The revenue act of 1971 reinstated the investment tax credit which was previously temporarily suspended. Under this law, 1/3 of 7% of cost is credited for assets with depreciable lives of 3-5 years, 2/3 of 7% of cost for assets with depreciable lives of 5-7 years, and 7% of cost for assets with depreciable lives of 7 or more years. Clearly, vessels would qualify for the full 7%, yet containers could only receive credit for 2/3 of 7%. If the asset is disposed of prior to its depreciable life, the government must be reimbursed for the difference between the original credit taken and the credit based on the asset life at disposal. If a credit cannot be used in a given year, it may be carried forward or back subject to certain limitations. Further, taking of investment credit does not reduce the depreciable value of the asset. As was the case for accelerated depreciation, many steamship companies cannot take full advantage of investment tax credit due to insufficient net income in a given year. By similar reasoning, this situation gives rise to leasing arrangements, whereby the lessor passes on the tax savings to the lessee, again in the form of reduced lease payments.

5. Dividend Income: An important tax rule is that dividends on corporate securities owned by a steamship company are 85% exempt from taxation. If the corporation receiving dividends owns 80% or more of the dividend paying firm, no tax is paid at all since the owner can file a consolidated return.

6. Carry Back and Carry Forward: If a net loss is incurred by a steamship company, this loss can be carried back as much as three years or forward five years. In this way, the company does not lose the tax shelter provided by expenses written off in the year of the net loss. However, if carried forward, a partial loss of the shelter is incurred due to the time value of money.

C. Capital Gains Tax

In addition to ordinary income as described in the preceding section, a steamship company may own "capital assets" which, upon their sale, may give rise to a capital gain or loss.

Real and depreciable property are not considered capital assets, yet, are treated as such in the event of a net capital gain. The tax rate on long term capital gains (for assets held 6 months or more) is only 25%. In the case of depreciable property, a net capital gain only occurs when the property is sold at a price higher than its original cost. Gains over book value due to depreciation are taxed as ordinary income as this gain is considered recaptured depreciation. This is an important distinction as will be shown in Chapter V for the case of capital construction funds.

A provision of the Merchant Marine Act of 1936 allows a shipping company to trade into the government an obsolete ship in exchange for an allowance on the purchase price of a new vessel. If a gain or loss is recognized on this transaction, it is not recognized for tax purposes. Another case of disposal of a vessel is if it is sunk, destroyed, or condemned. Here, the owner may receive compensation through insurance or other procedures. Such compensations greater than the value of the vessel are tax exempt if used for vessel replacement before a certain period of time.

Capital losses can never be deducted from ordinary income as a tax shelter. They may only be used to offset a capital gain. For this purpose they can be carried forward for five years.

D. Property Taxes

Property taxes are a large expense to most industries. However, due to the fact that a large part of their assets are vessels, shipping companies escape this form of local taxation. Real property taxes are levied on land, buildings and improvements. In some cases personal property taxes are applied to inventories, furniture, fixtures, trucks, cranes, stevedoring gear, accounts receivable and bank deposits. This tax liability is generally minimal for a shipping company.

E. Foreign Tax Credits and Foreign Source Income

U.S. tax law provides for reciprocal tax exemptions for companies with foreign subsidiaries. Under this law, foreign taxes can be treated as a tax credit and deducted from federal income taxes. This credit, however, is limited as follows:

$$\frac{\text{TOTAL FOREIGN TAX CREDIT}}{\text{TOTAL U.S. TAX LIABILITY*}} \leq \frac{\text{TOTAL FOREIGN SOURCE INCOME}}{\text{TOTAL U.S. TAXABLE INCOME*}}$$

The taxpayer has the option of calculating these ratios for either the aggregate credit or on a per country basis. The limitation has the broad effect of partially prohibiting the credit of taxes paid in countries with a higher tax rate than that of the U.S.

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*Note that U.S. taxable income includes income from foreign sources. U.S. tax liability is calculated on this base.

Until 1971, a large portion of the income earned on vessels owned by U.S. companies had to be considered foreign source income. As a result, certain leasing arrangements, recently allowable in connection with Construction Differential Subsidy and/or Title XI financing, became very difficult. In the opinion of a former financial manager of a major U.S. shipping company, this limitation was a contributing factor toward the slow start of the 30 ships/year replacement program of the Merchant Marine Act of 1970. The problem was as follows:

Soon after the enactment of the Merchant Marine Act of 1970, with the shipping market in a healthy condition, several U.S. companies sought to build ships to replace and strengthen their fleets. Experiencing difficulty in financing such investments internally or by issuing debt, these companies sought leasing arrangements. Traditionally, the parties willing to act as lessors had been commercial banks and other special leasing companies. At that time, these potential lessors were already saturated with foreign source losses to balance gains associated with their foreign holdings. Therefore, if vessel income/loss were considered in foreign source accounts for tax purposes, a problem would arise. To take advantage of accelerated depreciation, such vessels would necessarily give rise to large foreign source losses in initial years. The potential lessors simply could not afford such losses in their foreign source accounts especially since there was no provision for carry forward or back of these foreign losses. The Treasury Department held that, indeed, vessel income was to be considered foreign source and thus a potential method of ship financing had been nearly eliminated.

Several corporations with no problem in taking on foreign losses in their foreign source accounts did provide a few leasing arrangements, yet this source of financing is, presently, far from reaching its potential. The future, however, is much brighter. The Revenue Act of 1971 provided a special provision revising foreign source income rules and allowing consideration of vessel income as domestic source income. This opens up the yet untapped major sources of lease financing which should soon become widely used in the financing of U.S. flag ships.

CHAPTER IV

TITLE XI FEDERAL SHIP MORTGAGE AND LOAN INSURANCE PROGRAM

A. Introduction

Perhaps the most "successful" of all government activities connected with the merchant marine is the Title XI Federal Ship Mortgage Insurance program. If we consider its goal as making available debt financing at low rates to shipowners, the program has shown and should continue to show a high level of achievement. Indeed, under Title XI, most shipowners can obtain debt costs of possibly 2-3% lower than the market would normally allow given the general state of the industry and the specific financial position of individual companies. It is the author's feeling as well as the feeling of several Maritime Administration officials that many companies could not obtain such debt financing at all without this form of government assistance.

With the exception of several unusual cases, the most widely used method of financing the debt portion of U.S. flag vessels involves the use of Federal Ship Mortgage and Loan Insurance. With its increasing flexibility allowing for many variations in financing schemes, there is little reason to expect this to change in the future. For this reason, much effort will be taken in attempting to cover the important points of the program. First, eligibility requirements and the extent and method of coverage will be discussed. Second, a detailed cash flow analysis is presented with a complete description of each flow as well as the documentation involved in the procedure. Third, basic financing alternatives available under Title XI are discussed including refinancing, pre- and post-delivery financing, and leaseback arrangements. Fourth, the application procedure is outlined, and fifth, pending legislation to update the present Title XI program is explained. Finally, a set of conclusions on the present and future condition of this important federal ship financing aid will be presented making use of points developed in this chapter.

B. The Program

The United States Government insures commercial loans and mortgages to finance a fixed proporiton of the "actual cost" of construction, reconstruction, or reconditioning of merchant and some other type vessels. This insurance is authorized and defined by Title XI of the Merchant Marine Act of 1936 as currently amended. The general guidelines for its implementation are contained in Title 46, Chapter 11, Subchapter D, Part 296 of General Order 29 as it is revised in the Federal Register. The program is administered by the Secretary of Commerce acting through the Assistant Secretary for Maritime Affairs (Head of the Maritime Administration). The following paragraphs will show what makes one eligible for such a program, what is covered by the program and the internal cash flows of the program.

1. Eligibility: The eligibility requirements for Title XI pertain basically to vessel type and owner/operator. The specifications are as follows.

a) The Vessel: In order to receive Title XI insurance the vessel must, in general, fall into one of the following categories: (i) passenger ship, cargo ship, combination passenger-cargo ship, hydrofoil, surface effect craft, tug, dredge, fishing vessel, oceanographic research or instruction vessel, all of which must be over five net tons; (ii) towboat, barge, scow, lighter, car float, canal boat or tanker, all of which must be over 200 gross tons; (iii) floating dry dock with a capacity greater than 35,000 tons and a beam greater than 125 feet between the wing walls. It should be noted that these requirements are quite broad and are subject to liberal interpretation. For example, a Title XI application for a semi-submersable oil rig was recently approved by MARAD. In addition to meeting the "vessel type" requirement, several other specifications must be met. The ship must meet the highest American Bureau of Shipping standards for vessels of similar age and type, conform to the regulations of the Safety of Life at Sea Convention and meet all standards set by the U.S. Coast Guard and other government agencies. All ships receiving Title XI must be built and documented in the U.S. and bid upon competitively in some form unless the vessel is purchased under certain rules with C.D.S.

b) Owner/Operator: The shipowner (mortgagor) must be a U.S. citizen. He must, in the opinion of the Secretary, possess the ability, experience, financial resources and other qualifications necessary to adequately operate and maintain the mortgaged property. In leaseback arrangements the lessee must meet certain of these requirements also. Detailed financial reports are submitted to MARAD to make certain of the facts in making these judgements. In addition to the owner/operator, other parties involved must be U.S. citizens and are subject to some financial scrutiny. These include the mortgagee, lender, managing agents (in the case of bareboat charters), and trustee (when public bond issues are involved). A requirement open to broad interpretation is that of "economic soundness". The applicant for Title XI must file detailed plans demonstrating to the Secretary that the ship in question is of such a nature that it can be put into service and enjoy relatively certain economic success.

c) The eligibility requirements just stated do not, in practice, cause considerable difficulty to prospective applicants They are, many times, broadly interpreted by MARAD in the interest of building the U.S. fleet. It is quite possible for foreign interests to become partially involved as parties in the Title XI financing method (mostly as bondholders) which adds to its flexibility, yet detracts somewhat from the favorable balance of payments effect of having a U.S. flag ship in lieu of one flying foreign colors.

2. Coverage: A Title XI Mortgage or Loan Insurance Contract is between the trustee (lender or mortgagee) and the U.S. Government. It provides, in general, in the event of specified defaults by the borrower or mortgagor, for the payment by the United States to the trustee of interest on and the unpaid balance of the principal amount of any insured loan or mortgage.

a) Mortgage and/or Loan: The Title XI program is designed to insure two types of debt instruments as was previously inferred. These are the "Construction Loan" and "Ship Mortgage". Construction loans are used for the short-term financing of ship construction, reconstruction or reconditioning of eligible merchant vessels while work is in progress. These loans are secured only by the ship construction contract and borrower's interest in the unfinished ship. They must necessarily be repaid or replaced by long-term mortgage loans upon delivery of the ship. In practice, the government will generally sign a contract to insure both the loan and later the mortgage so that generally the loan flows quite smoothly into the mortgage and involves the same creditors. The mortgage loan is secured by the actual completed vessel and provides funds for the long-term financing of construction, reconstruction or reconditioning of the eligible vessel.

b) Actual Cost: The "actual cost", upon which maximum Title XI insurance coverage is based, includes the following items.

i) Normal contractor's items of cost (less) any CDS or National Defense Feature payments.

ii) Commitment fees on the loan or mortgage during the construction period.

iii) Interest on the loan during the construction period.

iv) Other items such as inspection, design, and owner's outfitting costs.

The following items are specifically excluded from actual cost:

i) Legal fees and expenses.

ii) Accounting fees.

iii) Commitment fees and interest except as mentioned above.

iv) Fees for securing loan or mortgage.

v) Printing and filing fees connected with Title XI

vi) Underwriting or trustees' fees.

vii) Documenting fees.

viii) Investigation fee.

ix) Yearly Title XI premium.

x) Predelivery operating expenses and vessel insurance.

xi) Surveying fees.

"Actual cost" is generally less than the "capitalizable cost" of the vessel as figured for accounting and tax purposes, but in most cases it is quite close.

c) Maximum Insurance Coverage: On the following page is Table IV-1 which shows the maximum percentage of the "actual cost" of the ship covered by Title XI insurance. It is the maximum percentage which is, in practice, debt financed. The remainder is usually equity capital supplied directly by the owner, sometimes through a government regulated "capital construction fund" which will be discussed later in this paper.

d) Maximum Duration: A construction loan is insured only for the period of construction, after which the ship must be financed through a mortgage loan. The mortgage loan may extend for the duration of the "economic life of the vessel". An upper limit is placed on this economic life as follows.

Type of Ship	"Economic Life"
Tankers and Liquid Bulk	20 years
Other New Vessels	25 years
Reconstructed Vessels	(Determined on individual basis)

It should be noted that most foreign countries offer vessel financing for a maximum duration of only seven years.

e) Aggregate Principal and Interest Insured: The statutory limit on total principal and interest which may be insured under the Title XI program is now $3 billion (recently raised from $1 billion by the 1970 Merchant Marine Act). Figure IV-1 on the following page shows a history of the level of insured principal and interest over the past 13 years. In June 1970, 53% of all outstanding principal and interest insured was for freighters, 39% tankers, and the remainder was either combination carriers, barges, tugs or hydrofoils. It was estimated that by June 1971, the total value of contracts approved and in force was over $1.168 billion, thus demonstrating a marked recent growth of participation in the program.

Table IV-1

Title X Coverage Schedule

Category	Max. Insurable % of "Actual Cost" 75%	87 1/2%
1) Any vessels built with CDS	X	
2) Any vessels transporting goods on inland waters only	X	
3) Any passenger vessels operating solely on inland rivers, less than 1000 gross tons and capable of speed greater than 8 knots		X
4) All oceangoing tugs of more than 2500 horsepower		X
5) All oceangoing barges of more than 2500 gross tons		X
6) All other vessels greater than 3500 gross tons and capable of a speed greater than 14 knots		X
7) All other vessels less than 3500 gross tons and capable of a speed less than 14 knots	X	

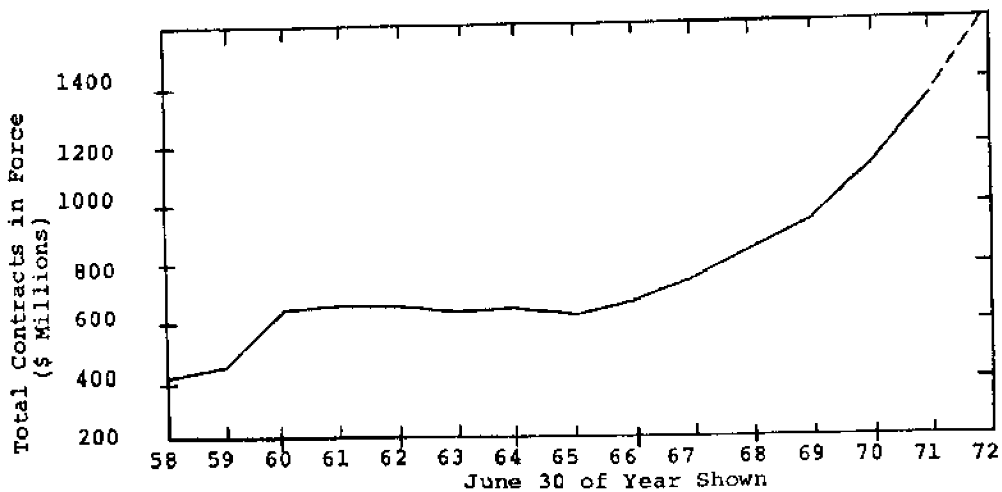
Source: Maritime Administration

f) Federal Ship Mortgage and Loan Insurance Fund: With the creation of the Title XI program, a revolving fund was set up in order to make available the necessary liquid assets to carry it out. There was an initial appropriation of $1 million for this fund and by law the Department of Commerce is permitted to borrow from the Treasury in the events that large default payments exhaust the fund's existing assets. According to Maritime Administration officials, this has only occurred once, at which time $15 million was borrowed. However, for the past 10 years the program has operated in the black with present net U.S. Government equity of over $30 million. Figure IV-2 shows the fund's history for the past 10 years. It should be noted that the rate of growth of the fund has been equal to or better than the growth in total insurance contracts. The Maritime Administration does not feel, however, that the program is excessively profitable. They point out that even at the fund's present high level, it would take only 2-3 large defaults to wipe out all its assets.

Figures IV-3 and IV-4 are income statements and balance statements of the fund for fiscal years 1970 and 1971. They show, for instance, that premiums on mortgage loans make up better than half the fund's income, with investment of the fund providing a sizable portion. Essentially, the only expense the program shows is an occasional default payment. In the entire history of the program only eight actual defaults on

Fig. IV-1

Aggregate Amount of Principal and Interest Insured Under the Title XI Federal Ship Mortgage Insurance Program

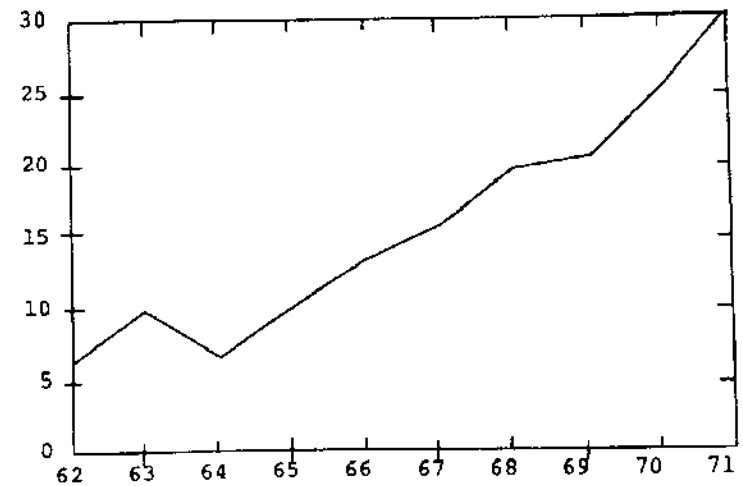


Date	Contracts in Force ($ Millions)
June 30, 1958	219.1
June 30, 1959	257.1
June 30, 1960	449.0
June 30, 1961	464.1
June 30, 1962	458.8
June 30, 1963	431.2
June 30, 1964	454.5
June 30, 1965	421.6
June 30, 1966	485.2
June 30, 1967	562.1
June 30, 1968	651.6
June 30, 1969	751.6
June 30, 1970	919.4
June 30, 1971	1168.0

Source: Maritime Administration Annual Reports

Fig. IV-2

Balance (U.S. Government Equity) In the Federal Ship Mortgage Insurance Revolving Fund



Date	Balance in Fund ($ Millions)
June 30, 1962	6.0
June 30, 1963	9.8
June 30, 1964	6.8
June 30, 1965	9.8
June 30, 1966	12.9
June 30, 1967	15.2
June 30, 1968	19.0
June 30, 1969	20.0
June 30, 1970	25.1
June 30, 1971	30.3

Source: Maritime Administration Annual Reports

Fig. IV-3

Income Statement

	Year Ended June 30	
Income:	1971	1970
Premiums on mortgage loans	$3,354,866	$3,163,822
Income on investments	1,074,885	745,440
Interest earned on notes and mortgages	722,826	911,501
Premiums on construction loans	485,435	124,770
Investigation and filing fees	371,585	315,117
Miscellaneous revenue	15,000	17,612
	$6,024,597	$5,278,262
Expenses:		
Loss on foreclosure of vessel	$ 809,655	
Other expenses	1,972	$ 212
	$ 811,627	$ 212
Net income from operations (schedule 5) (exhibit 3)	$5,212,970	$5,278,050

U.S. Department of Commerce - Maritime Administration Statement of Operations of Federal Ship Mortgage Insurance Revolving Fund For the Years Ended June 30, 1971 and 1970

Source: Maritime Administration

ASSETS

	June 30, 1971	June 30, 1970
CASH AND FUND BALANCES:	$ 167,958	$ 376,282
Fund balance with U.S. Treasury	$ 167,958	$ 376,282
ACCOUNTS AND NOTES RECEIVABLE:		
Premiums and fees receivable	353,250	101,882
Accrued interest receivable - Notes and mortgages	218,272	339,446
Notes receivable	136,741	
	$ 708,263	$ 441,328
INVESTMENTS - U.S. GOVERNMENT SECURITIES	22,749,245	14,059,581
LOANS RECEIVABLE - DOMESTIC FIRMS:		
Mortgage loans	$20,360,519	$22,051,601
Less allowance for losses	9,927,825	9,173,949
	$10,432,694	$12,877,652
VESSEL OWNED	150,000	
DEFERRED CHARGES:		
Insurance advances - H. S. VICTORIA		$ 9,039
Expenditures pertaining to libeled vessels	$ 719,828	713,498
	$ 719,828	$ 722,537
Less allowance for losses	719,828	713,498
	$ -0-	$ 9,039
	$34,208,160	$27,763,882

LIABILITIES

	June 30, 1971	June 30, 1970
ACCOUNTS PAYABLE	$ 2,816	$ 2,816
DEFERRED AND UNDISTRIBUTED CREDITS:		
Unearned insurance premiums	3,143,333	1,954,383
Securities and cash held pending litigation (Skouras)	719,377	677,019
	$ 3,862,710	$ 2,631,402
EQUITY OF THE UNITED STATES GOVERNMENT:		
Balance beginning of the fiscal year	$25,129,664	$19,851,614
Net income from operations (exhibit 3) (schedule 6)	5,212,970	5,278,050
Balance at end of fiscal year (exhibit 1)	$30,342,634	$25,129,664
	$34,208,160	$27,763,882

U.S. DEPARTMENT OF COMMERCE - MARITIME ADMINISTRATION
FEDERAL SHIP MORTGAGE INSURANCE REVOLVING FUND
BALANCE SHEET - JUNE 30, 1971 AND 1970

Source: Maritime Administration

Figure IV-4

vessels have been recorded, most of which are now in service. This fact is largely due to MARAD's effort to act as a buffer between the mortgagee and the mortgagor at times when the mortgagor faces economic difficulty. They quite regularly effect advances and/or deferrals of mortgage principal. payments to avoid the occurrence of a total default which would mean insurance payment in full by the government. Due to this practice, the Title XI program has acted to stabilize the financing of many U.S. ships for companies that would otherwise be faced by financial embarrassment costs at frequent intervals. Even when a default occurs, insurance is paid, and the government forcloses a mortgage, the net loss is generally small. For instance, the greatest single net loss was $3.6 million on a default involving the tanker Titan, where the Maritime Administration paid $11.9 million in mortgage insurance, but recovered $8.3 million through the sale of the vessel two years later.

It should be stressed that although administrative costs to the government are not included in the accounting figures cited, the Title XI program has yielded great benefit to the U.S. shipping industry with little cost to society. It is the only major program designed to promote the U.S. merchant marine which does not involve any direct or indirect subsidy.

C. Cash Flow Analysis and Details of the Title XI Program

1. Brief Explanation

The purpose of this section is to outline in detail the mechanics of financing a ship using first a construction loan which is designed to flow smoothly into a mortgage loan after delivery of the ship. Both these instruments are assumed to be insured under Title XI. "Smooth flow" in this case, means that the same creditor(s) (bondholders) are involved for both loan and mortgage. Figure IV-5a) and b) is a schematic diagram outlining the situation just described. It includes 1) all major cash flows involved, 2) documentation, 3) major parties involved, nad 4) the various funds created to implement the procedure. A thorough understanding of this diagram should leave the reader with the essential knowledge required in comprehension of the method by which large numbers of ships are financed in the United States.

Referring now to Figure IV-5, a brief explanation is as follows: Figure IV-5a shows the cash flows involved in financing during construction with the issue of merchant marine bonds. The circles represent parties involved, the rectangles are funds and flows, and the parallelograms are documents and agreements. Each of these items is described in more detail later in this section. Subsequent to government approval of the application for construction loan insurance and the applicant's qualification in the area of net worth and working capital requirements, the various documents defining all transactions are drafted. These are the trust indenture, loan agreement, escrow agreement, and Title XI loan insurance contract. If there is to be a similarly insured mortgage insurance contract are also drawn up. This phase gives rise to filing fees, investigation fees and legal, consulting, printing and accounting fees paid by the borrower. The next event is the actual closing of all contracts and drawdown of bond proceeds. Additional legal fees as well as bond underwriter's or agency fees are encountered at this time. The bond proceeds are deposited in an escrow fund held by the Treasury Department and a construction fund held by the trustee. The company must also deposit the expected interest payments on money in the escrow fund and pay the first 25% or 12-1/2% of the "actual cost" of the ship to the shipyard. (Note: whenever the phrase "12-1/2% or 25%", "87-1/2% or 75%" is encountered, it refers to maximum coverage allowable as outlined in Table IV-1.) the borrower must also start to make interest payments to the lender and pay in advance the yearly Title XI insurance premium charge. At the time the ship is officially delivered, this construction loan will flow directly into a mortgage loan. The mortgage loan arrangement is shown in Figure IV-5b. Many of the items described for the loan will be the same during the mortgage with a few exceptions. For example, principal payments (amortization) must begin, the yearly insurance premium is increased, and a restricted fund is generally set up to provide additional collateral from vessel operating profits.

The sections that follow give a detailed explanation of all points covered in Figure IV-5 and this diagram should be consulted regularly while reading each section. It should be remembered that this is not the only possible arrangement for Title XI financing and alternative strategies will be presented in later sections.

2. Documentation and Major Parties Involved:

In the process of obtaining a construction loan and/or mortgage with Title XI insurance theron, several major documents must be drafted and agreed upon by combinations of the parties involved. Basically, there are three such parties in these agreements: 1) the owner (who is referred to as "borrower" during the construction loan period and "mortgagor" during the mortgage period), 2) the trustee (who is "lender" during the construction loan period and "mortgagee" during the mortgage period), and 3) the U.S. Government (represented by the Maritime Administration, Department of Commerce). The documents described in the following paragraphs clearly define, in legal terms, the responsibilities, commitments and requirements of each party involved. They are represented by parallelograms in Figure IV-6, which shows graphically where they fit in. Many of the required terms of these contracts are outlined in either Title XI of the Merchant Marine Act of 1936 or General Order 29, Title 46, Chapter II-D appearing in the federal register. Figure IV-6 is a copy of an actual table of contents of a "Commitment to Insure Loan and Mortgage" by the U.S. Government. It shows all major documentation required to fully carry out a construction loan and mortgage loan as insured under the Title XI program.

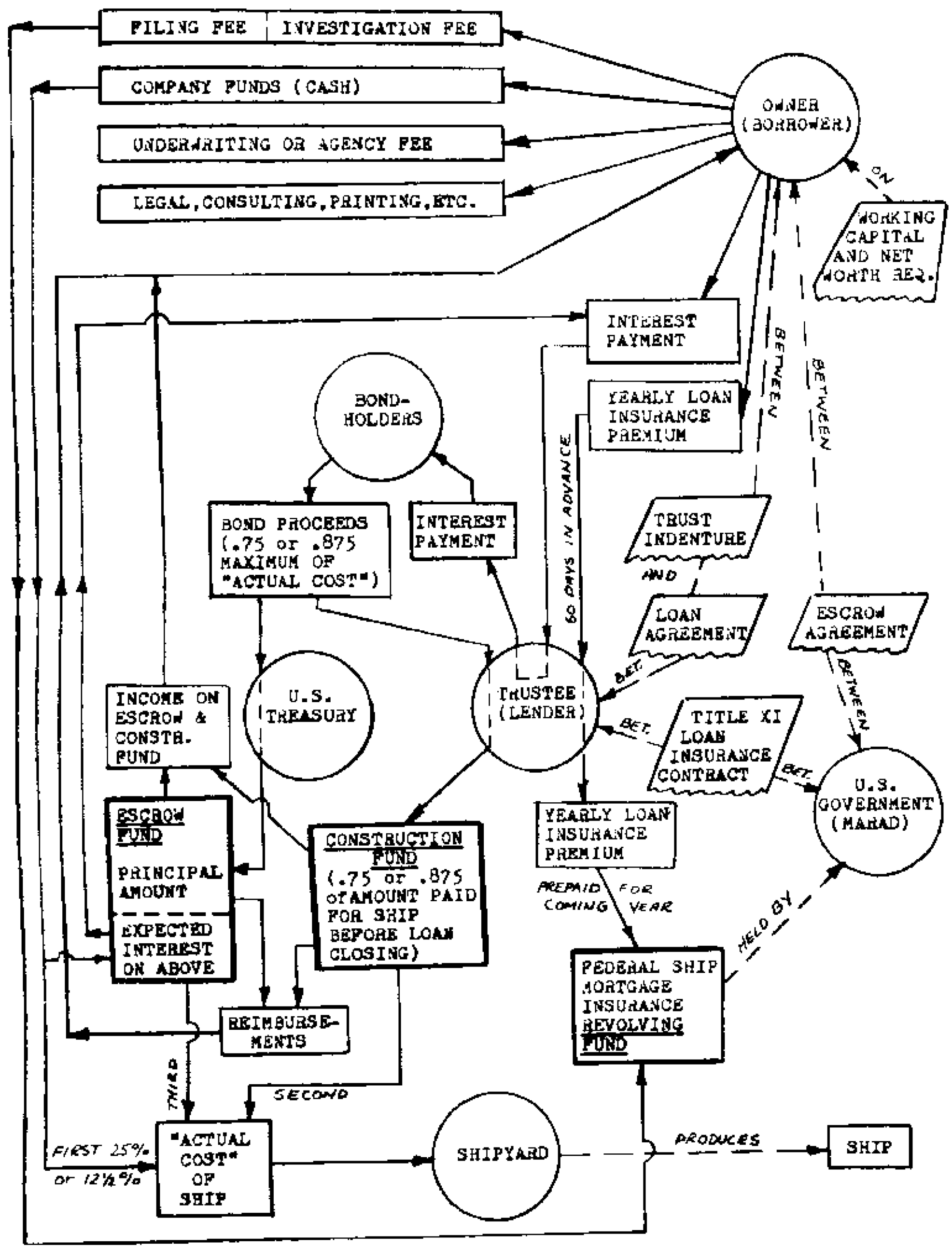


FIG. IV-5a): FINANCING DURING CONSTRUCTION WITH A TITLE XI CONSTRUCTION LOAN*** CASH FLOW AND DOCUMENTS DIAGRAM

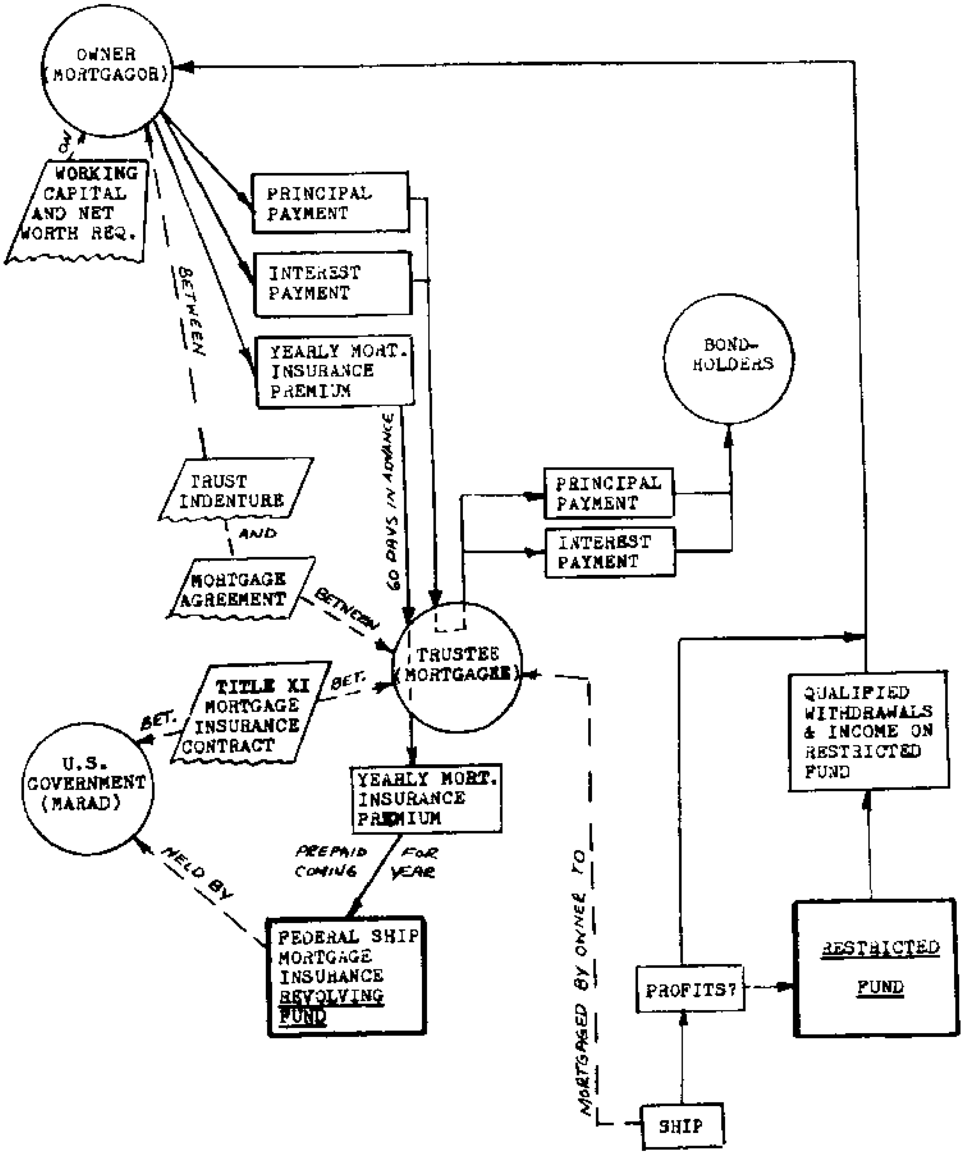


FIG. IV-5b: FINANCING AFTER CONSTRUCTION WITH A TITLE XI MORTGAGE LOAN*** CASH FLOW AND DOCUMENTS DIAGRAM

__________________________CORPORATION

(HULL ___)

FINANCING

DOCU-
MENT

1. Loan Insurance Commitment.
2. Appendix I — Purchase Agreement.
3. Schedule I — List of Underwriters.
4. Schedule II — Form of Delayed Delivery Contract.
5. Appendix II — Commitment Letter.
6. Appendix III — Trust Indenture.
7. Exhibit A — Provisions incorporated into Trust Indenture by reference.
8. Exhibit B — Guaranty Agreement.
9. Exhibit C — Construction Contract (with Consent of Shipbuilder annexed).
10. Exhibit D — Ship Mortgage.
11. Exhibit 1 — Provisions incorporated into Ship Mortgage by reference.
12. Exhibit 2 — Form of Definitive Bonds.
13. Appendix IV — Loan Insurance Contract.
14. Exhibit A — General Assignment Form under Loan Insurance Contract.
15. Exhibit B — Bond Assignment Form under Loan Insurance Contract.
16. Appendix V — Loan Agreement.
17. Exhibit A — Provisions incorporated into Loan Agreement by reference.
18. Exhibit B — Opinion of Company Special Counsel.
19. Appendix VI — Escrow Agreement.
20. Appendix VII — Documents amending ________________ Title XI financing documents and related documents.
21. Mortgage Insurance Commitment.
22. Appendix I — Mortgage Insurance Contract.
23. Exhibit A — General Assignment Form under Mortgage Insurance Contract.
24. Exhibit B — Ship Mortgage Assignment Form under Mortgage Insurance Contract.
25. Exhibit C — Bond Assignment Form under Mortgage Insurance Contract.

FIGURE IV-6
TABLE OF CONTENTS FROM
"Commitment to Insure Loan and Mortgage"

Following is a brief description of the important documents:

a) Trust Indenture: The Trust Indenture is a contract between the borrower or mortgagor and the trustee who represents the lender or mortgage. This contract establishes a long-term agreement between the borrower and lender outlining restrictions and requirements of both parties for the duration of the outstanding bonds. It usually includes the following items: 1) a complete description of property pledged or mortgaged, 2) a complete description of bonds, 3) authorization of amount of bonds to the issued, 4) a list of covenants or restrictions placed on the borrower by the lender, 5) a detailed definition of what constitutes a default and how it may be remedied, and 6) a description of the "construction fund" to be held by the trustee during construction.

b) Title XI Loan or Mortgage Insurance Contract: This insurance contract is between the U.S. Government and the trustee. Basically, it guarantees payment of interest and/or principal on the mortgage or loan. It includes the following items in detail: 1) extent of insurance, 2) period of insurance, 3) termination of insurance, 4) demand for and payment of insurance, 5) insurance premiums required to be paid by the trustee to the U.S. Government, 6) covenants placed on the trustee (lender or mortgagee) by the U.S. Government, and 7) miscellaneous agreements.

c) Loan Agreement: The loan agreement is a contract between the trustee (lender) and owner (borrower). This agreement secures the construction loan for the period of the loan by placing certain responsibilities upon the shipowner and designating the unfinished ship as partial loan security. It also includes items similar to those stated in the trust indenture. Specifically, such points as vessel insurance, payment from owner to trustee of Title XI Loan Insurance premiums, definition of defaults and remedies thereon, rights of the Secretary of Commerce, terms of bond redemption and procedure for replacement of the loan with a mortgage are covered.

d) Mortgage Agreement: The mortgage is a contract in which the owner (mortgagor) pledges the ship to the trustee (mortgagee) as security for the loan in question after the ship is delivered. It contains points similar to those appearing in the loan agreement if such a loan is to be replaced by a mortgage. Also, included in this contract are certain restrictions on the working capital and net worth of the mortgagor as well as requirements as to the creation of a restricted fund into which vessel profits must be deposited.

Restrictions in the Case of Non-Payment: In general, the mortgage agreement will contain provisions financially restricting the mortgagor in the case of his failure to make timely payments according to the obligations secured by the mortgage. The Secretary of Commerce generally requires that the following restrictions be included in the mortgage in case of such an occurrence.

1) No capital may be withdrawn.

2) No share capital may be redeemed or converted to debt.

3) No dividends may be paid.

4) No loans may be made to people related to the company.

5) No investment in securities of a related company may be made.

6) No indebtedness to any company-related person may be paid off.

7) No salary over $25,000 may be paid.

8) No new fixed assets may be acquired.

e) Escrow Agreement: The escrow agreement is a contract between owner and trustee describing the terms of creation of the escrow fund. It defines such items as execution and termination date, investment of the escrow fund, extension clauses, and other miscellaneous rules and regulations. The escrow fund will later be discussed in more detail.

3) Working Capital and Net Worth Requirements: In addition to the normal restrictions placed on the borrower in the aforementioned documents, it is the policy of the Maritime Administration to outline the financial requirements for eligibility for the Title XI program. These are included here and blocked out in Table IV-2 even though they do not constitute either a real cash flow nor an actual fund. They do, however, place important financial requirements on the buyer as to minimum working capital and net worth.

a) Working Capital: To be eligible for mortgage or loan insurance the applicant must submit evidence showing that, at the time of contract execution, he will have sufficient working capital to carry out the venture. The level of this working capital is specifically defined as shown in Table IV-2. "Working capital" is simply defined as the firm's total current assets.

b) Net Worth: To be eligible for mortgage insurance, the applicant must submit evidence showing that, at the time of contract execution, he will have sufficient net worth to carry out the venture. "Net Worth" or equity capital must consist of outstanding paid-in capital stock, paid-in surplus and earned surplus. At least half of this net worth must be represented by common stock equity as opposed to preferred issues.

Example: Net Worth Calculation

Common Stock Equity

Common Stock (par value)	xxx
Paid-In Surplus*	xxx
Earned Surplus (retained earnings)	+xxx
Total Owner's Equity**	xxx
Preferred Stock	+xxx
Total Net Worth***	xxx

Table IV-2

Summary of Working Capital and Net Worth Requirements

Type	Working Capital	Net Worth
Mortgage Only or Construction Loan To Be Replaced by Mortgage	Purchaser's working capital must be ≥ the sum of: 1) Estimated capitalizable cost of vessel (less) amount of insured mortgage or construction loan commitment. 2) 8% of estimated capitalizable cost of vessel (which approximates one year's operating expense). 3) One year's premiums for required vessel insurance (hull, marine, war risk). 4) The first year's mortgage insurance premium. 5) Additional amounts determined necessary by the Secretary	For the Mortgage, the purchaser's net worth must be ≥ the sum of: 1) Estimated capitalizable cost of vessel (less) amount of insured mortgage 2) 4% of estimated capitalizable cost of vessel. 3) Additional amounts determi determined necessary by the Secretary
Construction Loan Only	Purchaser's working capital must be the following: 1) Estimated capitalizable cost of vessel (less) amount of insured construction loan commitment	None

*All proceeds from a stock issue in excess of par value are considered "paid-in surplus."

**Must be at least 50% of total net worth.

***In the general accounting sense, preferred stock is not included in descriptions of net worth, but for these purposes it is.

4. Explanation of Funds and Flows: The following is a more detailed explanation of the elements included in Figure IV-5.

a) Filing Fee: A filing fee of $100 must accompany the original request made for "an approval in principle" of the particular financing scheme the applicant has in mind. If the application procedure progresses further, this $100 is credited toward payment of the "investigation fee". If the request for approval is turned down by MARAD, one half of this fee is returned to the applicant.

b) Investigation Fee: When the detailed application forms are presented to the Maritime Administration, an "investigation fee" must be paid to cover the costs of processing the application. These costs include such items as administrative services, appraisal of properties offered for insurance and inspection during construction. By law, this fee may range from 0%-1/2% of the original principal amount of the mortgage or loan insured. In practice, the Maritime Administration sets investigation fee rates as follows:

Table IV-3
Investigation Fee Schedule *
(Add 10% surcharge if Construction Loan is involved)

Investigation Fee (Mortgage Only)		Original Amount of Principal
1/2%	ON	First $100,000
1/4%	ON	Next $200,000
1/8%	ON	All Amounts over $300,000

* Source: Interviews with Maritime Administration, January 1972

It should also be noted that, if the application is turned down, one-half of all investigation fees paid are refunded to the applicant.

c) Underwriting Fees or Agent's Fees: When a bond issue to the general public is involved, the services of an underwriter or agent are called upon. It is the function of both of these concerns to market the securities in question (bond issues connected with Title XI insurance are generally called "Merchant Marine Bonds". In return, the issuing company pays a certain fee for these services. The two different concerns are best described as follows:

i) Underwriter: The underwriter performs the function of bearing the risks of adverse price fluctuations during the period in which a new issue of securities is being distributed. Underwriters are generally investment bankers who purchase the bonds in advance of their sale to the public at a price below what they expect to be able to market them for. This price differential is generally called the underwriting fee. There is usually one managing underwriter with 10-60 underwriters forming a syndicate under it. Each of these underwriters distributes the bonds to members of the "selling group" who may be investment bankers, dealers or brokers. Thus, the selling group is the retailer and the underwriting syndicate is the wholesaler. The Maritime Administration estimates that underwriting fees for Merchant Marine Bonds are generally about 1% of the total amount issued.

ii) Agency: An "agency" also markets bonds, yet they do no risk bearing. The agency merely sells the bonds on a "best efforts" basis and in return, receives a fixed "agent's fee" of approximately 1/2% of the total amount issued.

d) Legal Consulting, Printing, Accounting Fees: As was shown in the section under documentation, extensive legal matters must be brought to order in the process. In addition, these documents, as well as bonds and application forms, must be printed. A rough estimate of the lower bond on legal and printing fees is about $20,000. Similarly, consulting fees in connection with the application procedure and proof of economic soundness may be as high as $20,000 or more. The value of the accounting costs is very difficult to estimate.

e) Yearly Title XI Insurance Premium: The major source of income to the program, as shown earlier, consists of yearly insurance premiums received by the Maritime Administration. These premiums must be prepaid for the forthcoming year beginning on the day the insurance contract goes into effect. These payments are from the mortgagee or lender (trustee) to the U.S. Government on this date, but only to the extent that the mortgagor or borrower (owner) has already paid the mortgagee or lender. This should become clear after tracing the flow of yearly premium on Figure IV-5. It should also be noted that the mortgagor or borrower must pay this fee to the mortgagee or lender sixty days in advance of the date on which the premium is due to the government. Officials at the Maritime Administration provided the following rules used in determining what insurance premium will be charged. Basically, the premium charged is based on risk - a factor determined by the company's financial strength and operating ability. In general, however, premiums are determined from a simple measure of Net Worth/Long Term Debt according to the following tables on the next page.

The net worth/long term debt ratios are figured on a company-wide basis, not only on its investment in ships. Company-wide, in this case, means the closest corporate body to the vessels unless a parent company also agrees to guarantee the mortgage or loan in question. The calculation must follow generally accepted accounting principles and must include "potential debt" due to the mortgage and/or loan in question.

Most companies, according to the Maritime Administration, fall into the category of 15-60% net worth/long term debt. Previous to the above criteria, all subsidized lines were merely charged to the minimum rate of 1/2% on mortgage insurance. MARAD reported that this procedure was based on the lines more established positions, capital construction funds, reserve funds, and special reserve funds. Non-subsidized operators generally paid 3/4% on mortgage insurance. The new guidelines do not

Table IV-4

Mortgage Insurance Premiums

Statutory Limit: 1/2-1% of average outstanding principal*

Evaluation: Since March, 1970, mortgage insurance premiums are re-evaluated each year

R = Net Worth / Long Term Debt	P = Yearly Premium Rate (Mortgage)
R < .15	1%
.15 ≤ R < .60	3/4%
.60 ≤ R < 1.00	5/8%
1.00 ≤ R	1/2%

Table IV-5

Loan Insurance Premiums

Statutory Limit: 1/4%-1/2% of average outstanding principal*

Evaluation: Once only

R = Net Worth / Long Term Debt	P = Yearly Premium Rate (Loan)
R < .15	1/2%
.15 ≤ R < 1.00	3/8%
1.00 ≤ R	1/4%

*"Average outstanding principal" excludes sums deposited in escrow funds.

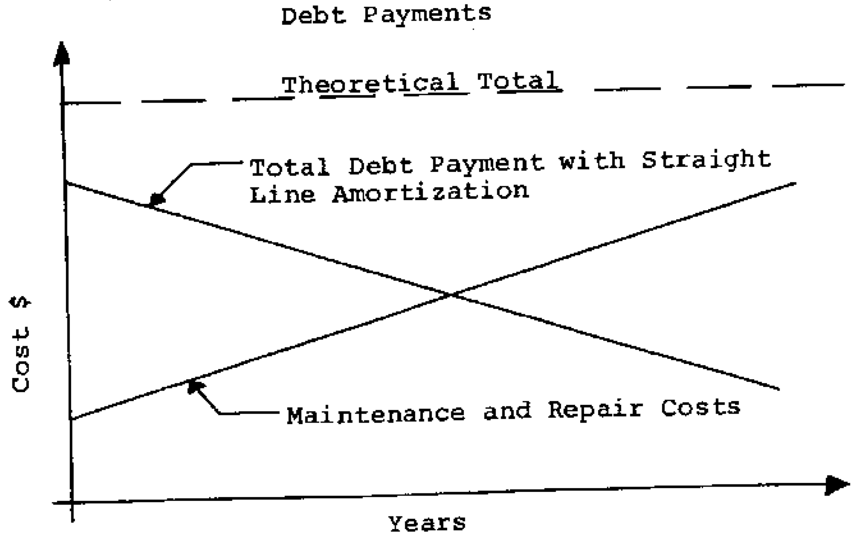
significantly alter the rates that occur in practice, yet they do make clear what criteria are used in their determination. It should also be pointed out that these formulas are not statutory and in certain cases special judgements are made. For example, if the ship in question already has an ironclad, long-term bareboat charter, premiums may be adjusted downward accordingly.

f) Interest Payments: In general, debt instruments insured through Title XI receive rates close to those received by the most stable corporations. There is a statutory limitation on these rates which is, however, open to broad interpretation: the bonds, notes, or other obligations must bear interest at rates not exceeding what the Secretary of Commerce determines to be "reasonable", taking into account the prevailing private market rates. The construction loan, if transacted separately from the mortgage loan (i.e., separate debt instrument) will generally pay interest at close to the prime lending rate. This loan, then, would be completely refinanced after construction by long-term bonds secured by a mortgage. However, this type of arrangement might necessarily give rise to increased transactions costs due to the lack of "smooth flow" of debt from the construction period to post-delivery period as illustrated in the previous example (Figure IV-5). In general, if construction is financed with the same bonds to be used after construction, the interest charged will be the long-term rate.

Merchant Marine Bonds as insured under Title XI consistently receive a Moody's rating of AAA and are marketed with interest close to the average rates for such bonds. A history of the average level of these rates is included in Chapter II. It should be noted that the Government requires Merchant Marine Bonds to be sold at 100% of face value so that interest rates noted on such issues indicate the true interest paid though not necessarily the effective interest rate to the issuing company.

g) Principal Payments: The Maritime Administration prefers that ships financed through Title XI be amortized on a straight-line basis. This clearly not statutory as the law only states that amortization provisions be satisfactory to the Secretary of Commerce. The majority of debt insured under the program is, however, retired in equal installments (straight line) over the economic life of the ship. This necessarily means higher total interest and principal payments (total debt) in the early years of the mortgage. This policy is justified MARAD officials feel, by the following arguments: (i) Shipping is a very cyclical industry and ships tend to decrease in market value rapidly: this is perhaps the most powerful argument in favor of amortizing straight-line vs. having level total debt payment. The government, in its capacity as insuring agent, protects the program's stability by requiring a closer correspondence between actual market value of the ship and the current debt secured by the ship. This assures the program of encountering a minimum of loss in the case of a total default on the loan as was illustrated earlier in discussions of the internal cash flows of the Title XI program; (ii) Maintenance costs increase over the vessel's life: The point can be made that straight line amortization and, consequently, higher total debt payments in early years which increase progressively over the life of the ship as shown in Figure IV-7. To the extent that this is true, the cash flows for a particular ship would tend to be more even over the life of the ship. However, due to accelerated depreciation rules, book profits may not tend to be quite as smooth, assuming all other factors equal.

Fig. IV-7
Theoretical Balance of Maintenance and Total Debt Payments



This argument is one which is largely regulatory in nature (i.e., deciding for the shipowner how to plan his cash flows) and may not necessarily be in the shipowner's best interest as "responsible owner and/or operator."

The question of allowable amortization rates is one, I believe, that should be carefully reviewed by MARAD. The very complex question of "Will the program be endangered financially if LEVEL DEBT or some other amortization scheme were allowed?" should be evaluated. If the answer is NO, I believe more flexible debt retirement should become the policy. It should be mentioned that, in the case of leaseback arrangements, where a long-term charter was already secured, MARAD has approved more level debt payments (increasing amortization). In fact, there is a history of one "balloon payment" of principal upon maturity of the debt issue.

h) Escrow Fund and Construction Fund: For the purpose of financing during construction using the proceeds of a public bond issue, the Secretary is authorized to create an escrow fund into which most of the bond proceeds are deposited until needed for payment to the shipyard. The remaining part is deposited in a construction fund held by the trustee. The mechanics of these funds are somewhat complicated, yet are important in understanding the process by which many ships are financed during the construction period. By law the following sums must be deposited in the escrow fund after bonds are issued: (i) the excess of principal of the loan or mortgage over 75% or 87-1/2%, as the case may be (see Table IV-1), of the amount already paid by or for the account of the mortgagor for the "actual cost" of construction of the vessel, plus (ii) the estimated interest on this amount for the period of the escrow agreement. All sums deposited in either the Escrow Fund or the Construction fund may be invested in certain prescribed interest-bearing securities. An understanding of required deposits at drawdown* and the necessary withdrawal procedures can best be illustrated by the following example.

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*"Drawdown is defined here as the process of bond proceeds being received. There may be several drawdowns during the escrow period.

Fig. IV-8

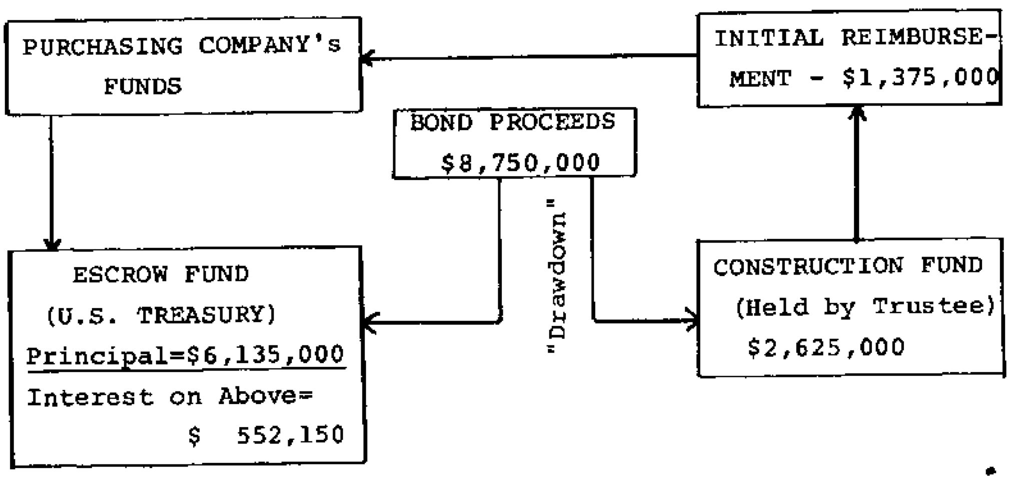
Conditions Immediately Following Initial Drawdown

Example - Escrow Fund and Construction Fund

Assumptions:

1) "Actual cost" of Ship = $10,000,000.
2) No construction differential subsidy: 84-1/2% coverage
3) Interest rate = 6%
4) Interest due = semi-annually
5) Amount already paid by owner for "actual cost" to shipyard before initial "drawdown" = $3,000,000.
6) Initial drawdown 1/1/72 ⟩ 1-1/2 years
7) Expected delivery date of vessel 6/1/73 ⟩

8) Original escrow agreement for 1-1/2 years



KEY EVENTS

1) Initial drawdown takes place on January 1, 1972. The following calculations determine the magnitude of the above initial conditions (see Figure IV-8).

a) Bond Proceeds (Maximum)

$$= \begin{bmatrix} .875 \\ \text{or} \\ .75 \end{bmatrix} \times \text{(Actual Cost)}$$

$$= (.875)\ (\$10,000,000) = \underline{\$8,750,000}$$

b) Construction Fund Deposit

$$= \begin{bmatrix} .875 \\ \text{or} \\ .75 \end{bmatrix} \times \begin{bmatrix} \text{Amount Paid to Yard} \\ \text{Before Initial Drawdown} \end{bmatrix}$$

$$= (.875)\ (\$3,000,000) = \underline{\$2,625,000}$$

c) Escrow Fund Deposit

i) Principal $= \begin{bmatrix} \text{Total} \\ \text{Bond} \\ \text{Proceeds} \end{bmatrix} - \begin{bmatrix} \text{Construction} \\ \text{Fund} \\ \text{Deposit} \end{bmatrix}$

= (\$8,750,000) - (\$2,625,000)=<u>\$6,135,000</u>

ii) Expected Interest During Escrow Period $= \begin{bmatrix} \text{Interest} \\ \text{Rate} \end{bmatrix} \times \begin{bmatrix} \text{Years} \\ \text{of} \\ \text{Escrow} \\ \text{Agreem.} \end{bmatrix} \times \begin{bmatrix} \text{Principal} \\ \text{in} \\ \text{Escrow} \\ \text{Fund} \end{bmatrix}$

= (.06) (1.5) (\$6,135,000)=<u>\$552,150</u>

As shown in Figures IV-5 and IV-8, the construction fund and principal in the escrow fund come from the bond proceeds. The expected interest deposit in escrow must come directly from the funds of the vessel owner (purchaser).

2) After the initial drawdown (closing) the purchaser can request the trustee to reimburse out of the construction fund all monies in excess of 12-1/2% or 25% of the level of the construction fund (in the case 12-1/2%).

Reimbursement $= \begin{matrix} \text{Initial Deposit} \\ \text{in} \\ \text{Construction Fund} \end{matrix} - \begin{matrix} \text{12-1/2\%} \\ \text{or} \\ \text{25\%} \end{matrix} \times \text{"Actual Cost"}$

= (\$2,625,000) - (12-1/2%) (\$10,000,000)

= <u>\$1,375,000</u>

3) The next "Actual Cost" payment to the yard will be paid first from the new balance in the construction fund (\$1,250,000) and then from the Escrow Fund. If the purchaser had not already paid its entire equity requirement into the ship (in this case \$1,250,000), no withdrawals could be made from either fund.

4) On June 1, 1972, an interest payment becomes due to the bondholders on the entire principal amount for 1/2 year. Calculation of where this interest comes from is as follows:

Total Interest	\$262,500	= (1/2) (.06) (\$8,750,000)
From Escrow	<u>184,050</u>	= (1/2) (.06) (\$6,135,000)
From Purchaser's Funds	78,450	= difference

5) If the purchaser has already paid at least 12-1/% or 25% (in this case 12-12/%) of actual cost from company funds, and in our example, it has the entire interest payment (\$262,500) can be reimbursed to the purchaser from the principal in the Escrow Fund. This is because interest paid on construction loans are included in the "Actual Cost" of the vessel.

This process (events 3,4,5) continues throughout the period of the escrow agreement. All this time, any deposits in these funds yield interest from their investment in short-term securities (usually government bonds).

6) June 1, 1973 arrives and the purchaser wishes to keep the escrow fund open to pay the balance of the "Actual Cost" to the yard at some later date. This may be due to late delivery or incomplete work, etc. If the escrow agreement is extended the purchaser must deposit additional expected interest on the remaining amount of principal in the escrow fund for the period of the extension.

EXAMPLE:		\$1,000,000 in Escrow on 6/1/73 Escrow Agreement Extended 6 months
ADDITIONAL EXPECTED INTEREST TO BE DEPOSITED	=	(1/2)(.06)(\$1,000,000) = \$30,000

7) Closing of Escrow Fund: The Secretary of Commerce must make a final determination of the "actual cost" of the vessel. If 87-1/2% of this figure is less than \$8,750,000, bonds must be redeemed to a point where 87-1/2% of debt is indeed invested in the actual cost of the ship. The remainder in the fund will, of course, go to the company.

8) It should be noted that at the time of actual delivery of the ship, the construction loan should be replaced by a mortgage. If loan and mortgage involve the same creditor, this is a "smooth" transition as was previously demonstrated.

It might be helpful, in understanding the Escrow Fund System, to refer back to Figure IV-5 and trace each of the cash flows described above.

i) Restricted Fund: As a further protection to the U.S. Government against default, MARAD usually regulates certain provisions of the mortgage agreement. One such provision generally requires the shipowner to deposit, within 120 days after the end of each fiscal year, a portion of its operating income into a restricted fund. This fund is designed to accrue additional collateral for the mortgage. The fund can be in the form of cash or securities and qualified withdrawals require the Secretary's permission. Such withdrawals can be made for transfer to capital construction fund, offsetting a net operating loss, improving the vessel, or prepayment of the mortgage obligation(s). The requirement that the fund be set up is not an absolute necessity. In the case where certain long-term charters are involved, MARAD will waive this requirement, yet the mortgagor must still negotiate satisfactory mortgage terms with the actual lender (usually a trustee representing bondholders). Since the restricted fund is a factor in many Title XI mortgages, a brief summary of deposit requirements follows. It should be noted that the restricted fund is a post mortgage execution counterpart of the initial net worth eligibility requirement previously described.

Each year the lesser of "A" or "B" must be deposited in the restricted fund where

$$A = I - (P_n + r \times E)$$

or

$$B = P_{n+1} + 1/2 \max [0, (A - P_{n+1})]$$

I = Vessel's net income (before depreciation, but after federal income tax)

P_n = Principal amount paid in preceding year on obligation(s) secured by the mortgage (amortization)

P_{n+1} = Estimated principal amount to be paid in coming year on obligation(s) secured by the mortgage (amortization)

E = Owner's equity in the vessel - the greater of (i) mortgagor's investment in the vessel at the time of mortgage execution or (ii) [1.04 x capitalizable cost of vessel] - [the amount of insured mortgage]

r = "Reasonable" return on investment (usually about 10%) All sums deposited in the fund may, in addition, be invested in certain interest-bearing securities.

All sums deposited in the fund may, in addition, be invested in certain interest-bearing securities.

The following table shows an example of the calculation of required deposit for 2 different values of adjusted income.

Table IV-6

Restricted Fund Example

Variables	Case I	Case II
I =	$1,000,000	$1,500,000
E =	$2,000,000	$2,000,000
r =	10%	10%
$P_n = P_{n+1} =$	$ 500,000	$ 500,000
A =	$ 300,000	$ 800,000
B =	$ 500,000	$ 650,000
Required Deposit: min (A,B) =	$ 300,000	$ 650,000

j) Federal Ship Mortgage Insurance Fund: This is included here only for completeness as it was thoroughly explained in a previous section.

k) Merchant Marine Bonds: Although other obligations may be insured under Title XY, the most popular debt instrument is known as the Merchant Marine Bond. Figure IV-9 is a copy of Page 1 of an offering circular for such a bond issue. This

FIGURE IV-9

OFFERING CIRCULAR

$18,622,000

Falcon Tankers, Inc.

UNITED STATES GOVERNMENT INSURED* MERCHANT MARINE BONDS

Falcon Lady Series

$ 233,000	4.125%	Serial Bonds Due October	1, 1971
$ 233,000	4.50 %	Serial Bonds Due April	1, 1972
$ 233,000	4.75 %	Serial Bonds Due October	1, 1972
$ 233,000	5.00 %	Serial Bonds Due April	1, 1973
$ 232,000	5.25 %	Serial Bonds Due October	1, 1973
$ 232,000	5.50 %	Serial Bonds Due April	1, 1974
$ 232,000	5.75 %	Serial Bonds Due October	1, 1974
$ 232,000	5.875%	Serial Bonds Due April	1, 1975
$ 232,000	6.00 %	Serial Bonds Due October	1, 1975
$ 232,000	6.125%	Serial Bonds Due April	1, 1976

and

$6,960,000 7.55 % Sinking Fund Bonds Due April 1, 1991

Falcon Duchess Series

$ 116,000	4.125%	Serial Bonds Due October	1, 1971
$ 234,000	4.50 %	Serial Bonds Due April	1, 1972
$ 234,000	4.75 %	Serial Bonds Due October	1, 1972
$ 234,000	5.00 %	Serial Bonds Due April	1, 1973
$ 234,000	5.25 %	Serial Bonds Due October	1, 1973
$ 235,000	5.50 %	Serial Bonds Due April	1, 1974
$ 235,000	5.75 %	Serial Bonds Due October	1, 1974
$ 235,000	5.875%	Serial Bonds Due April	1, 1975
$ 235,000	6.00 %	Serial Bonds Due October	1, 1975
$ 236,000	6.125%	Serial Bonds Due April	1, 1976

and

$7,110,000 7.55 % Sinking Fund Bonds Due April 1, 1991

Principal and semi-annual interest (April 1 and October 1) payable at the office or agency of the Company in New York, New York

*Principal and interest insured by the United States of America under Title XI of the Merchant Marine Act, 1936, as amended, which expressly provides that: "The faith of the United States is solemnly pledged to the payment of interest on and the unpaid balance of the principal amount of each mortgage and loan insured under this title."

In the opinion of counsel for the Company, the Bonds are exempt from registration under the Securities Act of 1933, as a "security issued or guaranteed by the United States."

The Serial Bonds of each Series mature by their terms on the respective dates set forth above. The Sinking Fund Bonds will be subject to a sinking fund commencing October 1, 1976 calculated to retire 96⅔% of the principal amount of the Sinking Fund Bonds of each Series prior to maturity. The Sinking Fund Bonds will also be redeemable at the option of the Company at the regular redemption prices set forth herein, provided that no such redemption may be made prior to April 1, 1981 through refunding at an effective interest cost to the Company of less than the interest rate on the Sinking Fund Bonds.

PRICE 100%

(Interest accrues from date of delivery which is expected to be March 11, 1971.)

The Bonds are being offered by the several Underwriters named herein subject to prior sale, when, as and if delivered to and accepted by the Underwriters, and subject to approval of certain legal matters by counsel for the Company, and by counsel for the Underwriters, and subject to certain other conditions. It is expected that delivery of Bonds purchased from the several Underwriters will be made on or about March 11, 1971.

A.G. Becker & Co.
INCORPORATED

The date of this Offering Circular is March 4, 1971 figure illustrates the bond retirement scheme over a period of 20 years. The initial 4-1/2 years involve short-term serial bonds with specific retirement dates and, consequently, lower interest rates. This is done specifically to attract investors who do not wish to get involved in the risk of long-term securities, the most important being commercial banks. Following the retirement of serial bonds, additional principal is retired at regular intervals using a sinking fund. This is simply an agreement whereby the borrower makes predetermined periodic principal payments to the trustee who, in turn, repurchases and, thereby retires a certain number of bonds each period.

Generally, the bonds also have a call provision which allows the sinking fund bonds to be redeemed in whole or in part at the company's option. In order to make this call, the company generally must pay a call premium running as high as the stated interest rate if the bonds are redeemed a full twenty years in advance. A typical call premium appears in Figure IV-10. These call provisions are generally exercised for refinancing purposes.

D. The Basic Financing Alternatives Under Title XI

1. Refinancing Option: An important aspect to be considered in any large scale financing scheme is the ability to refinance particular obligations should interest rates become more favorable. In the case of mortgage debt insured under the Title XI program, the law is very specific. It will be explained why the law is at present somewhat unfavorable. A mortgage insured with Title XI may be refinanced under the following conditions.

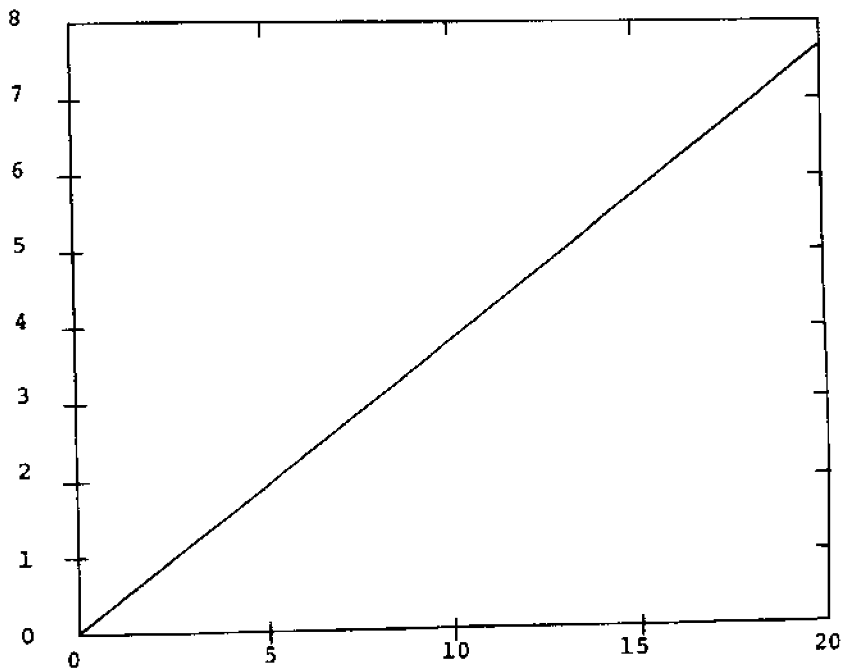
a) The principal amount of the new mortgage may not exceed the unpaid principal amount of the original mortgage.

b) The interest rate on the new mortgage shall not be higher than the interest rate on the original mortgage.

In anticipation of refinancing, the borrower might arrange his debt in long term (20-25 years) sinking bonds similar to those shown in a previous section which include call provisions. This would enable the borrower to repurchase any or all the bonds; however, he will generally pay a sizable premium to execute such an action. This often precludes equitable refinancing unless interest rates were to decline drastically. Indeed, many trustees will insist that the indenture include a "non-refinancing" clause with such a long-term obligation. An alternative is to issue short or immediate term securities (0-5 years) which must be refinanced at maturity. At a time of high interest rates where there is an expectation of rates falling in the future, a borrower might be well advised to use this form of debt. In addition, short-term lending rates are generally lower than those on long-term obligations. There is always a risk here, however, that interest rates will rise instead of fall which means more costly future debt. Condition (b) of the Title XI refinancing option includes an added risk, however: the risk of not getting mortgage insurance at the time of refinancing. It is this

Fig. IV-10

Call Premium Schedule for Bonds in Fig. IV-9



fear that has prevented U.S. shipping companies from taking on short or intermediate term obligations at times of high interest rates which might offer a favorable refinancing option. As will be shown later, legislation is presently under consideration to remove this refinancing restriction.

2. Three Basic Methods of Financing During Construction:

The construction phase may consist of 1-2 years, especially in the case of a United States Shipyard. The cost of financing the vessel during this construction period is, therefore, quite sizable. The shipyard generally requires periodic payments representing work completed on the new vessel. This creates a financing problem for the purchaser. It can be generally attacked in one of three ways in connection with a Title XI mortgage.

a) Drawdown Entire Expected Debt Portion of Ship: This is the case where a construction loan is initiated as detailed in Figure IV-5. Title XI Loan Insurance is involved and bonds are generally the debt instrument as the Secretary is authorized to create an escrow fund for the management of bond proceeds. The high interest cost of these bonds during the construction period is partially offset by investments of the escrow fund in short-term securities which mature with the planned progress of the ship construction. A disadvantage of this method is the large amount of cash which must be put up for expected interest on the amount in the escrow fund for the entire construction period. For example, each $1M in the escrow fund at, say 8%, requires $80,000 initial deposit for each year of construction. An advantage of this arrangement is its smooth flow into the mortgage loan period.

b) Serial Drawdown: If payments to the shipyard can be closely anticipated, the bonds or other instruments can be marketed in the necessary amounts just prior to the date when funds are needed. If the timing is exact, no escrow fund must be set up and predeposit of interest is avoided. Again, we assume Title XI Loan Insurance. A disadvantage of this method is increased brokerage, legal, and accounting fees and perhaps higher interest rates. Again, however, the loan can be designed to flow directly into the mortgage and involve the same debt instruments. A major problem with this scheme is, of course, timing, and the unpredictability of shipyard progress. Recently the author asked officials of the Maritime Administration if they would insure a construction loan in the form of a LINE OF CREDIT, which is similar to serial drawdown, but does not require specific timing. By this arrangement a bank or other financial institution would commit itself to lend upto a specified maximum amount of funds at any time during a specified period. The interest rate may or may not be specified and sometimes a commitment fee is required. This type of loan would generally require total refinancing after the construction period. According to MARAD, in fact, an application for Title XI insurance on just such an arrangement is now pending before MARAD.

There are two legal questions which must first be resolved, however. They are: (i) can MARAD make a commitment to insure a construction loan without guaranteed drawdown? and (ii) can the construction loan so executed be refinanced at a higher interest rate. The law is specific on refinancing mortgages; however, there is no clear-cut rule for construction loans. The Maritime Administration did feel that these legal problems could be dealt with and that such applications would be acceptable. This would represent a significant expansion of construction period financing options.

c) Finance Privately During Construction (No Title XI Construction Loan): With a commitment to insure mortgage from the Secretary in hand, the potential shipowner might obtain financing for the construction period privately at reasonable rates. This is especially true if the owner is or is backed by a strong corporation. When the prime lending rate is low, it can usually be shown that this type of private financing will be cheaper than any scheme available under Title XI. By not insuring the construction loan, the purchaser avoids the yearly insurance premium and prepayment of interest on the escrow fund. He also generally avoids problems of periodic drawdown since line of credit arrangements are clearly possible. Lenders look favorably on the borrower's commitment from the government to insure the mortgage which will replace the loan and the short term lending rate should be adjusted accordingly.

3. Financing After Construction: As was demonstrated earlier, the major portion of debt issued for the 20-25 year insured mortgage period is in the form of long-term merchant marine bonds. Relaxation of refinancing restrictions, however, is likely to change this situation as short and intermediate

term securities are issued in anticipation of lower interest rates in the future. At present, a small portion of the mortgage debt issued usually consists of serial bonds maturing in 2-7 years. These securities are attractive to commercial banks who generally would not get involved in any lending of over 7 years maturity. The longer term sinking fund portion of the mortgage debt is generally marketed to the public, to pension trusts, to state retirement systems, and to life insurance companies.

4. Leaseback Arrangements: The basic advantages and disadvantages of leasing and leaseback arrangements were shown in Chapter II. It was further shown in Chapter III how the "foreign source income" problem was a major obstacle to this type of financing arrangement since the enactment of the 1970 Merchant Marine Act. It might be interesting at this point to present two opinions on why leasebacks have become so popular in the past years.

According to a former financial manager of a major U.S. shipping, the decision to lease is made only after the company has gone as far as it can in the debt market on the basis of its existing net worth and working capital (remember that Title XI insurance has clear-cut requirements on these items). Since leasing is "off balance sheet" financing, the new capital equipment is provided through a form of hidden debt. In general, he felt, U.S. shipping companies have little or no fear of debt and cost of financial embarrassment is a seldom considered factor in any capital budgeting or capital structure decision. In short, the feeling is, "if you can't borrow anymore, start leasing." I feel that this statement, if true, could be a strong argument for the attractive capital construction fund program which will be discussed in the next chapter. In addition, "step leasing" has become a very popular alternative and will be further discussed in Chapter VII.

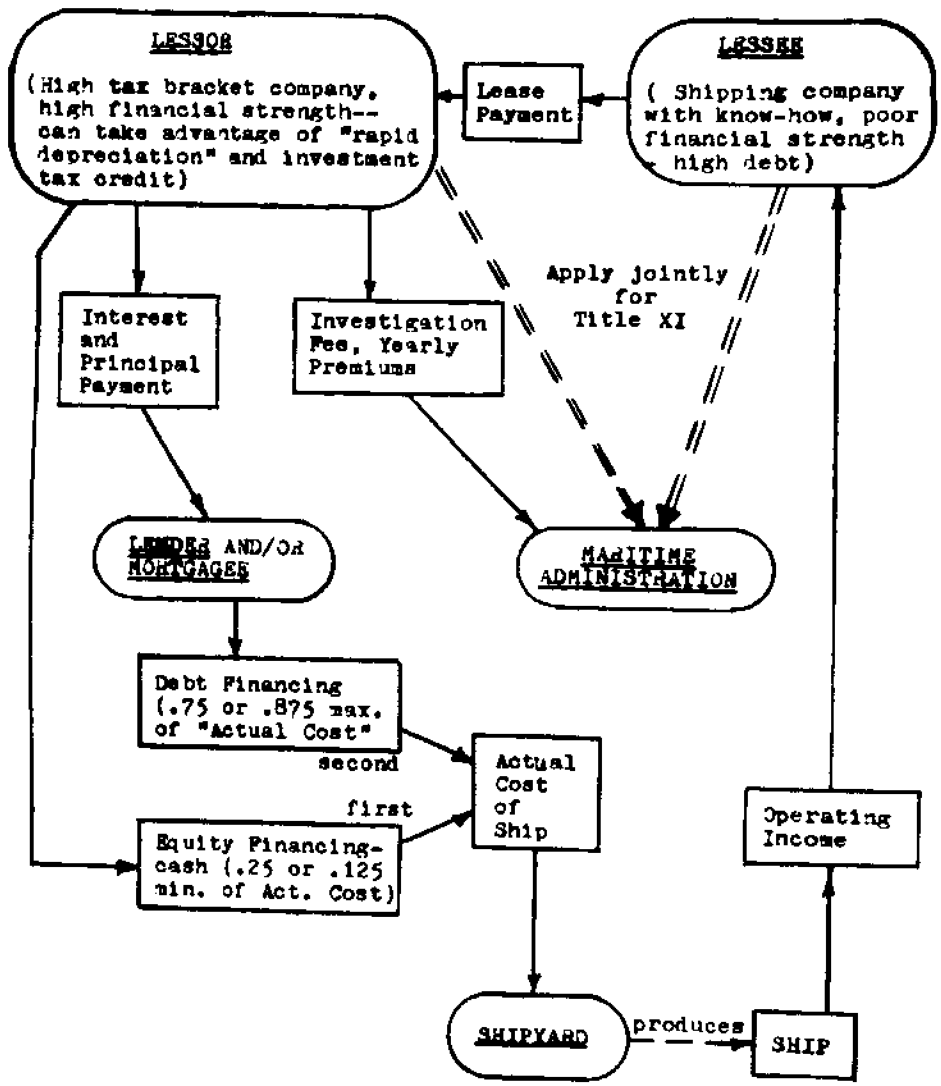
Contrary to an opinion stated above, officials at the Maritime Administration felt that the popularity of leasing was not a result of the companies involved extending their debt capabilities as far as possible. They pointed out that even relatively strong companies will do it simply as an attempt to retain their present credit rating or for other reasons such as cash flow and capital rationing policy. Further, the lessor certainly must scrutinize the financial position of the lessee since they stand to lose their "front end money" or equity in the ship should a default occur and Title XI insurance is paid. Many times, however, the basis for evaluating the lessee's "financial position" is not an overall measurement of the company, but the examination of a solid long-term character arrangement, often connected with the vessel to be leased.

Figure IV-11 shows the major parties and cash flows involved in a typical leaseback scheme permissible under the Title XI program. The lessor and lessee apply jointly for loan and/or mortgage insurance. The lessor fulfills the working capital and net worth requirements and the lessee provides the necessary operating experience. The lessor pays all mortgage and/or loan obligations, Title XI insurance premiums, and other

Figure IV - 11

TYPICAL LEASING ARRANGEMENT UNDER TITLE XI

SIMPLIFIED CASH FLOWS



costs associated with purchasing the ship. In return, the lessee pays him predetermined lease payments so arrived at as to allow the lessor certain net profit over the years of the lease. This method has become popular and should increase in use after the difficulties of foreign source income are resolved.

E. Application Procedure

The following is a list of the major steps taken by the applicant and the Maritime Administration in working toward a final closing on Title XI mortgage and/or loan insurance contract.

1. Applicant requests "Approval in Principle" letter. Included with this request is a brief outline of the proposed investment and a $100 filing fee. This letter will certify that the request was on file prior to keel laying, a present requirement to receive construction loan insurance.

2. Secretary sends applicant "Approval in Principle" letter.

3. The applicant now must file a detailed report concerning his company and the project to be financed according to MARAD form MA-163. The major points which must be included are as follows:

a) Proposed loans including interest rate and amortization schedule.

b) Citizenship, organization type, ownership of company.

c) Business affiliations of organization.

d) Management of organization.

e) Property presently owned.

f) Presentation of project to be financed.

i) Capitalizable cost
ii) Proposed security issue and underwriters.
iii) Design characteristics of vessel and their economic justification.
iv) Proposed operation of vessel
v) Forecast of operating cash flows for one voyage, one year, and entire economic life.

g) Summary of fees and charges to be paid in connection with mortgage or loan.

In addition, the Maritime Administration may request more information to supplement the above.

4. At the conclusion of the application filing, a "Title XI Examiner" reviews the information carefully and send a report to the Chief of Subsidy Administration and in the case of a non-subsidized line to the Maritime Administration. In this report the examiner evaluates the economic soundness of the proposed project.

5. If the Maritime Administrator finds in favor of the proposed loan or mortgage he will send to the applicant a "Commitment to Insure" letter which includes the following points:

a) Approval of applicant's ability to build and operate the ships as U.S. citizens.

b) Approval of design.

c) The total approved "actual cost" of the ship broken down by major category.

d) Approval of economic soundness.

e) Net worth and working capital required at loan and/or mortgage closing.

f) Determination of investigation fee and insurance premium fee.

g) Any waivers to be granted.

h) Approval of trustee.

With this letter, the U.S. Government has strongly committed itself to insure the loan and/or mortgage subject to the above terms and conditional upon preparation of necessary documentation.

6. Preparation of necessary documentation subject to the approval of MARAD.

7. Loan and/or mortgage closing and initial drawdown.

Recent articles about the program have noted that the application procedure sometimes takes 3-6 months. True, say MARAD officials, yet this is mainly due to the slow response of applicants in preparing the necessary applications and providing other information. They noted that some applications have been processed in a single weekend if there is an urgent need to close.

F. New Legislation

The original Title XI Act was passed in 1938, yet until 1953 only 12 transactions were entered into under it. As was demonstrated in an earlier section, the use of this program has grown steadily since that time. In fact, the reason was legislation in the 1950s which made Title XI more flexible and attractive to potential shipowners. Recently, a bill (H.R. 9756) was introduced into Congress amending Title XI. It has been under development for two years by the American Institute of Merchant Shipping in cooperation with the Maritime Administration. On February 7, 1972, it was passed by the House and approval is expected by the Senate. It is a technically complicated bill, yet in practice, simply alters the present Title XI program according to the following points.

1. Refinancing: The present law prohibits refinancing of a Title XI obligation at an interest rate higher than that of the original debt. New legislation would eliminate this prohibition leaving refinancing interest rates subject to approval of the Secretary. This is a significant change for reasons mentioned in an earlier section on refinancing.

2. Time of Obtaining Guarantee to Insure: Presently, loan insurance requires an application on file prior to keel laying and mortgage insurance requires the mortgage be placed on the vessel less than one year after delivery. New legislation will permit guarantee of both obligations without regard to filing date.

3. Government Guarantee of an Obligation: One of the major points of the new bill is a proposed change in the government's role in the financing transaction. The existing law provides that the government insure the loan or mortgage which, by its nature, requires many complicated documents involving borrower, lender, trustee, and the government as shown earlier. The bill provides that the United States guarantee instead, the payment of principal and interest on the obligation itself. Therefore, all security including the mortgage would be held by the government, not the trustee. This necessarily means, it is felt, less complexity to underwriters and investors accompanied by enhanced marketability of the securities. Several officials at MARAD, however, expressed their doubts as to just how much reduction in documentation would actually come about.

4. Reduction in Qualifying Tonnage for Barges: Presently, barges must be of over 200 gross tons in order to qualify for Title XI. New legislation lowers this figure to 25 gross tons and, if the barges are carried aboard ship, can have insured debt on upto 87% of their cost. This change is of particular importance to operators interested in the new barge-carrying vessels such as LASH or Seabee.

5. Statutory Vessel Life: New legislation will drop the arbitrary maximum of a 20-year economic life for liquid bulk carriers. Economic life and therefore, maximum term of loan will be decided by the Secretary subject to a maximum of 25 years.

6. Security Tied to Vessel: In general, the existing law has the effect of tying each bond to a single vessel. The proposed legislation allows that the government guarantee of an obligation may relate to more than one vessel. This would allow bond issues of an increased size and, hopefully, better marketability. In addition, it would allow proceeds of obligations secured by existing vessels to finance construction, reconstruction, or repair of facilities or equipment pertaining to marine operations.

7. Escrow Fund: Currently, the government is only authorized to set up an escrow fund in the case of sale of bonds to the general public. In addition, total projected interest on money in the escrow fund must be deposited in advance by the prospective shipowner. The new bill would extend the escrow fund to all forms of Title XI financing and leave required predeposit of interest to the discretion of the Secretary.

Several other technical changes are included in the bill, yet all significant points are included above. There is nothing in this legislation which increases the government's obligations and no increases are predicted in cost to the government related to the merchant fleet. Even so, it corrects several major deficiencies in the present program as brought to light in previous sections.

G. Conclusions

1. Financing strategies making use of Title XI are and will continue to be the most widely used methods of financing United States Flag Ships. This is due to the fact that, in most cases, U.S. shipping companies cannot obtain debt with low interest rates without Title XI, if they can obtain it at all.

2. The major success of the Title XI program is due to the conscientious efforts on the part of the Maritime Administration to prevent defaults. In carrying out its mortgage-insurance function, MARAD acts as a buffer between the shipping industry and the financial market. In this capacity, it absorbs fluctuations in the financial health of particular steamship owners by deferring principal payments, etc., thereby, preventing many defaults and subsequent mortgage foreclosures. Since defaults are often avoided, the government minimizes insurance claims and the shipowner is spared financial embarrassment costs. Therefore, even though records of actual defaults do not indicate it, the Title XI program absorbs a good amount of the risk inherent in most shipping operations. The lenders require this buffer, for few are prepared to assume the risk-pooling role that MARAD has undertaken. The arguments stated above should answer a question such as, "Since there are few defaults and the Title XI program shows figures in the black, why can't shipowners get low interest rates without Title XI?

3. Title XI insurance premiums are not excessive. In the past 10 years, the Title XI program has netted over $25 million. Not shown in this figure are the costs connected with administering the program. If these costs were taken into account, the overall profit-loss figures would net out at close to zero. This explains why no other financially strong institution has chosen to compete with the government in insuring vessel mortgages. In addition, there are few whose guarantee would hold as much meaning.

4. Amortization rules connected with the Title XI program should be re-evaluated (see Section C.4.g).

5. Leasing under the Title XI program will become increasingly popular. This is mainly due to an expected increase in building U.S. flag ships for the bulk trades which are generally backed by long term charter agreements. Even companies with poor financial position can become low risk lessors with this type of ironclad charter in hand.

6. The new Title XI legislation (H.R. 9756) if passed will have a favorable impact on financing flexibility as was shown in Section F.

CHAPTER V

THE TAX-DEFERRED CAPITAL CONSTRUCTION FUND PROGRAM

A. Introduction

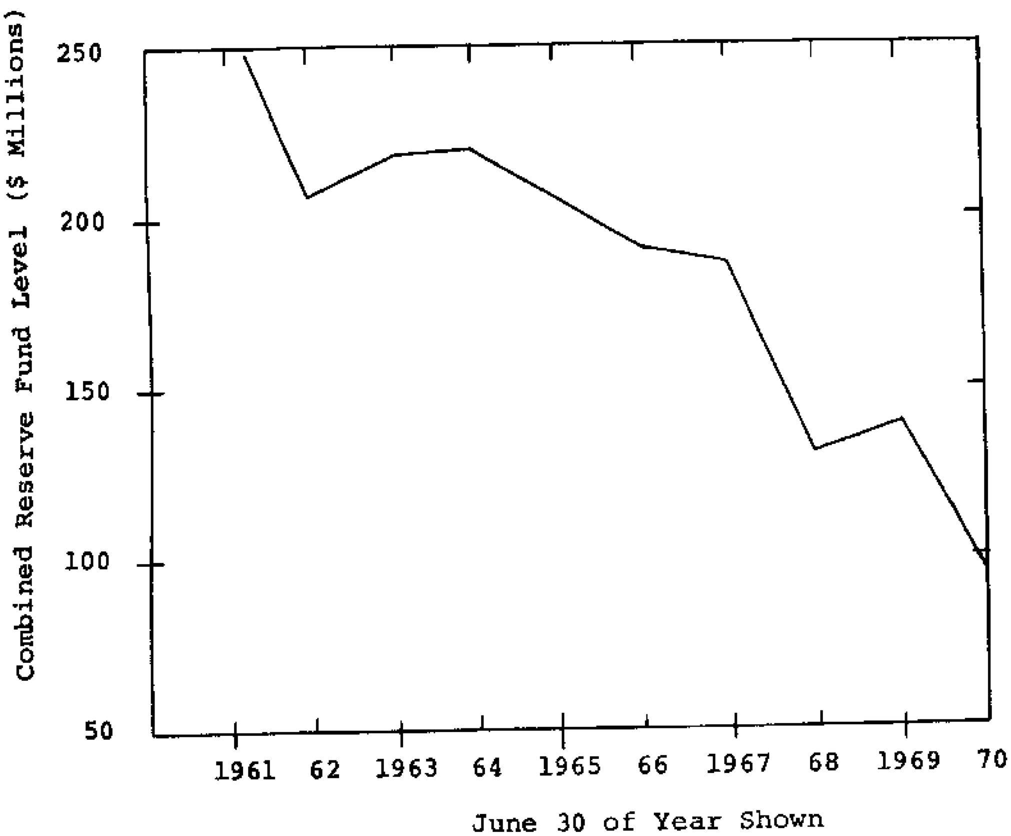
The previous chapter dealt with a program of key importance to the debt financing of U.S. flag vessels. In addition, the U.S. Government also administers a program which aids the U.S. shipowner in internal equity financing. This program is known as the "Capital Construction Fund". Unlike Title XI Mortgage and Loan Insurance, capital construction funds give rise to indirect subsidy for participating shipowners and operators. Stated simply, certain shipping companies may defer payment of income taxes by depositing ordinary income and/or capital gains in a specially created fund before paying taxes. If this money is used in the acquisition of new vessels or related equipment, taxes remain unpaid. However, the depreciation base of a new vessel is reduced as a function of the amount withdrawn from the fund to purchase it. This means that taxes are deferred, not exempted, since they are eventually "repaid" in the form of lost depreciation. In practice, though, a shipowner can receive, in effect, a tax-free permanent loan from the government if our reasoning is based on companies as going concerns. This concept will be developed later in more detail.

The tax-deferred capital construction fund has been in existence since 1947, yet prior to 1970 was only available on a meaningful scale to companies receiving operating subsidy. Indeed, subsidized companies were bound to create such a fund and mandatory deposits were required. The Merchant Marine Act of 1970 amended the law to allow any citizen of the United States who owns or leases an eligible vessel to establish a capital construction fund. Thus, non-subsidized companies became eligible. The new law also revised the rules for the fund's administration and structure to accommodate increased participation in the program.

Figure V-1 is a 10-year history of the aggregate level of the reserve funds of all subsidized lines. These companies were required to deposit earned depreciation, proceeds from disposition of vessels and a fixed percentage of their net profits into a capital reserve fund. In addition, they were required to deposit in a special reserve fund any profits earned over the amount necessary to give stockholders a 10% return on their investments. Figure V-1 shows a steady decrease in fund levels over the 10-year period shown. This can be explained by an increasing need to replace aging fleets and the rise in cost of new vessels.

Fig. V-1

Combined Level of Statutory Capital and Special Reserve Funds - All Subsidized Lines



Date	Reserve Funds ($ Millions)
June 30, 1961	261.5
June 30, 1962	205.8
June 30, 1963	217.2
June 30, 1964	219.6
June 30, 1965	205.1
June 30, 1966	192.9
June 30, 1967	185.6
June 30, 1968	130.0
June 30, 1969	135.9
June 30, 1970	95.2

Source: Maritime Administration Annual Reports

1. Eligible Contractor: Any citizen of the United States who owns or leases one or more "eligible vessels" may enter into a contract with the Secretary of Commerce to establish a capital construction fund.

2. Eligible Vessel: An eligible vessel is defined as any vessel constructed and documented in the United States. It must be operated in the foreign or domestic trade or in the fisheries of the United States. Eligible vessels are defined for the purpose of making them subject to the agreement contract for the purpose of deposits into the fund.

3. Agreement Contract: In order to participate in the program, the company must enter into a formal agreement with the Secretary to establish a capital construction fund. The agreement may apply to any or all of the citizen's eligible vessels, which then become "agreement vessels". In general, it will include the following points:

a) A provision for the volume of deposits in the fund necessary or appropriate to carry out its purposes.

b) Special rules governing deposits, qualified withdrawals, and non-qualified withdrawals. For deposits, the rules will include frequency of deposits, proportion coming from earnings, depreciation, etc.

c) A stipulation as to the length of time the agreement will be in force.

4. Ceiling on Deposits: The maximum amount allowed to be deposited in the reserve fund in a given year is equal to the sum of the following:

a) The owner's or lessee's taxable income attributable to the operation of agreement vessels in the foreign or domestic commerce or in the fisheries of the United States.

b) Depreciation taken on agreement vessels according to Section 167 of the Internal Revenue Code.

c) The proceeds from the disposition of an agreement vessel.

d) Income from investment of the fund's assets.

5. Investment of Deposits in the Fund: The assets of the fund may be invested in interest-bearing securities approved by the Secretary of Commerce. Up to 60% may be invested in stock registered on a national exchange. The pre-1970 law stated that investments were limited to those stocks which would be acquired by prudent men of discretion and intelligence in such matters who are seeking a reasonable income and the preservation of their capital.

6. Special Accounts: The 1970 legislation provides for the establishment of three separate accounts, the sum of which comprise the capital construction fund.

a) The Capital Account - deposits in this account do not give rise to tax deferral. Such deposits include depreciation, return to capital resulting from disposition of an agreement vessel, 85% of dividends from fund investments, and interest on non-taxable state and municipal bonds in which the fund is invested.

b) The Capital Gain Account - deposits in this account give rise to the deferral of taxation on long term capital gains (tax rate = 25%). Examples are net gains from the sale or disposition of, or from insurance proceeds on, an agreement vessel and long term capital gains on fund investments. These gains are offset by long term losses on fund investments if such a loss is realized.

c) The Ordinary Income Account - Deposits in this account give rise to tax deferral of ordinary federal income tax (marginal rate = 48%). Examples are taxable income of an agreement vessel, short term capital gains and losses, 15% of dividend income from fund invested securities, other taxable income on fund invested securities, and recapturable depreciation.

7. Qualified Withdrawals: Withdrawals may be made from the fund without paying federal income tax if they meet certain requirements. All withdrawals must be approved by the Secretary of Commerce and must be for the acquisition, construction, reconstruction or conversion of a "qualified vessel", or barges and for containers that are part of the complement of such a qualified vessel. A "qualified vessel" must be constructed and documented in the United States and operated in U.S. foreign, Great Lakes, or noncontiguous domestic trade or in the fisheries of the United States. Qualified withdrawals might also be made for the amortization of debt associated with such a qualified vessel, container or barge. Qualified withdrawals are treated as coming first from the capital account, second from the capital gains account and last from the ordinary income account until each account is exhausted. Portions used from the capital account do not reduce the depreciation base of the asset acquired. Portions from the capital gains account reduce the depreciable value of the asset by 5/8 of the amount used from this account (for a corporation). Portions used from the ordinary income account reduce the depreciable value by the full amount taken from this account. In this way, the government recaptures the taxes it deferred when funds were deposited in the accounts. Qualified withdrawals are to be treated as coming out of each account on a first-in, first-out basis for accounting purposes.

8. Non-Qualified Withdrawals: Non-qualified withdrawals are those made for purposes other than those for which qualified withdrawals may be made. They must also have the permission of the Secretary, however. These withdrawals are taxed in the year of withdrawal to the extent that taxes were deferred when they were deposited. In addition, any such tax liability is subject to an interest charge of an appropriate rate and is based on the amount of time the money withdrawn was in the fund. Non-qualified withdrawals are to be made in the reverse order given for qualified withdrawals and are treated on a first-in, first-out basis for accounting purposes.

9. Changeover: In the case of subsidized operators holding reserve funds under the pre-1970 law, these operators may convert their funds to the new form or keep them in their existing form until their subsidy contract with the Secretary expires.

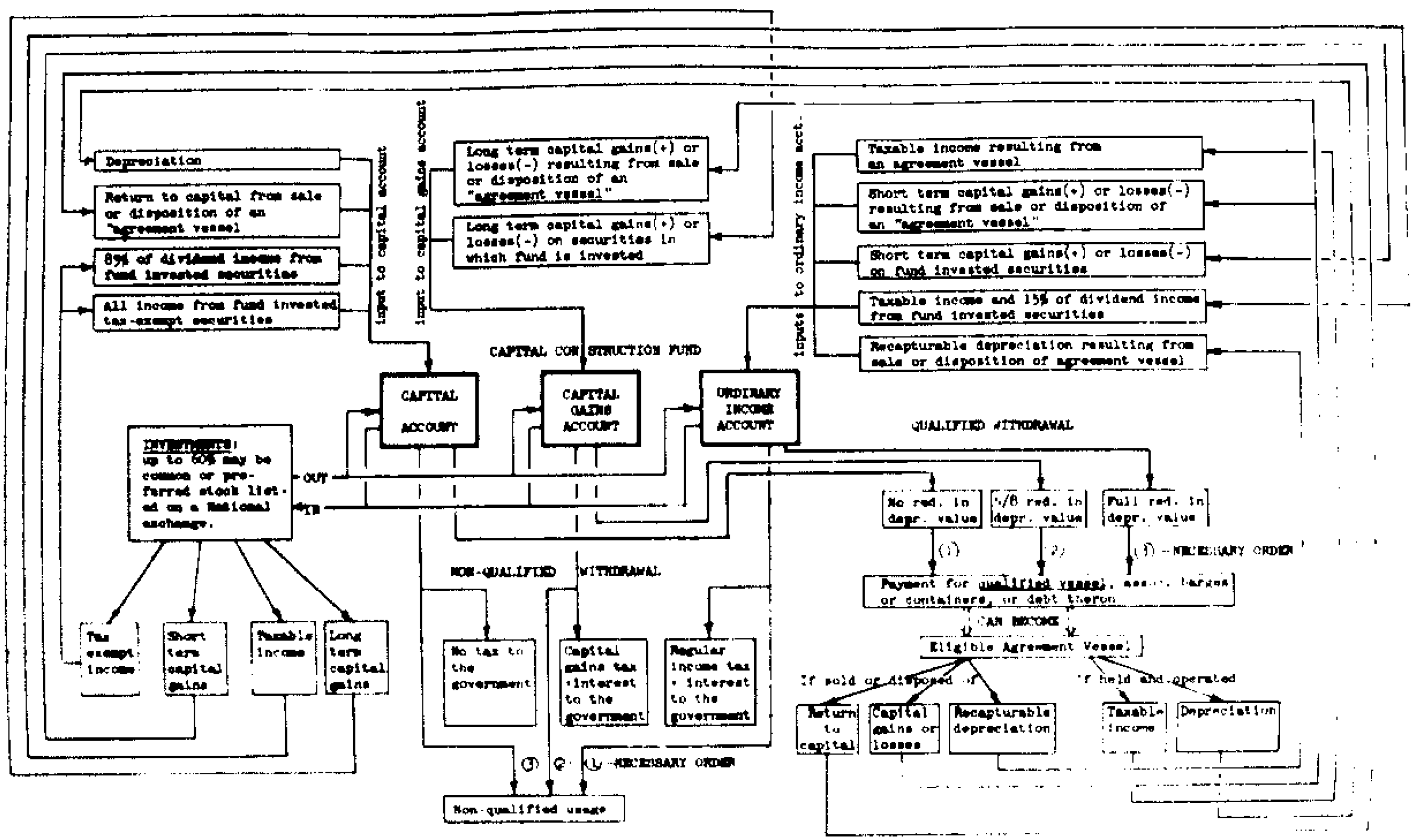
10. The Fund: The amounts in a capital construction fund are required to be kept in a depository or depositories specified in the agreement contract. They are subject to such trustee and other requirements as the Secretary deems necessary.

C. Cash Flow Analysis

Having explained the major concepts of the reserve fund program, we will now trace the actual cash flows that may take place after a typical U.S. shipping company creates such a fund. Figure V-2 is a schematic diagram which demonstrates the possible cash flows connected with a company having a reserve fund. To trace them, we will start with the qualified vessels of a company, remembering that they may be either owned or leased. This block appears near the lower right corner of Figure V-2. Below this block are the major net cash outflows possible resulting from such a vessel. If the vessel is sold, a return to capital, capital gains or losses or recapture of depreciation may result. If deposited in the appropriate reserve fund account as shown, no federal taxes need be paid. If the vessel is held and operated, taxable income and earned depreciation (non-taxable) may result to varying degrees. Again, if deposited in the appropriate reserve account, no taxes must be paid. Note, however, that earned depreciation does not give rise to any tax saving nor does return to capital.

There are now deposits in any or all of the reserve fund accounts appearing in the center of Figure V -2. These funds may immediately be invested in the securities of other corporations as shown in the box to the left of fund accounts. These investments give rise to various cash flows such as tax-exempt income, short term capital gains, taxable income, and long term capital gains. Again, these flows may be redeposited in

Figure V-2 : CASH FLOW CHART FOR THE CAPITAL CONSTRUCTION FUND PROGRAM



appropriate accounts without paying taxes as indicated in the diagram. This process can go on indefinitely, and it is up to the company holding the reserve fund to manage an efficient portfolio. When the company decides to invest in a new vessel it can make a qualified withdrawal from the fund by first liquidating the appropriate amount of securities (see Figure V-2). Withdrawals must be made in the order shown. These withdrawals will then comprise the equity portion of the new vessel and its associated equipment. The depreciation base of the new vessel and equipment is reduced as described earlier so that the government will regain over the depreciable life of the ship any taxes it lost as a result of deferral at the time of deposit in the fund. However, the owner of this new vessel can now make it an eligible agreement vessel for the purpose of deferring income to which it gives rise. The result is, then, further deferral of income taxes. If this cycle is to be maintained, the company has acquired an interest-free source of equity funds from the government for an indefinite period. The subsidy is approximately equal to the level of deferred taxes held in the fund and invested in the equity portion of qualified vessels and associated containers and barges. The value of the firm is increased by an equal amount.

Also included in Figure V-2 is the possibility that the company makes a non-qualified withdrawal. As described earlier, deferred taxes on amounts withdrawn must be repaid to the government at the time this type of withdrawal is made along with accrued interest. It is probable, however, that the interest charged by the government will be lower than the yield on an efficient portfolio of fund-invested securities and therefore the company could indeed realize a net gain from this type of transaction.

D. Present Administration of the Fund

The tax deferral possibilities of the reserve fund program should be quite attractive to any company interested in replacing or expanding its fleet. However, following the passage of the 1970 Merchant Marine Act which included the reserve fund legislation, there was no rush of applications to create funds. The reason for this was the considerable confusion over fund policies not specifically defined in the statute. In particular, the major concern was over whether or not the Maritime Administration would impose requirements as to how much a company must deposit in each reserve fund account. Indeed, at the end of 1970, MARAD did not know itself if such requirements would be made since these issues had to be negotiated with the Treasury Department. Previous reserve fund contracts with subsidized lines contained a first-in depreciation rule. That is, before any ordinary income could be deposited in the fund, all earned depreciation of the company had to be deposited first. The question everybody had was whether or not such a rule would be incorporated in post-1970 reserve fund contracts.

Since the deposit of depreciation does not give rise to any tax relief, prospective participants in the program saw no advantage to tying up this large cash flow in a restricted fund. The lack of specific policy on this subject was a major obstacle, admits the Maritime Administration, to participation in the reserve fund program soon after enactment of the Merchant Marine Act of 1970. Some others in the industry will go even further to say that confusion over reserve fund policy was a contributing factor to the slow start of the entire 1970 maritime program to revitalize the U.S. merchant marine. The author tends to agree with this point.

On July 22, 1971, a specific statement of policy appeared in the Federal Register[1] with regard to capital construction funds. An "interim" or experimental agreement was reached between the Department of Commerce and the Treasury Department containing clarification of reserve fund legislation and the general form of the contract agreement which future participants would be obliged to sign. This agreement announced that funds would be created on an interim basis to see if a different policy would be appropriate. The important points of this document are as follows:

1) In addition to the eligibility requirements mentioned earlier, the participant must demonstrate that he has a specific program for the acquisition, construction, and/or reconstruction of one or more qualified vessels.

2) Deposits of depreciation are made voluntary. This was the important rule which potential participants were hoping for. It meant an increase in the amount of taxes a participant could defer in a given year since he could deposit earnings in the fund and keep depreciation as a cash flow for other business needs. The ceilings on the total deposits shown earlier are still in effect. The only mandatory deposits are the proceeds resulting from the sale or disposition of an agreement vessel and earnings on fund-invested securities.

3) Due to the fact that this policy is only effective on an interim basis, the investments of the fund must have maturities of one year or less and be easily marketable. This will most certainly change when permanent funds are established.

4) Buying on margin or short selling is prohibited in connection with fund investments.

5) In lieu of having a "restricted fund" for purposes of Title XI financing (see Chapter IV), a required amount may be kept on deposit in the capital construction fund.

[1]The Federal Register, "General Order 109, Chapter II, Subchapter K, Part 390", July 22, 1971.

6) Participants must make available detailed records concerning agreement vessels to the Secretary at any time.

7) The interim agreement will be terminated upon execution of a permanent agreement.

The important points shown above should give rise to greatly increased participation in the reserve fund program in the future.

E. An Example

To show how the use of a capital construction fund (heretofore designated as CCF) can aid in the equity financing of a shipping company, the following hypothetical example is given:

Assumptions

1. A small company owns two "eligible" vessels only with a present book value of $5M each. Their original value was $10M each but they are now 10 years old.

2. There was an original $14M in long term debt at 8% associated with these two vessels which is currently amortized to $7M in debt. Amortization is $700,000/year (straight line for 20 years).

3. The federal income tax rate is 50%.

4. Straight line depreciation is employed over a 20-year vessel life (total depreciation on the two vessels is $1M per year).

5. All financial statements used are for the last day of the year in question.

Year 0

The balance sheet at the present time (we will call it year 0) is as follows:

Balance Sheet - Year 0
(figures given in dollars)

Assets	
Current Assets (cash)	5,000,000
Fixed Assets (net)	10,000,000
Total Assets	15,000,000
Liabilities	
Current Liabilities	3,000,000
Long Term Debt	7,000,000
Total Debt	10,000,000
Net Worth (equity)	5,000,000
Total Liabilities	15,000,000

Year 1

In year 1 the company enters into an agreement contract with the Secretary to initiate a capital construction fund. The company's two eligible vessels become "agreement vessels". The income statement for the first year under this contract is as follows:

Income Statement - Year 1

Operating Revenue	4,500,000
Operating Expense	2,000,000
Depreciation Expense	1,000,000
Long Term Interest Expense (8%)	560,000
Total Expense	3,560,000
Income Before Taxes	940,000
Retained Earnings into CCF	940,000

The company decides to place all its income before taxes in the CCF, thereby incurring no tax liability in year 1. It also must amortize $700,000 of its long term debt connected with the two vessels. The accounts in the CCF after year 1 are as follows:

CCF - Year 1

Capital Account	-0-
Capital Gain Account	-0-
Ordinary Income Account	940,000
Total in CCF	940,000

The balance sheet for year 1 then becomes:

Balance Sheet - Year 1

Assets	
Current Assets (cash)	5,300,000
Fixed Assets (net)	9,000,000
Capital Construction Fund	940,000
Total Assets	15,240,000
Liabilities	
Current Liabilities	3,000,000
Long Term Debt	6,300,000
Total Debt	9,300,000
Net Worth (equity)	5,940,000
Total Liabilities	15,240,000

In just one year, then, the company has avoided $470,000 in taxes and, if we assume that the company will always have a CCF, this $470,000 represents a permanent increase in the value of the firm. The price of common stock should adjust to this increase and stockholders should experience increased capital gains during years in which the fund grows due to tax deferred income. This, of course, assumes perfect information. In effect, the government is providing matching funds through deferral of taxes for the internal equity financing of the firm.

Year 2

We now take the same company through another year. We assume that the fund was invested at rate of 10% over the past year. All returns were in the form of dividends equaling $94,000. Fifteen per cent of these dividends ($14,200) go into the ordinary income account and the remainder, $79,800, is deposited in the capital account (see Figure V-2). Also, just before the end of year 2, the company acquired a small tanker (qualified vessel) at a cost of $7,200,000. Twelve and one-half per cent ($900,000) was equity financed using money in the CCF. The remainder, $6,300,000, was financed through mortgage debt at 8% interest. The income statement for year 2 is as follows:

Income Statement - Year 2

Operating Revenue	4,500,000
Operating Expense	2,000,000
Depreciation Expense	1,000,000
Long Term Interest Expense (8%)	504,000
Total Expense	3,504,000
Income Before Taxes	996,000
Retained Earnings in CCF	996,000
Extraordinary Earnings (Income on CCF)	95,000

Again, the company decides to put all its income before taxes in the CCF, thereby incurring no tax liability for year 2. It must also amortize $700,000 of old long term debt on the newly acquired vessel. The CCF accounts are also affected. $900,000 in equity was taken from the ordinary income account just prior to year's end. However, $79,800 in CCF income is placed in the capital account while $15,200 in CCF income goes to the ordinary income account. In addition, $996,000 retained income for year 2 is deposited in the ordinary income account. The resulting balance in the CCF is as follows:

CCF - Year 2

Capital Account	79,800
Capital Gain Account	-0-
Ordinary Income Account	1,050,200
Total in CCF	1,130,000

It should be noted that since $900,000 was taken from the ordinary income account to purchase the new tanker, its depreciation base for tax purposes becomes (7,200,000 - 900,000) = $6,300,000. The allowable depreciation expense for tax purposes next year is then (1/20) (6,300,000) = $315,000 for the new tanker. The balance sheet at the end of year 2 now becomes:

Balance Sheet - Year 2

Assets	
Current Assets (cash)	5,600,000
Fixed Assets (net)	15,200,000
Capital Construction Fund	1,130,000
Total Assets	21,930,000
Liabilities	
Current Liabilities	3,000,000
Long Term Debt	11,900,000
Total Debt	14,900,000
New Worth (equity)	7,030,000
Total Liabilities	21,930,000

Notice that, for business accounting purposes, the new vessel was capitalized at its full value of $7,200,000 even though the depreciation base was reduced to $6,300,000. For the next 20 years, the company will "pay back" the tax that was deferred through a reduction in depreciation tax shelter. The reduction is $900,000 over 20 years or $45,000 per year. The resulting extra tax liability is, then, $22,500 per year. However, by redepositing earnings of $45,000 per year in the CCF, the company can extend this tax deferment even further. In this way a company can obtain equity funds from the government to use for an indefinite period. For a growing company, reserve funds can mean a quick build-up of equity funds as well as accumulation of necessary working capital. In the example just shown, total assets were increased from $15,000,000 to $21,930,000 while the debt/equity ratio went only from 2.00 to 2.12 over a period of two years. Also, during that time the company accumulated $600,000 in working capital from depreciation cash flows.

F. Summary

The extension of tax-deferred capital construction funds to non-subsidized operators should be an important stimulus toward the replacement of an aging U.S. merchant fleet. The tax relief it provides is substantial and can have a dramatic effect on the growth of a company by allowing a fast build-up of equity funds and an accumulation of working capital. The present interim agreement concerning policy allows for no required deposits of depreciation. This enhances the usefulness of the fund to participants by allowing more flexibility in cash flow planning. When used in conjuction with Title XI debt financing, deposits in the capital construction fund giving rise to tax deferral may be made in lieu of required restricted fund deposits through special agreement. In any case, the value of a capital construction fund should be great to many U.S. shipping companies. At present, the Maritime Administration is doing a study to determine the potential future impact of such funds on loss in government revenues as well as the benefits to be derived as a result of this subsidy.

CHAPTER VI

MAJOR DIRECT SUBSIDY PROGRAMS OF IMPORTANCE TO U.S. SHIP FINANCING

A. The U.S. Maritime Program

The purpose of this chapter is to outline the major points of the United States maritime program. In addition, the importance of financing to this overall program will be discussed.

1. The Current Vessel Replacement Program: The 1970 Merchant Marine Act dealt with two major areas. First, it committed the United States to a major vessel construction effort for 10 years. It authorized the appropriation of such sums as are necessary for the construction of 300 ships in the next 10 years. This necessarily requires increased funds for construction differential subsidy and national defense features. Although the Act authorizes such funds, annual appropriations are still necessary for the purpose of continuing the program from year to year. The second area dealt with was the mechanics of merchant marine aid legislation in the areas of subsidy and non-subsidy programs. There was a great need to update major portions of these statutes to render the merchant marine program more responsive toward building a modern fleet.

If we accept the necessity of having a substantial U.S. flag merchant fleet, there is much evidence to suggest that some program is necessary for building new vessels. It is clear that the free market, in addition to pre-1970 maritime programs, did not provide it. Figures VI-1 and VI-2 show the average age of various segments of the U.S. fleet as compared to foreign flag vessels. An Ernst & Ernst study showed that by mid-1970, almost 80% of the unsubsidized dry cargo fleet was over 20 years old and that its average overall age was 28 years. This unsubsidized segment represents over 55% of our ocean-borne dry cargo fleet. The same study showed that the subsidized dry cargo fleet had an average age of about 13 years, very close to the average age of similar type foreign flag fleets. The U.S. flag tanker fleet as shown in Figure IV-2 was about 20 years old in 1970 compared to an age of about 11 years for similar foreign flag vessels. From this information, it is clear that scrappings should outnumber newly constructed vessels for the U.S. flag if the trends indicated in Figures VI-1 and VI-2 continue. This theory is borne out dramatically by recent data issued by the U.S. Department of Commerce. Table VI-1 shows the level of active ocean-going vessels since December, 1969. It shows a decline of 40% in the number of active U.S. flag ocean-going ships in just two years.

Figures VI-1,2
Average Age of Selected Shipping
Fleets

Fig. VI-1
Dry Cargo Fleets

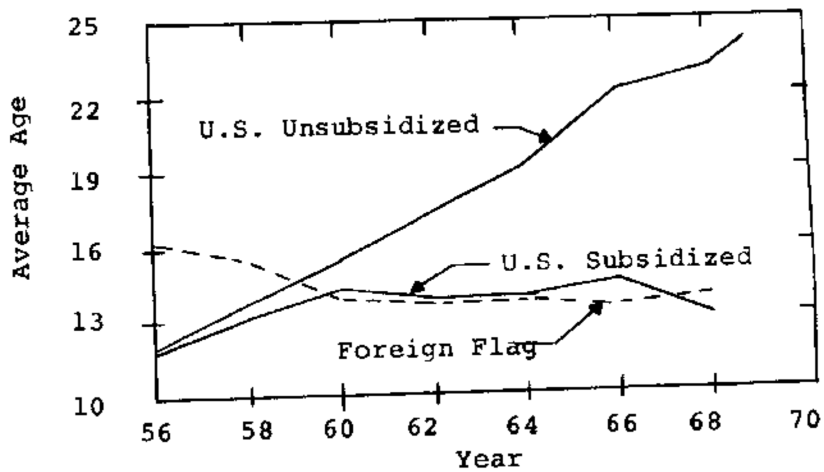
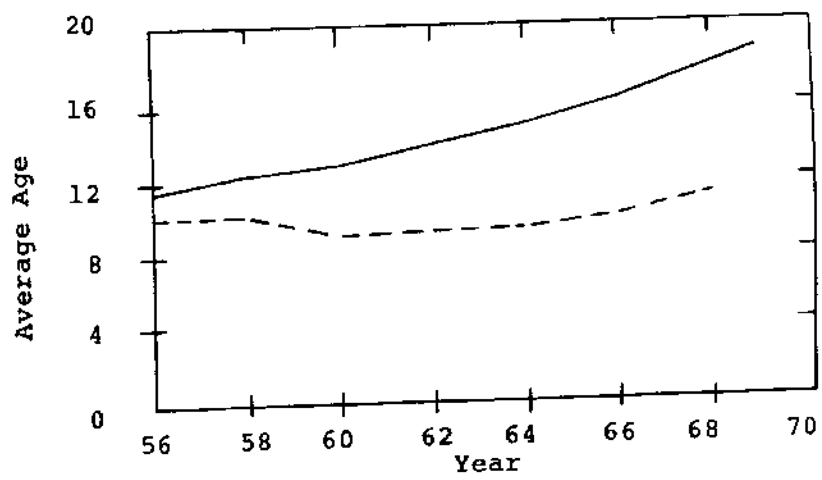


Fig. VI-2
Tanker Fleets



Source: Supplement to "Economic Impact of Tax Deferred Capital Funds for Unsubsidized Vessel Operators" by Ernst & Ernst.

Table VI-1

NUMBER OF ACTIVE OCEAN-GOING U.S. FLAG VESSELS

Date	Number
Dec. 1, 1969	937
June 1, 1970	836
Dec. 1, 1970	766
June 1, 1971	701
Dec. 1, 1971	563

Source: U.S. Department of Commerce News

It has been projected that if no new ships were built, the U.S. fleet would consist of less than 310 vessels by 1980. Even if 300 vessels are built in the 1970's, the fleet will show a substantial net decline in number although not necessarily in total deadweight.

Further evidence indicating the decline of U.S. merchant marine strength is the steady fall in the percentage of U.S. ocean-borne foreign trade (tonnage) carried in U.S. bottoms. Figure VI-3 shows this decrease graphically. In 1969, only 4.8% of the total U.S. foreign commerce was carried by U.S. flag ships. The breakdown by vessel type shows that 21.3% of all liner cargoes were carried by U.S. ships, but only 2.1% of non-liner cargoes and 3.6% of tanker cargoes were carried in U.S. vessels. Although very recent data are not available, the total percentage of U.S. commerce carried in U.S. flag vessels has no doubt fallen even lower corresponding to the drastic shrinkage of the U.S. fleet since 1969.

2. The Slow Start of the Vessel Replacement Program: The funds appropriated for construction differential subsidy in fiscal year 1971 (July 1, 1970 - June 30, 1971) equalled $238 million. To the surprise of many MARAD officials, applications for CDS that year were not overwhelming. Indeed, at the end of fiscal 1971, only 71% or $169 million of appropriated CDS funds were actually committed. These government expenditures represented $392 million in total shipbuilding contracts for the following construction:

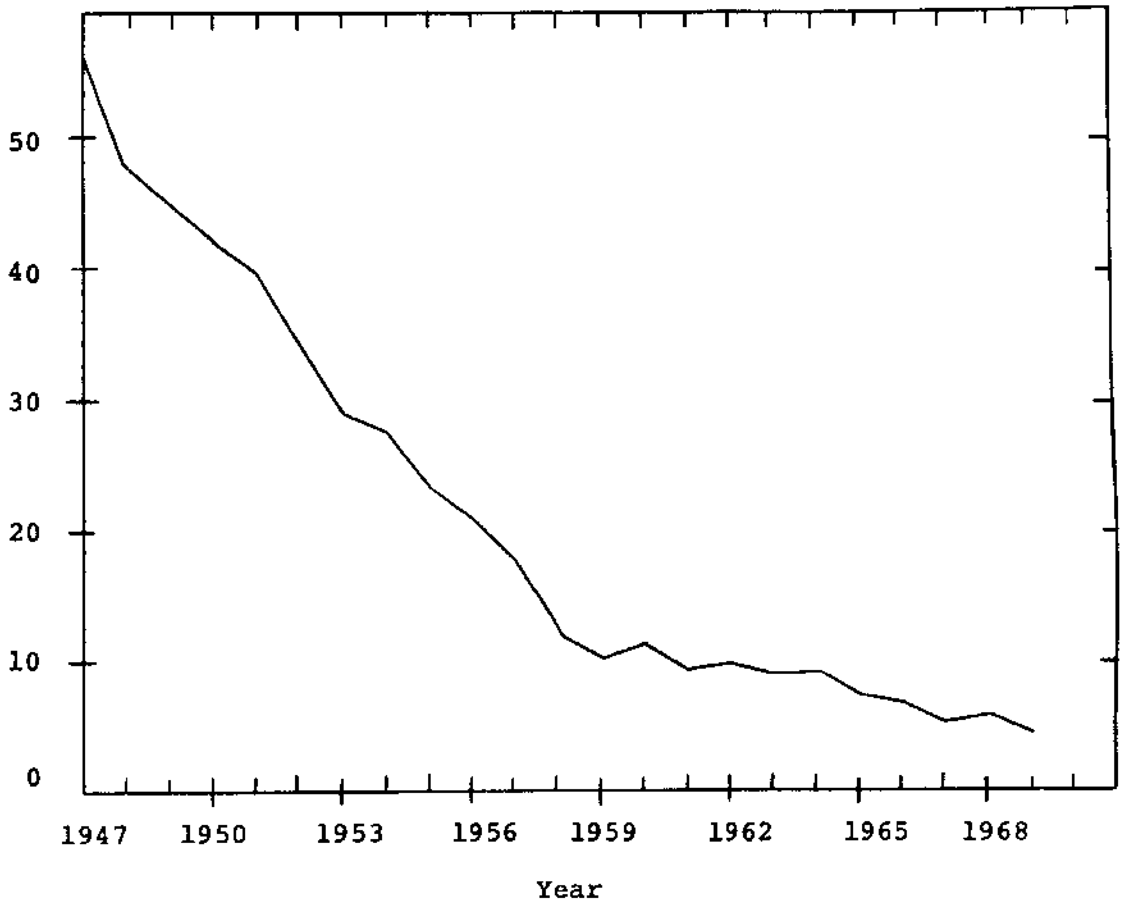
11 conversions (to containerships)
3 new containerships
7 new LASH vessels
2 new Oil-Bulk-Ore vessels

In that same year about 135 U.S. flag vessels were scrapped or laid-up. With $69 million to carry over into fiscal 1972, Congress has appropriated an additional 229.7 million for the year ending June 30, 1972[1]. It is not likely that the total of

[1] "Traffic World", July 12, August 9, 1971.

Fig. VI-3

Total Percentage of U.S. Foreign Trade
Carried by U.S. Flag Vessels (Tonnage)



Source: MARAD Annual Report, 1970.

$298.7 million available for CDS will be fully spent at that time. The future, however, looks a little better with an improved financing outlook. If the program is to become at all successful it must show increased activity in the next two years. Indeed, MARAD is still optimistic as the Maritime Administrator is seeking some $310 million in CDS funds for fiscal year 1973.

It is important to attempt to explain the slow start of the vessel replacement program. The major reasons are connected with financing difficulties and the problems associated with including the bulk shipping industry in the new maritime program. This is a segment of shipping where vessel replacement is much needed at the present time. A list of the major reasons for the slow start of the program, as this author sees them, is as follows:

a) Foreign Source Income Problem: This issue was described in detail in Chapter III. It greatly hindered the innovative financing method of vessel leasing. The problem has since been corrected.

b) Confusion Over Tax-Deferred Reserve Fund Policy: This issue is fully described in Chapter V. Many shipping companies are greatly in need of equity and working capital which such funds supply. The problem has been solved, at least for an interim period, to the advantage of shipowners and operators.

c) Generally Poor Economic Conditions: The late 60's and early 70's have been less than economically bright for the nation in general. High interest rates and tight money were a major problem in vessel financing.

d) Instability of the Shipping Industry: As Mr. Richard F. Pollard on behalf of the Chase Manhattan Bank stated: "... With alternate methods of employing funds available, many analysts are loath to spend the time necessary to explore an industry that appears, on the surface, complicated at best, and at worst, completely unstable. It is this instability whether caused by lack of comprehensive maritime policy or other disruptive influences that forces investors to shorten their risk parameters when considering ocean transportation."[1]

e) Labor Instability: Several parties have expressed a concern over the lack of stability connected with seafaring and longshore labor. This concern is certainly reasonable in that investors must be able to make reasonably accurate profit projections on which to base their decisions.

f) Poor Flexibility of Government Policy Toward Bulk Shippers: The entire machinery of the Maritime Administration has been traditionally geared to the liner trades. The greatest need for vessel replacement in the early 70's is in the growing U.S. bulk trades. Gradually, however, MARAD is providing for the particular needs of this industry and has shown increased flexibility which should stimulate more activity in bulk vessel construction.

3. Forms of Subsidy Available to U.S. Shipping Companies:

a) Indirect Subsidy: Indirect subsidy is derived mostly from inflated freight rates resulting from certain protected U.S. trades. The laws providing this are 1) The Merchant Marine Act of 1920, known as the Jones Act, reserving domestic trade to U.S. flag ships, 2) The Act of 1904 which requires military cargo to be carried in U.S. flag vessels, and 3) The Cargo Preference Act which requires at least 50% of government-aid cargoes to be carried on American flag vessels if they are available at "reasonable" rates. Another indirect form of subsidy is the Tax-Deferred Reserve Fund Program described in Chapter V.

[1] Statement prepared for hearings before the House Merchant Marine Subcommittee, March 2, 3, 4, 1970.

b) Direct Subsidy: The major forms of direct subsidy to U.S. shipping and shipbuilding are Construction Differential Subsidy (CDS) and Operating Differential Subsidy (ODS). The total appropriations for the Maritime Program for fiscal year 1972 are broken down as follows:

Table VI-2

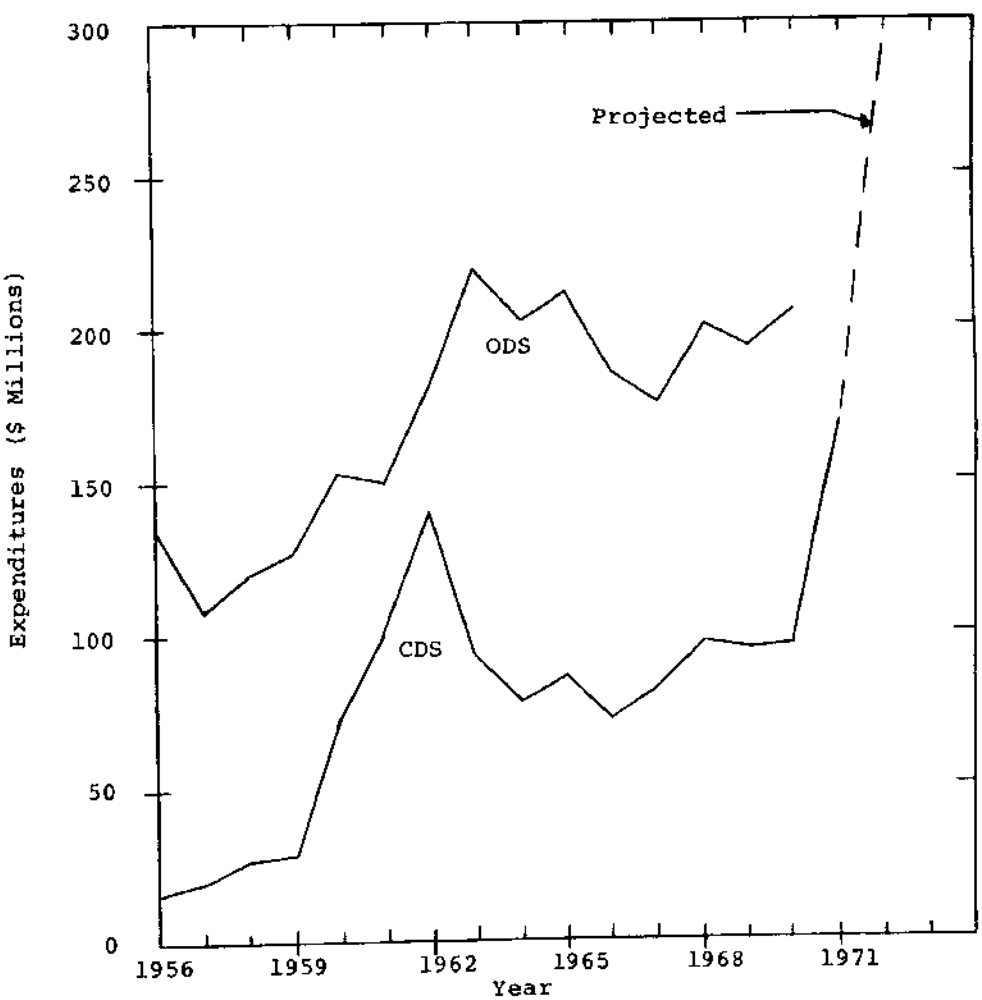
MARITIME PROGRAM APPROPRIATIONS - F.Y. 1972

Construction Differential Subsidy	$229,687,000
Operating Differential Subsidy	239,140,000
Research and Development	23,750,000
Administrative Expenses	22,210,000
Maritime Colleges	2,200,000
Total	$516,987,000

Source: "Traffic World", Aug. 9, 1971

A historical plot of CDS and ODS appropriations appears in Figure VI-4. The remainder of this chapter will present the important points of the CDS and ODS programs.

Fig. VI-4
CDS and ODS Expenditures



Source: MARAD Annual Reports

B. The Construction Differential Subsidy Program

Construction Differentail Subsidy (CDS) can be applied for by any "ship purchaser" (U.S. citizen) or U.S. shipyard to build a new vessel for such operation. (The 1970 Merchant Marine Act allowed a shipyard to apply directly for subsidy, hoping to encourage shipyard participation in design work and to promote economies in construction.) In either case, the subsidy is paid directly to the shipyard. In addition, Title V of the Merchant Marine Act of 1936 provides a method of borrowing directly from the government to finance both CDS and non-CDS vessels. In practice, however, these direct government loans have not been available for many years due to lack of funds.

1. Details of the CDS Program: The details as stated here are a review of the important points of Title V of the Merchant Marine Act of 1936, as amended:

a) Requirements:

i) The proposed ship purchaser must possess the ability, financial resources, and meet other qualifications necessary for the operation and maintenance of the new vessel.

ii) The vessel must meet design specifications meeting the requirements of the foreign trade of the U.S. and must be suitable for national defense use as determined by the Navy.

iii) The granting of aid must be consistent with the promotion of the U.S. merchant marine.

iv) Vessels receiving CDS must be documented in the U.S. for at least 25 years.

v) "Buy American": All materials, articles and supplies used in connection with CDS must be, so far as is practicable, American produced.

vi) All vessels built with CDS must be used in the foreign trade of the U.S. temporary transfer (less than six months) to domestic trade may be permitted with a suitable recapture of subsidy.

b) Level of CDS: The amount of reduction from shipyard price to selling price of a ship is known as construction differential subsidy. Therefore, CDS = SHIPYARD BID - ESTIMATED FOREIGN COST. The estimated foreign cost is made by studying foreign shipbuilding centers and using data on similar type foreign built vessels. The following limits on percentage of CDS paid are included in the 1970 Act. They are gradually lowered to stimulate productivity increases in U.S. shipyards.

FISCAL YEAR	MAXIMUM [CDS / SHIPYARD BID]
'71	45%
'72	43%
'73	41%
'74	39%
'75	37%
'76 and thereafter	35%

CDS grants must meet these levels "unless the Secretary shall have given due consideration to the likelihood that the above percentages will not be attained and that the commitment to the ship construction program may not be continued." There is much feeling that such a situation may exist by the mid-70's when the above requirement falls to 35%.

c) Methods of Obtaining Subsidy: After an application for CDS has been approved, the Secretary may secure bids on behalf of the applicant for construction of the vessel. The lowest responsible bidder is chosen. Until June 30, 1973, the Secretary may accept a price for the ship which was negotiated between a shipyard and the proposed owner if it meets the productivity requirements mentioned earlier and certain other proofs of reasonable pricing are presented. This should help shipyards market "standard designs" with CDS and will probably be extended beyond 1973 if successful. Once an agreeable price is arrived at, there are two methods by which the prospective owner can purchase the ship:

i) Direct Government Loan: The Secretary can purchase the vessel at the bid or negotiated price and sell it back to the owner at the estimated foreign cost. The purchaser need only put down 25% of this cost on the purchase date and pay off the remainder over 25 years in equal installments. Interest payments must be made on the unpaid principal at a rate equal to the government's cost of borrowing money. This method of financing is extended to purchasers of non-CDS foreign or domestic trade ships on the same terms except that only 12-1/2% is required for down payment. Direct government loans, although lawful, have not been available for some time due to the lack of appropriations. Although the 1970 Merchant Marine Act changed the interest rate on these loans from 3-1/2% to the government's cost of borrowing money, it is not expected that direct government loans will become available in the near future. It is felt that the Title XI mortgage program is adequate to meet the debt financing needs of shipowners and direct government loans would add nothing but another administrative problem.

ii) Private Financing: If a qualified purchaser wishes to purchase a vessel in accordance with an application for CDS, the Secretary may only pay the CDS plus national defense features cost of the vessel. CDS will be calculated on the basis of either the lowest responsible bid or the negotiated price. If bidding was employed, the purchaser is not constrained to buy from the lowest bidder but the CDS calculation will remain unchanged. The remaining portion of the purchase price is to be paid by the purchaser employing whatever financing he chooses.

2. Administration of the CDS Program: There was never any legal exclusion of non-subsidized (not receiving ODS) operators from the CDS program; however, only the traditional subsidized lines were historically ever granted construction subsidy. Since the 1970 Merchant Marine Act extended ODS to the bulk trades, it was expected that previously non-subsidized operators in general would be considered for CDS. This required the alteration of regulations to accommodate bulk operations. The major policies now in effect concerning the administration of CDS are as follows:

a) Allocation of CDS Funds: Funds will be allocated according to the following criteria concerning the proposed project.[1]

i) Success in meeting shipyard productivity requirements.

ii) Vessel transport capability and shipping productivity.

iii) Employment of standard ship designs.

iv) Increase in foreign trade penetration.

v) Support of national defense interests.

vi) Reduction in ODS required by the vessel.

vii) Cubic and deadweight capacity and speed.

viii) Cargo handling efficiency.

ix) Estimated revenues and cost of operation.

b) Availability of Ports: No application for CDS will be approved unless the vessel to be built will have sufficient U.S. port facilities to accommodate it within a reasonable period of time.[2]

[1] "Code of Federal Regulations", General Order 46, Part 251.1, Appendix 2.

[2] "Code of Federal Regulations", General Order 46, Part 251.2

c) Foreign to Foreign Operations: A major question many operators had in late 1970 and early 1971 was the extent to which bulk vessels would be permitted to engage in foreign to foreign trade. To settle this question, the following regulations were put forth for bulk vessels built with CDS:

i) During any three years of a specific five-year period at least 50% of the total ton-miles of cargo carried or total gross revenues earned in each of the three years must be carried or earned in the U.S. foreign trade.

ii) At least 35% of the total ton-miles of cargo carried or total gross revenues earned in all five years combined must be carried or earned in the U.S. foreign trade.

iii) The two above regulations shall apply for the first 20 years of a liquid-bulk vessel's life and the first 25 years of a dry-bulk vessel's life.[3]

3. Recent History of CDS: The extension of CDS to bulk vessels was confirmed by the granting of subsidy to two OBO's in F.Y. 1971 and three 38,300 DWT tankers thus far in F.Y. 1972. There is a rather large contract for nine 25,000 DWT tankers to be built with CDS and leased to the Military Sealift Command in the process of being approved at the time of this writing. It involves an example of the type of innovative financing we can expect to see in the future of U.S. shipping. It includes the participation of a leasing company, an operator, and a long term charter to the military.

There is another movement in the industry of interest concerning CDS. That is the attempt to obtain CDS on large (225,000 DWT) tankers for which the U.S. presently has no ports of sufficient depth. One contract has been signed for such a project and another is presently under consideration. This leads the author to believe that MARAD is interpreting its own regulations with much flexibility.

C. The Operating Differential Subsidy Program: The term "subsidized operator" refers to a shipping company which has an operating differential subsidy (ODS) contract with the U.S. Government. This program provides assistance to the subsidized operator in the form of direct payments. These payments are designed to make up the difference between vessel expenses incurred were the same vessel operated under foreign registry. It is important to understand the basic highlights of this program to appreciate the financial and other ramifications of entering into an ODS contract. The Merchant Marine Act of 1970 made important changes in this subsidy program which will be noted as they arise.

[3] "Code of Federal Regulations", General Order 46, Part 278.4.

1. Details of the ODS Program: The details stated here are a review of the important points of Title VI and VIII of the Merchant Marine Act of 1936, as amended:

a) Requirements:

i) The applicant for ODS must possess the ability, experience, financial resources, and other qualifications necessary to enable him to conduct the proposed operations.

ii) The vessels receiving ODS are to be used in an essential service in the foreign commerce of the U.S. The 1970 Merchant Marine Act specifically includes bulk carriers as meeting this requirement. Previously, they were excluded from receiving ODS. In addition, the Great Lakes foreign trade is now included.

iii) The vessels receiving ODS must meet direct foreign flag competition.

iv) No ODS may be paid for coastwise or inter-coastal trade unless it is part of a longer international voyage.

v) ODS may not be granted if it would give undue competitive advantage over or be prejudicial to other citizens of the United States. The laws also prohibit granting of subsidy to two or more operators on a given trade route unless service on that trade route is inadequate.

vi) All vessels receiving ODS must be less than 25 years of age (unless special exception is made), be constructed in the U.S., and be manned by U.S. citizens.

vii) A requirement of much unsettled controversy is the exclusion of receivers of ODS from owning foreign flag vessels. Any operator receiving ODS may not own, charter, or act as agent or broker for, or operate any foreign flag vessel that competes with an essential American flag service. In special cases, the Secretary may waive this provision and the 1970 Merchant Marine Act allows for the following exceptions: 1) Presently unsubsidized bulk operators may continue to hold existing foreign flag vessels in their fleet until April 15, 1990. (Note that this exception does not apply to presently unsubsidized cargo liners.) 2) Broker or agent activities may be carried out until April 15, 1972.

b) The Level of ODS: The operating differential subsidy payment is calculated by subtracting estimated foreign costs from U.S. costs with respect to the following items:

i) Wages of officers and crew

ii) Insurance costs

iii) Subsistence of officers and crew on passenger vessels only.

iv) Maintenance and repair costs not covered by insurance.

The 1970 Merchant Marine Act made explicit the fact that ODS shall equal the difference between U.S. and foreign costs. Previously it was on a "less than or equal to" basis which meant uncertainty as to the future cash flows connected with an ODS vessel. Another important change made by the 1970 act was the repeal of the "recapture provision". Previous to 1970, all operators receiving ODS had to return to the government one-half of all profits in excess of a 10% return to equity. It was hypothesized that this rule did much to discourage innovative management since there was a ceiling on profits. Repeal or recapture, it is hoped, will encourage more competent management of subsidized firms.

2. Administration of the ODS Program: With the inclusion of bulk carriers in the ODS program, there was much uncertainty as to one very important question: "To what extent would bulk operators be permitted foreign to foreign voyages and still receive subsidy?". The answer came with a regulation which allows a very liberal amount of non-U.S. foreign trade. Table VI-3 shows the level of ODS granted for various levels of U.S. foreign trade for bulk carriers.

Table VI-3

PERCENTAGE LEVEL OF ODS FOR BULK CARRIERS FOR VARIOUS DEGREES OF PARTICIPATION IN U.S. COMMERCE

U.S. Import-Export Foreign Commerce / Total Cargo Carried	Subsidy Earned / Subsidy Otherwise Payable
.50 - 1.00	1.00
.40 - .499	.50
.30 - .399	.40
.00 - .299	.00

The determination of percentage U.S. export and import foreign commerce shown in Table VI-3 can be calculated on either a ton-mile or gross revenue basis. If an ODS contract covers more than one vessel, data on these vessels can be aggregated as long as no single vessel shows less than 30% U.S.-foreign trade. Since no bulk carriers are yet in service under ODS, the applicability of this regulation has not been tested.

3. Recent History of ODS: The author has learned of two applications for ODS on oil tankers during 1972. In one case, the company involved pledged that it "will not carry cargo subject to the cargo preference statutes at premium rates." The American Maritime Association, however, protested on the grounds that vessels receiving ODS should not have government-generated cargoes at all. On February 27, 1972, the Maritime Administration advised Congress that it plans to earmark $15.8 million of the $232 million it is seeking for ODS next year for bulk carriers. No specific companies were mentioned, but MARAD stated that it plans to pay ODS on 24 bulk carriers in addition to 196 cargo liners and four passenger ships.*

D. Restrictions on Financial Management Under Direct Subsidy Programs

An important factor to be considered in deciding whether or not to apply for direct subsidy is the management restriction connected with such a subsidy. Traditionally, subsidized lines have been closely examined and influenced by the Maritime Administration. This practice was largely a result of the pre-1970 ODS recapture provision mentioned earlier. In order to protect its interests in the recaptured ODS, MARAD influenced any major decision to be made. As a result, management was discouraged from initiating innovative projects for fear of government red tape. Also, by law, any operator receiving either construction or operating subsidy must submit detailed cost and revenue records for its vessels, overall accounting statements, and any other records MARAD requests. Cargo liners are still required to operate on specific trade routes according to a fixed sailing schedule. Subsidized operators are also forbidden to own or lease foreign flag vessels. There is evidence to suggest that the influence of MARAD on subsidized operators is decreasing. It is MARAD's own admission that higher productivity can be gained through more flexibility on their part. Nonetheless, the restrictions and regulations that remain should be an important factor in the decision as to whether to obtain subsidy or not.

*"Journal of Commerce", December 20, 1971; January 20 and February 28, 1972.

CHAPTER VII

FINANCIAL DECISION MAKING FOR U.S. SHIPPING COMPANIES - SUMMARY AND CONCLUSIONS

This study has presented and analyzed the major points related to the financing of U.S. shipping companies. The purpose of this final chapter is to incorporate these ideas into a decision making framework. Financing decisions must be made on the basis of reliable data, analytical analysis, and, most of all, expert judgment. Whereas some decisions will rely heavily on financial calculations, others must be based largely on intangible and sometimes controversial issues. The following sections will outline the basic decisions related to vessel financing as well as the major issues involved. Reference will be made to the earlier chapters which apply to each decision.

The financing decisions to be made by a shipping company are usually, but not necessarily, related to a specific vessel or group of vessels. This is due to the large acquisition cost connected with each investment unit. Because of this, it is important to consider other decisions not directly related to the acquisition of new capital which will have major effects on the new investment project and the financial management of the firm as a whole. Figure VII-1 shows the major financial decisions to be made when acquiring a new vessel. They are not necessarily made in the order indicated in the figure and must often be considered concurrently as many of the decisions are interactive.

A. Operating Subsidy

As shown in Figure VII-1, the decision to receive operating subsidy or not should be part of the financial plan of the shipping company. This is especially true now that ODS has been opened up to the bulk trades and there is an actual decision to be made by many companies. It must be stressed, of course, that the desire to obtain ODS does not necessarily mean that it will be granted. In Chapter VI the details of the ODS program were presented. The program is designed to make U.S. ship operating costs equal to foreign costs through direct subsidy. Whether ODS indeed accomplishes this should be analyzed carefully by the applicant with respect to the specific ODS contract he will sign. The new wording of the ODS law provides that ODS "shall equal" the difference between certain U.S. and foreign operating expenses. This is a considerable improvement over the original "shall not equal the excess of parity with foreign operating costs" wording. The new wording affords the operator greater certainty as to the level of ODS he will receive. In addition, he is no longer

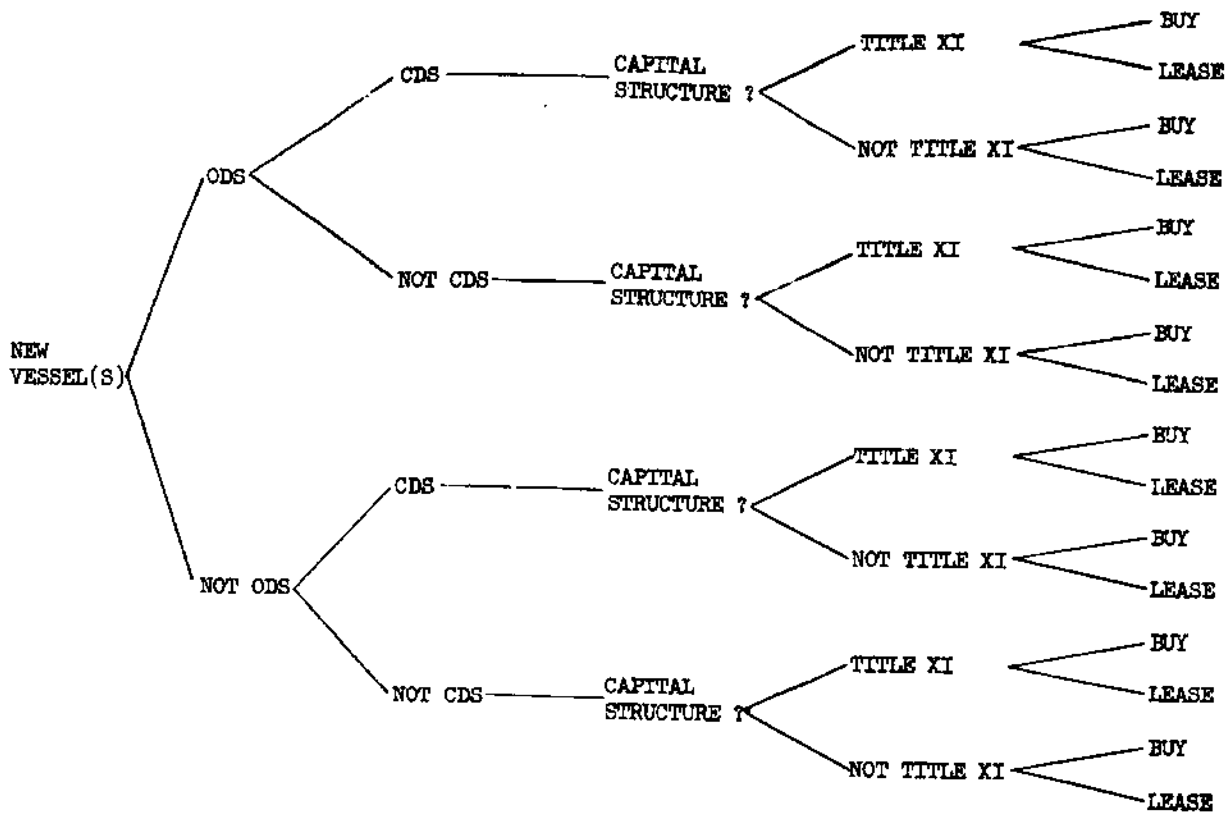


FIGURE VII-1 : VESSEL FINANCING DECISION TREE

We see that many of the considerations here are intangible, yet they must be skillfully judged upon in making the ODS decision. It must be remembered that the decision is also affected by whether or not the company already owns ships with ODS.

B. Construction Subsidy

The other major subsidy question to be considered is whether or not to build a new U.S. flag vessel with CDS. Construction subsidy is now available to bulk operators for the first time and many companies are now faced with the opportunity to apply. In Chapter VI, the details of the CDS program were presented. The program is designed to make the acquisition cost of a U.S. built vessel comparable to the foreign cost of a similar ship. For cargo liner trades, it is usually necessary for the operator to receive both ODS and CDS if he is to operate a competitive U.S.-foreign service demonstrating the interdependence of ODS-CDS decisions. The bulk trades, through long term charter contracts, might be interested in CDS without ODS. An example is where CDS tankers are charted to the government at lower than the usual non-CDS rates but higher than foreign rates. The advantages of lower U.S. construction costs through CDS must be weighed against the following disadvantages:

a) The CDS vessel is generally excluded from the protected U.S. coastwise trades.

b) There is a limitation on the amount of foreign to foreign trade in which a CDS vessel may participate.

c) The operator will be audited by the government and his financial decisions may be affected.

In summary, any decisions concerning ODS and/or CDS will yield different inputs to the overall investment decision. The major categories affected are: 1) operating costs, 2) vessel acquisition cost, 3) the expected future revenue stream and 4) the degree of expected government intervention in management decisions. The change in these four factors should be carefully analyzed with respect to ODS and CDS.

C. Tax-Deferred Capital Construction Funds

Not included in Figure VII-1 is the decision of whether or not to create a capital construction fund. Since it is not directly related to particular vessels, but rather to the overall equity financing of the firm, it does not appear on the diagram. In Chapter V, the Capital Construction Fund Program was described and analyzed. With its extension in 1970 to non-subsidized segments of the U.S. fleet, it has generated a major decision for all U.S. shipping companies. Recently a ruling was made allowing for no required depreciation deposits into the fund. As was demonstrated in Chapter V, this allows participating operators to obtain a quick build-up of equity funds and the accumulation of working capital. This indirect subsidy can have massive effects on the financial strength of any shipping company. Unless the operator feels that he cannot tolerate any of the resulting government involvement in his business, there is no reason not to create such a fund. There are few restrictions on the vessels connected with the program and government involvement should generally be limited to auditing the company's accounts.

D. Capital Structure

The company's target capital structure and the effect of new financing on it should be an important consideration in financing decisions. In Chapter I, the effect of overall capital structure on risks, return, tax shelter and bankruptcy was demonstrated and it was shown how the idea of optimal capital structure might be approached. In addition, the existing capital structures for various segments of the industry were studied. It was shown that the transportation industry is generally characterized by high TOTAL DEBT/TOTAL ASSETS ratios and that the subsidized steamship operators are the most conservative with the lowest of such ratios.

E. Title XI Financing

The decision of whether or not to employ Title XI financing for shipping company debt depends largely on what other alternatives are open to the company. Except for some very unusual cases, shipping companies cannot obtain lower debt rates than through Title XI loans and mortgages. This fact is proven by the vast participation in the Title XI program by many segments of the U.S. shipping industry. It is, perhaps, the best vessel financing program anywhere in the world due to its unique ability to make possible vessel financing for 20-25 years. This compares to the usual maximum duration of loans for foreign flag ships of eight years. With ships growing larger, more technically sophisticated and more expensive, longer than eight-year payback schedules are in high demand. In view of these points, much effort was put forth in studying the Title XI program. Chapter IV contains a detailed analysis of the program, the cash flows involved, the application procedure, and new legislation designed to improve it. The limitations placed on companies employing Title XI by the government are generally no more severe than those which the company would experience if financing were obtained without Title XI insurance.

F. The Lease or Buy Decision

The lease or buy decision was treated in some detail in Chapter II. It was shown how leasing provides hidden debt or off balance sheet debt financing which may have favorable effects on credit standing. It was also demonstrated that year to year cash flows of the firm could be adjusted through leasing and that fast depreciation write-offs can be taken advantage of through this alternative. The basic costs connected with the advantage gained through leasing may be determined explicitly through calculating the net present value of the difference between buying and leasing. This amount can be thought of as the lessor's profit for providing the leasing service. To complete the study of the leasing decision, a cash flow analysis of the lease vs. buy decision will be presented based on tax considerations developed in Chapter III.

Leasing is basically a form of debt financing as viewed from the eye of the company acquiring the asset. The explicit costs of leasing are, almost without exception, higher than any buying alternative. It is important, however, to measure the cost of leasing and compare it to the cost of buying in a logical manner. There are three basic areas in which leasing and buying differ with respect to cash flows. They are:

1) The degree of debt financing provided.

2) The "interest rate" connected with this debt.

3) The timing of "depreciation" tax write-offs.

Of these three, it is logical to examine only 2) and 3) in making a comparison of leasing vs. buying costs. If we look at the overall financing policy of the firm, issue 1), the degree of debt financing provided is an external factor to any one particular financing decision. That is to say, the tax savings connected with new leverage provided by a particular financing decision should not be considered as a benefit when choosing among alternative financing plans. These tax savings should be considered only when approaching the capital structure decision as outlined in Chapter I. This leaves only issues 2) and 3) to be considered when comparing the explicit costs of buying vs. leasing.

The best method of explaining the comparison method is through a simple example: The President of a small shipping company has decided to purchase a vessel on the basis of NPV (net present value) calculations which he had made over a range of discount factors. He found that the venture should be quite profitable even at discount rates well above the company's usual "hurdle rate". He has been advised by the financial manager, however, that the NPV analysis was based on their ability to use "sum of years' digits" depreciation which, by his calculations, would cause the small company to have overall net operating losses in the early years of the new vessel's life. In addition to the problems this would cause in raising new equity capital in the next few years, the company would be forced to carry forward the losses, thereby losing the advantage of rapid depreciation. Both the President and the financial manager agree that it is important for the growing company to show high profits in the next few years to promote a good market for new equity issues they expect to make. In addition, they decided to evaluate the alternative of a long term financial lease as a method of acquiring the new vessel. If the yearly principal and interest costs of such a vessel could be paid on a "level" basis over 20 years, the financial manager has calculated, the desired timing of net profits could be met. A local bank has agreed to buy and lease the vessel to him on these terms at an 8-1/2% interest rate. The financial manager will now calculate how much this leasing alternative will actually cost him:

Assumptions:

Pre-tax cost of debt to company	8%
Pre-tax cost of leasing to company	8-1/2%
After tax cost of capital (hurdle rate) to company	10%
Acquisition cost of new vessel	$10M
Corporate tax rate	50%

1. The Cost of Buying: For the analysis, we will define the cost of buying as the INITIAL ACQUISITION COST LESS THE PRESENT VALUE AT THE FIRM'S COST OF CAPITAL OF DEPRECIATION GENERATED TAX SAVINGS. Note that the degree of debt and equity financing does not affect the acquisition cost. Any financing method used will have a NPV of total equity, amortization, and interest, at the company's cost of debt equal to $10 million. The cost of buying is calculated for three different depreciation methods in Tables VII-1, 2 and 3, which are self-explanatory.

2. The Cost of Leasing:[1] To evaluate the cost of leasing on a basis comparable to the cost of buying we must adopt an abstract approach to the problem. This requires calculating an "EQUIVALENT ACQUISITION COST" and "EQUIVALENT DEPRECIATION TAX SAVINGS". By this method we can evaluate the differences due to the higher lease interest rate and the change in depreciation tax shelter between the buying and leasing alternatives. In addition, the analysis is independent of the difference in tax shelter resulting from interest payments, a function only of the degree of leverage employed which is a capital structure decision as shown in Chapter I.

[1]The method employed here is similar to that demonstrated in Leasing of Industrial Equipment by Richard F. Vancil.

Table VII-1

The Cost of Buying Using Straight Line Depreciation

(Figures in $000's)

Year	Straight Line Depreciation	Tax Savings = Tax Rate (.50) x 1	Present Value of Tax Savings @ 10%
1	500	250	227
2	500	250	206
3	500	250	188
4	500	250	171
5	500	250	153
6	500	250	141
7	500	250	128
8	500	250	117
9	500	250	106
10	500	250	97
11	500	250	87
12	500	250	80
13	500	250	72
14	500	250	66
15	500	250	60
16	500	250	55
17	500	250	50
18	500	250	45
19	500	250	41
20	500	250	37
TOTAL	10,000	5,000	2,127

NPV COST = [AQUISITION COST]-[NPV OF DEPRECIATION TAX SAVINGS]

NPV COST = 10,000 - 2,127 = $7,873

Table VII-2

The Cost of Buying Using Double Declining Balance Depreciation, Switching to Straight Line When Faster Rate Can Be Achieved (Figures in $000's)

Year	D.D.B. Depreciation	Tax Savings = Tax Rate (.50) x 1	Present Value of Tax Savings @ 10%
1	1,000	500	454
2	900	450	372
3	810	405	304
4	729	365	249
5	656	328	204
6	590	295	166
7	531	266	136
8	478	239	112
9	430	215	91
10	387	194	75
11	352	176	62
12	352	176	56
13	352	176	51
14	352	176	46
15	352	176	42
16	352	176	38
17	352	176	35
18	352	176	32
19	352	176	29
20	352	176	26
TOTAL	10,000	5,000	2,580

NPV COST = [ACQUISITION COST] - [NPV OF DEPRECIATION TAX SAVINGS]

NPV COST = 10,000 - 2,580 = $7,420

Table VII-3

The Cost of Buying Using Sum of Years' Digits Depreciation (Figures in $000's)

Year	Sum of Years' Depreciation	Tax Savings= Tax Rate (.50)x 1	Present Value of Tax Savings @10%
1	952	476	432
2	905	453	384
3	857	429	322
4	810	405	276
5	762	381	237
6	714	357	202
7	667	334	171
8	619	310	145
9	571	286	121
10	524	262	101
11	476	238	83
12	429	215	69
13	381	191	55
14	333	167	44
15	286	143	34
16	238	119	26
17	190	95	19
18	143	72	13
19	95	48	8
20	48	24	4
TOTAL	10,000	5,000	2,746

NPV COST = [AQUISITION COST] - [NPV OF DEPRECIATION TAX SAVINGS]

NPV COST = 10,000 - 2,746 = $7,254

a) Equivalent Acquisition Cost: The leasing company will provide a "level lease" at 8-1/2% interest. This means we must find the value of a 20-year annuity with a NPV at 8-1/2% of $10 million. Using annuity tables, we find that yearly payments of $1,058,000 will satisfy these conditions. The lease payment schedule in Table VII-4 is a result of this calculation. To find the EQUIVALENT ACQUISITION COST, we will take the NPV at the company's pre-tax cost of debt (8%) of all future lease payments as follows:

Equivalent Acquisition Cost = NPV @ 8% of Future Lease Payments = $10,380,000

We have thereby adjusted the acquisition cost to include the present value of the premium paid to the leasing company for their services. IN THIS CASE, THE PREMIUM IS (10,380,000 minus 10,000,000) = $380,000.

Table VII-4

The Cost of Leasing with a Level Lease

With a Lease Cost of 8-1/2%

Year	(1) Lease Payments	(2) Balance on "Loan" During Year	(3) 8% Int-erest on Balance	(4) Non-Int. Deduction= "Deprecia-tion"Equiv-alent"	(5) Equiv. Deprec. Tax Savings	(6) Present Value of Tax Savings @ 10%
			(.08)×(2)	Col (1)-Col (3)	(.50)×(4)	
1	1058	10,000	800	258	129	117
2	1058	9,742	780	278	139	115
3	1058	9,464	757	301	151	113
4	1058	9,163	733	325	163	111
5	1058	8,838	706	352	176	109
6	1058	8,486	679	379	189	107
7	1058	8,107	649	409	205	105
8	1058	7,692	615	443	222	104
9	1058	7,249	579	479	239	102
10	1058	6,770	542	516	258	100
11	1058	6,254	500	558	279	98
12	1058	5,696	456	602	301	96
13	1058	5,094	407	651	326	94
14	1058	4,443	356	702	351	92
15	1058	3,741	300	758	379	90
16	1058	2,983	238	820	410	89
17	1058	2,163	173	885	443	87
18	1058	1,378	110	948	474	85
19	1058	430	34	1,024	512	84
20	1058	-0-	-0-	1,058	529	79
TOTAL	21,160		9,414	11,746	5,876	1,977

NPV COST = [EQUIVALENT ACQUISITION COST] - NPV OF EQUIVALENT DEPRECIATION TAX SAVINGS]

NPV COST = 10,380 - 1,977 = 8,403

b) Equivalent Depreciation Tax Savings: The calculation of a "depreciation equivalent" component of each lease payment is shown in columns 2, 3 and 4 of Table VII-4. We assume an initial balance of $10 million on the "loan" provided by the lease (see column 2). The interest component at the company's cost of debt is calculated in column 3. Column 4, therefore, shows the depreciation equivalent component of each lease payment. The calculation of the NPV of tax savings due to this equivalent depreciation is self-explanatory in columns 5 and 6. The NPV cost of leasing is shown at the bottom of the table as the "EQUIVALENT DEPRECIATION TAX SAVINGS".

3. The Cost of Buying vs. Leasing: The results of the analysis are as shown in Table VII-5 below:

Table VII-5

Results of Cost of Buying Vs. Leasing Calculations

Alternative	NVP Cost ($)
Buying Using S.L. Depr.	7,873,000
Buying Using DDB Depr.	7,420,000
Buying Using Sum of Yrs. Depr.	7,254,000
Leasing at 8-1/2%	8,403,000

The added present value cost to the company of leasing the vessel in lieu of buying is (8,403,000 - 7,254,000) = 1,149,000 if based on SUM OF YEARS' DIGITS DEPRECIATION. It is the amount that the original overall investment NPV caluclation for buying at the 10% hurdle rate should be reduced by, to obtain the true NPV of the project using lease financing. It was, however, decided earlier by the financial manager that the SUM OF YEARS' DIGITS METHOD could not, in any case, be used to full advantage due to the timing of future profits. It is more logical, therefore, to compare the leasing alternative to a buying alternative with a realistic depreciation method for the company involved. The financial manager of this company calculated that full straight line depreciation could be taken but that more accelerated methods could not. Therefore, the true explicit cost of leasing over buying for this company is ($8,403,000 - 7,873,000) = $530,000. It is this cost that must be compared to the benefits of profit timing and off-balance sheet financing, in deciding whether to buy or lease.

4. The Future of Leasing: It is the opinion of the author that leasing will be a major financing method employed for new U.S. vessels in the next decade. The foreign source income problem (see Chapter III) has been reconciled, which should open up many leasing opportunities. Mr. Richard F. Pollard on behalf of the Chase Manhattan Bank has stated: "It is our belief that vessel leasing could be an important vehicle for providing the investment capital needed to rebuild the U.S. fleet in much the same manner as aircraft leasing has produced the money to acquire new equipment in that industry."[2]

[2]Statement prepared for hearings before the House Merchant Marine Subcommittee, March 2,3,4, 1970.

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PART 8

FACTORS AFFECTING SHIPPING OPERATIONS

by

H. S. Marcus

Introduction

This volume puts together under one cover information on five topics affecting present and future shipping operations. Chapter I presents a cost model for ocean transportation, economics being a basic influencing factor for all industries. The next two chapters leave the traditional topic of economics per se to analyze problems affecting the future of the maritime field. Chapter II looks at the perplexing problems of using supertankers on the U.S. East Coast. No facilities presently exist in this geographic area with depths large enough to handle the new mammoth vessels. Although significant economic savings can be realized by building such facilities, several obstacles have blocked the construction of such a superport. Chapter III points out another problem of the merchant marine, the competition of new jumbo jets to containerships. The factors discussed in both these chapters will play an important part in future shipping operations.

The final two chapters deal with factors not frequently seen in the public spotlight, yet essential to the maritime industry. Chapter IV deals with the marine insurance industry. This chapter studies the effect of foreign powers on the insurance for the U.S. merchant marine and the effect of marine insurance on new technological innovations in the maritime field. In addition, recommendations are made concerning the role of the U.S. Government in the marine insurance industry. The final chapter explains the role of classification societies, their background and their purpose. The process of evolution in classification rules is described.

It is hoped that the several topics in this volume will provide reading of interest to both the person involved and experienced in the marine industry and to the casual observer who wishes to broaden his understanding of the maritime field.

CHAPTER I

OCEAN TRANSPORTATION COST MODEL

This section will describe a model that calculates the transocean costs for five vessel types. The logic is straightforward and is geared toward typifying the ocean service environment as nearly as possible. The model presented here is taken from the 1971 U.S. Department of Transportation report, Transoceanic Cargo Study. If the reader wishes further information on computerizing the model, he should refer to this DOT report.

There are two basic constraints imposed upon the model: (1) It is a general model and as such it can only characterize average operating environments; and (2) the number of user-supplied input parameters was kept small so as to minimize the user's effort. The model is specifically geared to provide the following answers:

- Dollars per ton, from the ocean terminal at the point of origin to the ocean terminal at the point of destination.

- Total transit time, in days, from the time the cargo arrives at the originating terminal to the time the cargo departs from the ocean terminal at the destination side.

- Sufficient cost and transit time detail to identify such factors as cargo waiting time, cargo handling and terminal cost, ocean transit time, cargo insurance or claims cost, documentation cost, etc.

The input parameters for operating this model come from two sources. One source is the output from a Design, Capital Cost, and Operating Cost computer program which defines the vessel's physical characteristics and its direct operating costs--these parameters appear in Exhibits I-5 through I-31.

The second input source is exogenous and fixes such factors as the one-way transocean distance, the cargo density, the value per pound, and a logic variable indicating a transit of the Panama Canal, etc.

All of the costs and productivity factors were generated at 1967 levels. Where changes in these elements were expected to take place during the 1970s, they were incorporated as the equations were formulated. In all cases, the test of "reasonableness" was the governing criterion.

A. Model Structure

The Service Model structure is essentially divided into five major blocks:

Block 1--accepts input from the Design, Operating Cost, and Capital Cost model

Block 2--accepts exogenous inputs

Block 3--constants definition

Block 4--logic and equation set

Block 5--output

Block 1 takes the 18 vessel parameters given in Exhibits I-5 through I-31 and puts them into compatible program form. No attempt at defining the internal structure of this block (or any other block) has been attempted since this would be beyond the scope of the study.

Block 2 accepts the exogenous trade parameters.

Block 3 incorporates the constants given in Exhibits I-1 and I-11 for definition of service characteristics, labor rates, escalation factors, etc.

Block 4 is composed of five parallel logic flows, one for each vessel type. Each vessel type passes through the function subsections defined in the equation section of this technical memorandum.

Block 5 is the output format.

B. Service Model Constants

1. Vessel Lost Time. Annual vessel lost time due to unforeseen delays, such as bad weather, breakdowns, port congestion, etc., and scheduled lost time such as annual drydocking, itinerary changes, etc. This annual lost time is taken as 15 days per year.

2. Vessel Load Factors. The load factors for break-bulk, container, and barge-carrying vessels were estimated to be: outbound, 0.828; and inbound, 0.552.

The load factors for bulkers and tankers are: 1 in the loaded direction; and 0 in the ballast direction.

3. Number of Port Calls. Break-bulk vessels make an average of six foreign port calls, and four U.S. port calls per voyage. There is a considerable variation in the number of port calls made by these vessels, but the above figures are generally representative of the more important trades.

For tankers and bulkers there is only one port call on the

U.S. side, and one on the foreign side.

Most container vessels currently operate on a box itinerary; that is, two foreign port calls and two U.S. port calls. These factors will probably change to single port calls on each side on the heavy port pair trades as the mega-container port becomes a worldwide reality--perhaps by the mid-70s.

Barge carriers will probably have itineraries with the number of ports somewhere between a container and break-bulk operation. For this reason it is anticipated that the barge carrier will make three port calls on the U.S. side, and four calls on the foreign side.

4. Entrance and Exit Time per Port. This factor defines the time in days it takes a vessel to enter the harbor from the pilot station and be made fast at the dock ready to begin working cargo (quarantine, immigration, customs clearance, etc.). It is observed that this can range from 1-2 hours to almost a full day. The study uses an average value of 0.2 days to enter and 0.1 days to exit the port, or a total time per call of 0.3 days. For bulkers and tankers this is reduced to 0.2 days per call.

5. Coastal Distances. The distance that each vessel travels on the transocean legs is the major portion of the total sea distance traveled; however, when more than one port call is made on each side, then the total sea distance traveled must be increased to account for this fact. The study represents this coastal distance as a ratio of the distance traveled for each port call to the one-way transocean distance. For bulkers and tankers this ratio has a value of 0 for both the foreign and U.S. coasts. For the other vessels a ratio of 0.05 per port call (U.S. or foreign) of the transocean distance is used.

The foregoing series of constants should allow the user enough flexibility to characterize virtually any service. The table of values that we have assigned these constants appear in Exhibit I-1.

6. Sea Speed. The sea speed of a vessel as used by the design model is the normal at-sea speed when the vessel is loaded to her design condition, that is, fully loaded with cargo of the design density. Variations in sea speed occur when the vessel is operating at other than a load factor of 100 percent, and/or at densities other than the design density. The assumption used in the service model is that the normal at-sea horsepower will always be used, and that variations in speed are due solely to variations in displacement.

Professor Benford has produced curves relating changes in speed to changes in the block coefficient, displacement, and horsepower utilized. The variations in speed for various block

EXHIBIT I-1. SERVICE CONSTANTS MATRIX (S_{IJ} VALUES)

Vessel Type	I \ J	1	2	3	4	5	6	7	8
Bulker	1	15	1	0	1	1	.2	0	0
Tanker	2	15	1	0	1	1	.2	0	0
Container	3	15	.828	.552	2	2	.3	.05	.05
Break Bulk	4	15	.828	.552	4	6	.3	.05	.05
Barge Carrier	5	15	.828	.552	3	4	.3	.05	.05

J	Description of J Column:
1	The annual lost time of the vessel.
2	The outbound load factor of the vessel for container, break-bulk, and barge carriers. For bulkers and tankers it is the loaded direction load factor.
3	The inbound load factor for container, break-bulk, and barge carriers. For bulkers and tankers it is the ballast leg load factor.
4	The number of U.S. port calls per voyage.
5	The number of foreign port calls per voyage.
6	The number of days taken to enter and exit a port.
7	The ratio of the U.S. coastal distance traveled to the one-way transocean distance for each U.S. port call.
8	The ratio of the foreign coastal distance traveled to the one-way transocean distance for each foreign port call.

coefficients were relatively minor and as such were disregarded. The study has taken the "current" sea speed as ratio of design sea speed and made it a function of the ratio of current displacement to design displacement. This, of course, allows for sea speeds greater than the designed sea speed and allows for loads greater than the design load. The study has restricted the increase in sea speed due to decreased displacement to being less than 20 percent greater than the design sea speed. The justification for this restriction is that, even in a light condition, enough of this ship's propeller will be out of the water to provide an effective upper limit on speed.

The equation below was derived from Professor Benford's studies of general cargo ships and ocean ore carriers, and from file data on vessel performance characteristics.

$$S_R = 1/(D_N/D_D)^{0.163}$$

S_R = speed reduction factor = S_N/S_D
S_N = new sea speed, knots
S_D = the design sea speed, knots
D_N = new displacement, long tons
D_D = design displacement, long tons

where $S_R \leq 1.2$

A plot of this equation is given in Exhibit I-2.

C. Panama Canal Transit Time and Costs. The transit costs for the Panama Canal were taken from the "Panama Canal Transit and Port Information" booklet. These were reduced to equation form for a single vessel parameter--balecube. Two equations were generated, one for the loaded transit costs of the vessel, and the other for the ballasted transit costs. These equations are as follows:

Loaded

$$P_{CT} = 480 + 0.9267(B_C/100)$$

Ballasted

$$P_{CT} = 480 + 0.7466(B_C/100)$$

P_{CT} = Panama Canal transit costs

B_C = the bale cubic of the vessel

The average transit time is approximately 1/2 day irrespective of vessel type for one transit--a round trip would have 1 day lost due to transits.

These equations are plotted in Exhibit I-3.

D. Cargo Handling Costs and Productivities

1. Bulkers. Modern bulk vessels typically operate in closed distribution systems. That is, ownership of the cargo and the cargo-handling facilities at each end of the service is coincident with the company controlling the bulk vessel's movement. However, there are notable exceptions to this--one, the coal movements from Hampton Roads, and two, the grain trade from the Pacific Northwest, Gulf, and Great Lakes. Because of the proprietary nature of cargo-handling costs and productivities, a restricted number of actual cases formed the basis of our analysis.

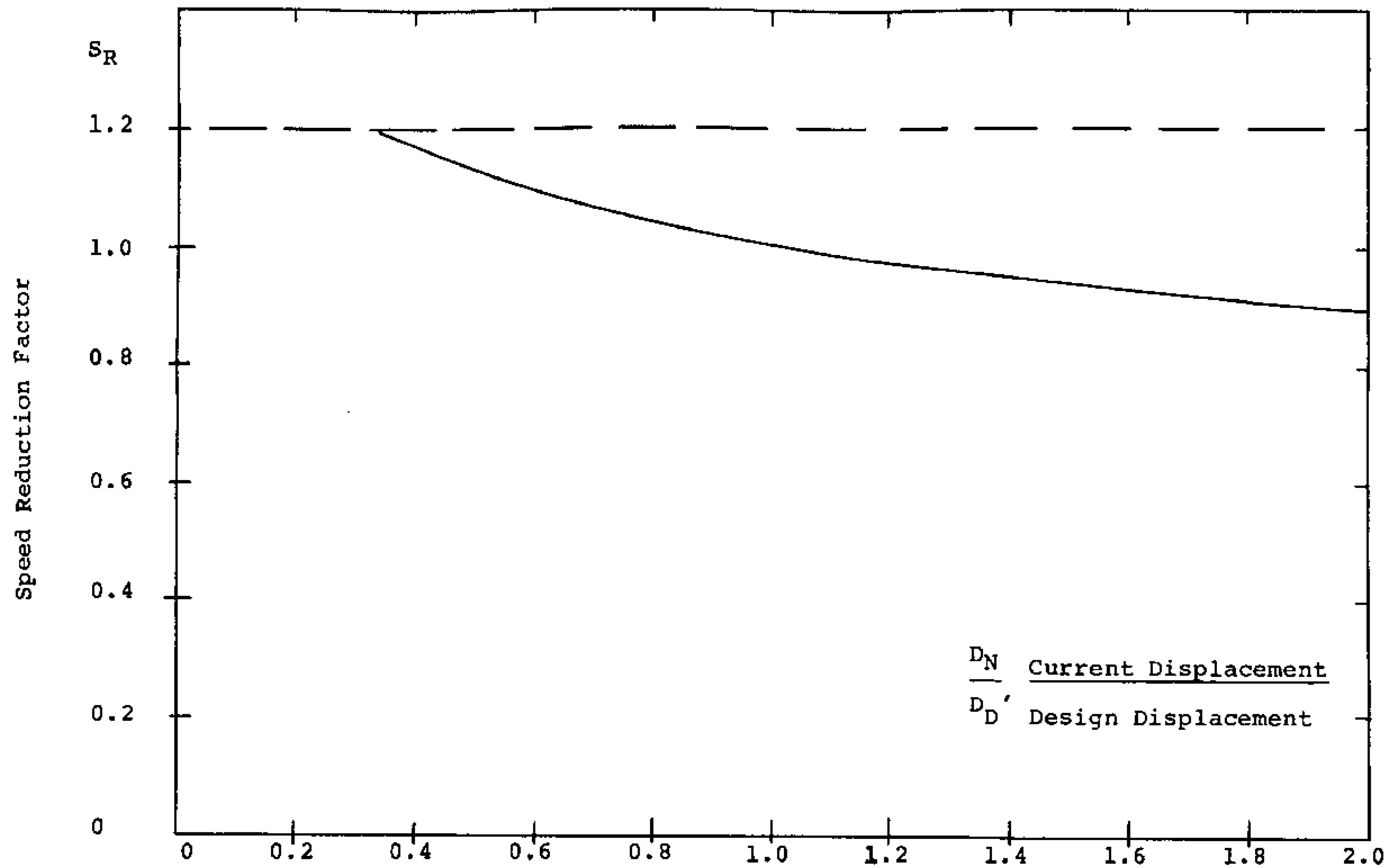


Exhibit I-2: <u>SPEED REDUCTION</u>

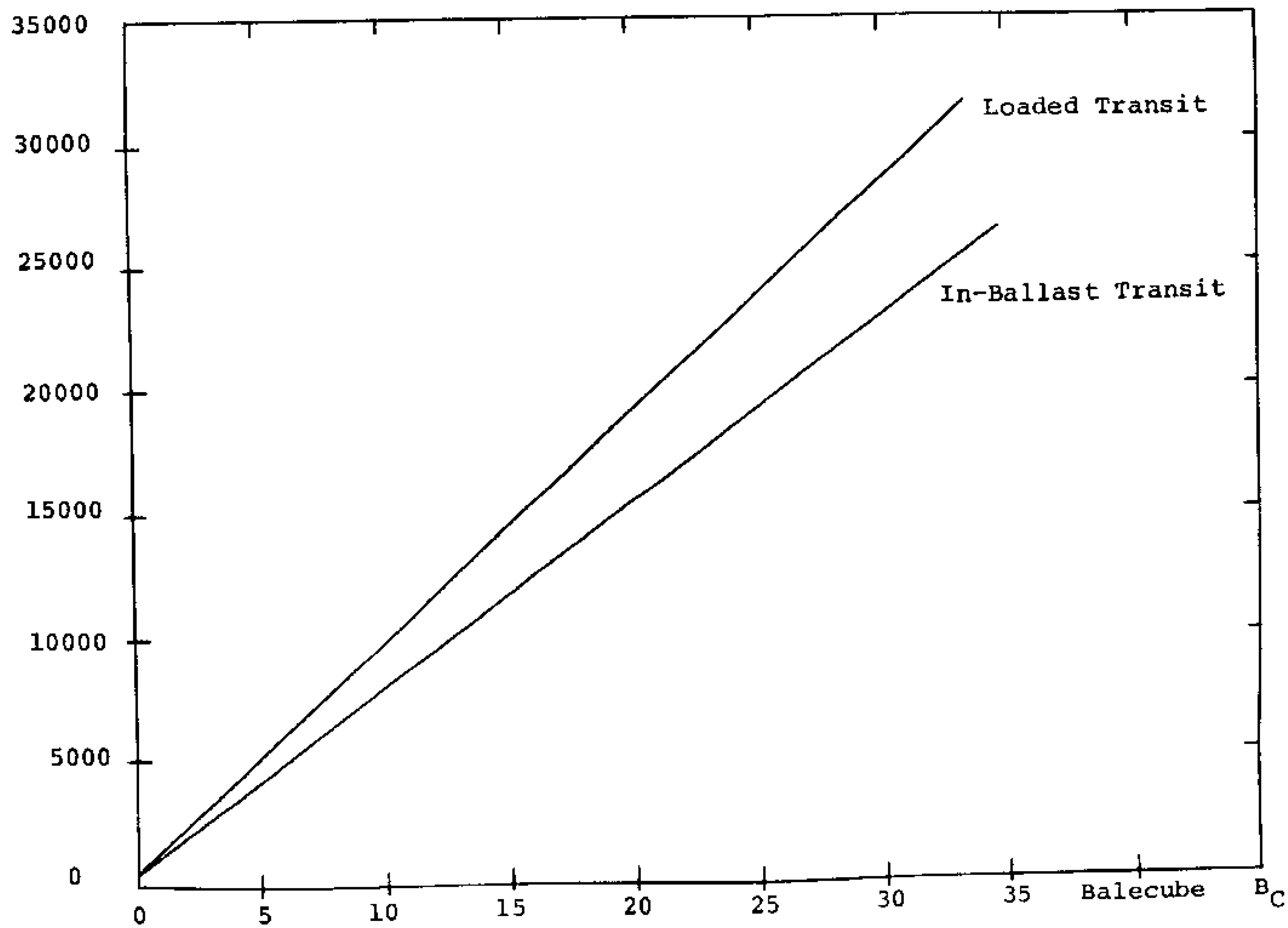


Exhibit I-3: PANAMA CANAL TRANSIT COSTS

This study has generated a family of equations for loading and discharging costs based upon the annual throughput of the facility and the density of the commodity. These equations were generated from file data as well as from published port tariff quotations for loading and discharging bulk commodities. The equations are given below:

Loading

$$L_C = 4540/[T_A^{.56} d^{.43}]$$

Discharging

$$D_C = 16500/[T_A^{.56} d^{.43}]$$

L_C = the cost per short ton to load the cargo on the vessel, \$/short ton

D_C = the cost per short ton to discharge the cargo on the vessel, \$/short ton

T_A = annual throughput of the facility, short tons

d = the cargo density, pounds/cubic foot

A plot of the above equation is given in Exhibit I-4. The cost from this equation is adjusted for different trade areas by using the labor ratio (that is, the ratio used for adjusting the port cost equations) and takes the form

$$L_{CR} = (.7 + .3L) L_C$$

$$D_{CR} = (.7 + .3L) D_C$$

L_{CR} = the cost per short ton of cargo loaded aboard the vessel in trade area R, \$

D_{CR} = the cost per short ton of cargo discharged

L = the ratio of the labor wage in region R to the wage rate in the United States

L_C = same as preceding

D_C = same as preceding

This indicates that approximately 70 percent of the cost for loading and discharging is capital or material cost, and that 30 percent of the costs are sensitive to variations in labor cost.

Experience with bulk systems indicates that, on the average, a vessel will spend time working cargo comparable to the time given for container and barge-carrying vessels (see the Container

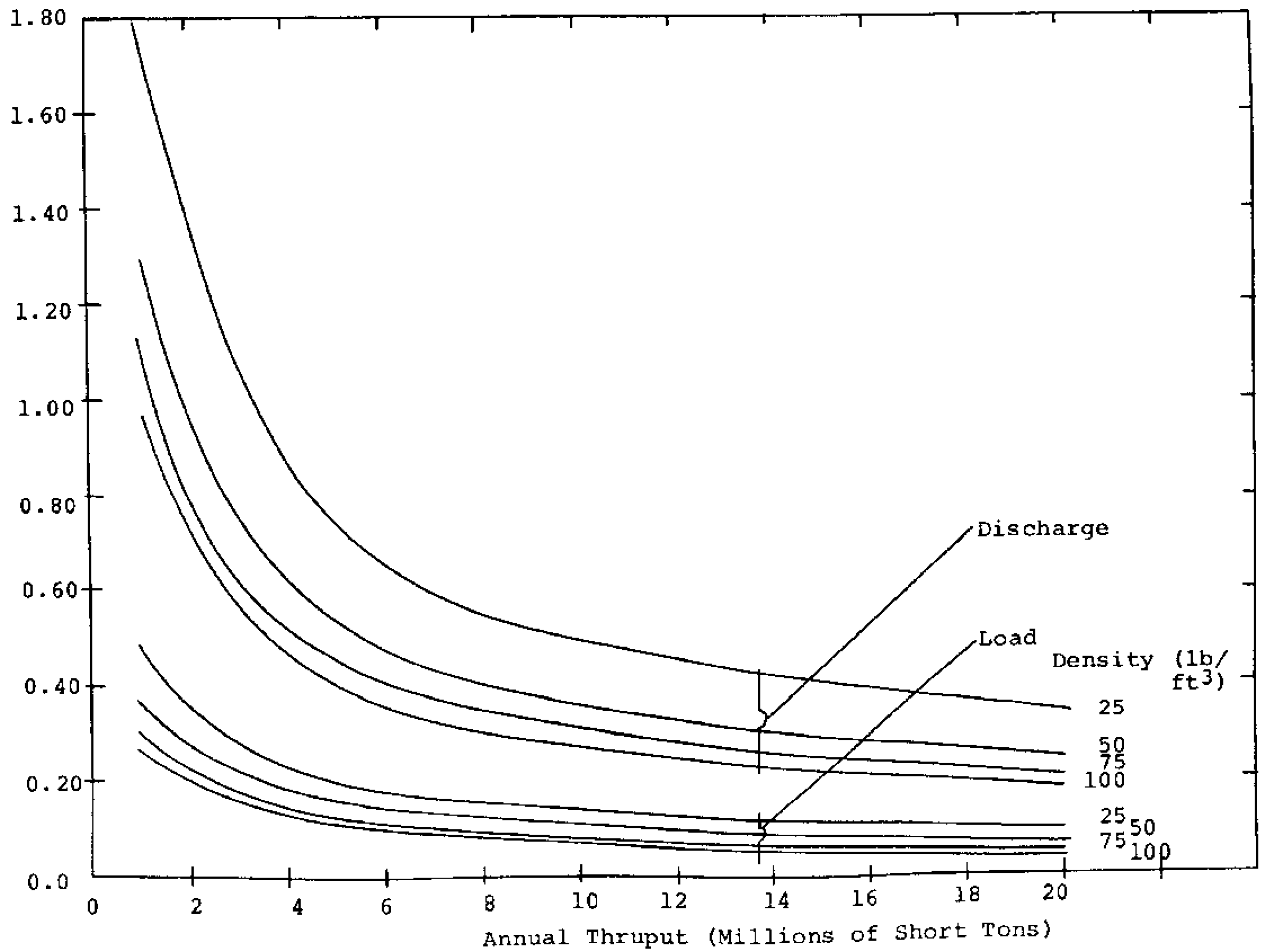


Exhibit I-4: Cargo Handling Cost Bulk Trades section). The actual loading rate, long tons of cargo per hour, is the same as the loading rate given for tankers. The discharging rate, long tons per hour, is taken as being one-half the loading rate. These equations are given below:

Loading

$$L_R = \frac{4.5\ D_{WT}}{d}$$

Discharging

$$D_R = \frac{2.25\ D_{WT}}{d}$$

L_R = the loading rate in long tons per hour

D_R = the discharging rate in long tons per hour

D_{WT} = the deadweight of the vessel, long tons of salt water

d = the density of the cargo, pounds per cubic foot

2. Tankers. Tanker services are very similar to bulk services, and differ largely because they are part of a more extensive distribution system. Because of this, discharging and loading costs are difficult to quantify since the discharging and loading facilities extend into a widespread distribution network inland. From the limited data sources available, it was found that the bulk loading cost equation was a good proxy for the loading or discharging costs of tankers.

The cargo-handling rate (long tons/hour) for tankers is given by the same equation as for bulkers when loading. The discharging rate is taken as being equal to the loading rate.

Tankers spend the least amount of time in port of any of the vessels. This is due primarily to two factors: one, few union restrictions on the hours shoreside personnel take to work the vessel; and two, oil transfer terminals have developed high volume, efficient operations. The ratio of time pumping to time at berth (or mooring) is assumed to be 11/12; or 22 out of 24 hours per day in port is spent pumping.

3. Container. Current container operations show that one gantry crane is generally used on vessels carrying between 200 and 300 containers, that two gantry cranes are used for 300 to 600 containers, and three gantries (when available) are used when loads exceed 800 containers. The typical working productivity of a gantry crane is about 22.5, 8' x 8' x 20' containers per hour, either on or off the vessel. Efficient loading or discharging operations can achieve rates of about 35 containers per gantry hour, whereas inefficient operations reduce productivity to about 12 to 15.

The total cost of handling a container from arrival at the terminal to loading aboard the vessel, or vice versa, can range from \$40 to \$130 per container handling. The variation is dependent upon such factors as: the number of shipments which arrive at the terminal uncontainerized; local labor rates; local containerization surcharges; tonnage assessments; the number of times empty containers are handled, etc. This cost includes terminal rent, container yard operations, container freight station operations, etc., (but excludes drayage costs). The average cost per container handling is taken as \$80. It was found that approximately 65 percent of this cost was sensitive to variations in the labor rate. The equation used to adjust for variations in labor rate from region to region is given below:

Average

$$C_C = 80(.35 + .65L_R)$$
$$= 28 + 52L_R$$

C_C = cost to handle one container one way through the terminal to the vessel, vice versa, \$

L_R = labor ratio in region R, U.S. = 1

Although the above equation appears to be generally representative of container handling costs, there was enough variation in the base figure to suggest the inclusion of two additional equations, a high and low, to illustrate the impact on handling costs. These equations are:

High

$$C_C = 38.5 + 71.5\ L_R$$

Low

$$C_C = 21 + 39\ L_R$$

C_C, L_R = as above

Generally, containerships are worked as follows: two shifts per day, seven days a week (and longer whenever possible). The effective or net working time per shift is taken as seven out of eight hours. This gives us a ratio of actual working time to time on berth of:

$$\text{Ratio} = \frac{7}{8} \times \frac{2}{3} = \frac{7}{12}$$

From the first paragraph, the equation used to determine the number of gantry cranes working a vessel is:

$$N_G = 1 + .002\ N_C$$

N_G = the number of gantry cranes

N_C = the containers aboard the vessel

The container handling rate (loading or discharging) is:

$$H_C = 22.5 + .045\ N_C$$

H_C = the number of containers handled per hour

N_C = as above

Exhibit I-5 shows the plot of the function used to derive the number of gantries used to load or discharge a vessel based on the containers aboard the vessel. It also shows the number of container handlings per hour as a function of the containers aboard the vessel.

For the cargo time spent waiting at the terminal, see the Cargo Terminal Time section.

4. <u>Break Bulk</u>. Break-bulk vessels, of all the vessels in this model, spend the longest time in port. This is due to the fact that the loading and discharging operation on these vessels is a very labor-intensive operation. Typically, a break-bulk vessel is worked on the following schedule: two shifts per day, Monday through Friday, and one shift on Saturday, where each shift contains eight hours. This gives a working period of 88 out of a total of 168 working hours per week. To arrive at the actual hours being worked, an additional reduction in the working time of 168 hours/week is necessary. This reduction accounts for time lost due to opening and closing the hatches, shifting gangs between hatches, bringing equipment aboard, etc. The time lost from each gang's shift due to these causes is between one and two hours, with an average loss of 1-1/2 hours per gang shift. This reduces the net working time per gang per shift to six and a half hours, and reduces the number of working hours to 71-1/2. The ratio 71.5/168 is the net cargo working time to time at the berth.

To determine the productivity of a break-bulk vessel, the number of gangs working the vessel must be determined. To do this, we used an equation given in an MCTC publication relating the number of sets of cargo gear aboard a vessel to the vessel's bale cubic capacity. Normally, one gang can work one set of cargo gear aboard a vessel. The preceding relationship would easily give us the number of gangs aboard a vessel if the following were not usually the case: cargo for a given port is divided unevenly among the hatches so that not all sets of gear can be used; and much of the time a vessel will not get the number of gangs requested due to labor shortages. For this reason, we take the number of gangs aboard a vessel as being 75 percent of the number of sets of cargo gear.

The gang productivity (short tons per gang hour) was taken from the San Francisco port study. The productivity equation which we use assumes substantial palletization of the cargo. This equation, as well as the equations for a fully palletized

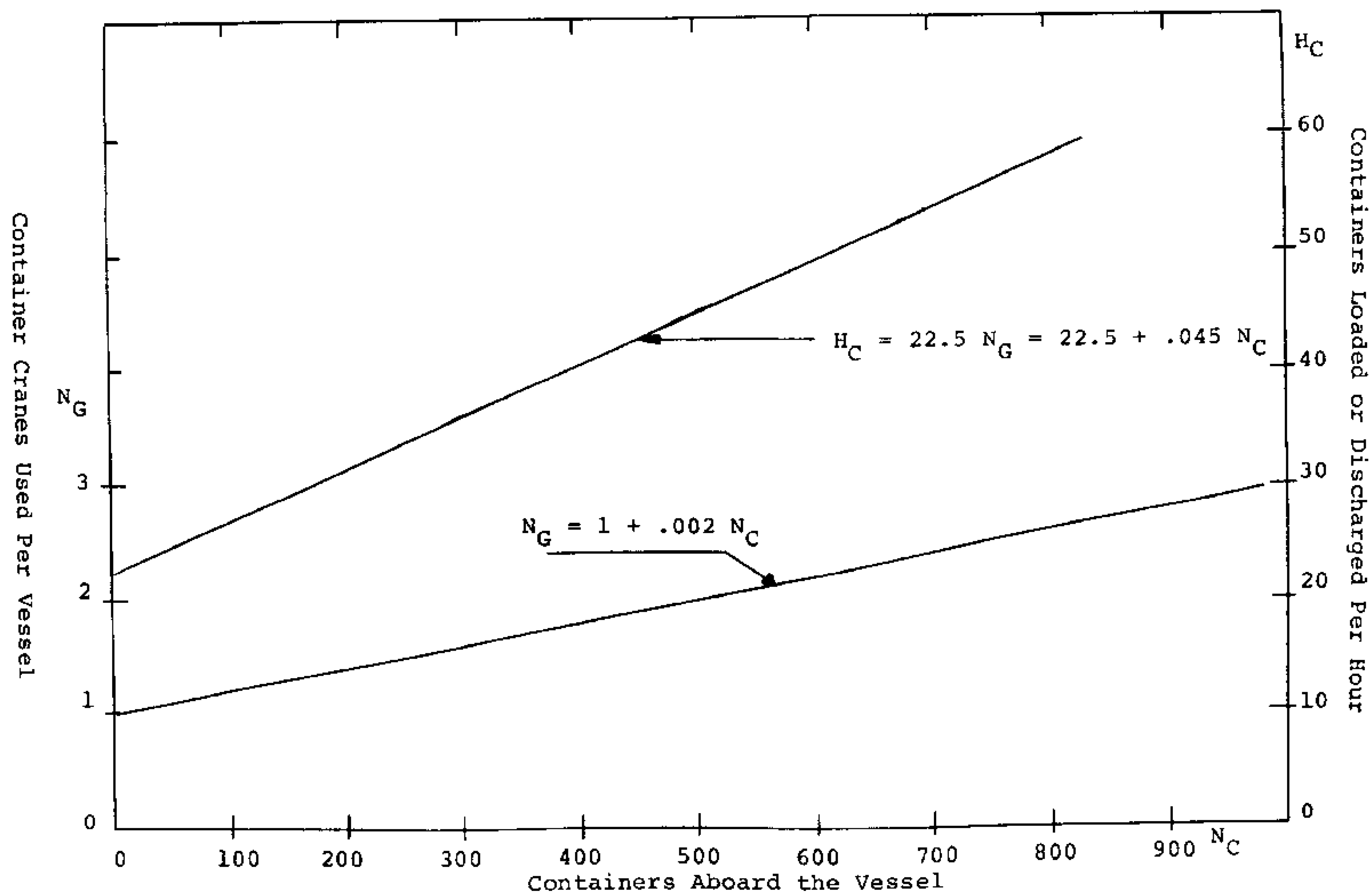


Exhibit I-5: NUMBER OF CRANES PER CONTAINER VESSEL operation and a non-palletized operation, are given below:

<u>Palletized</u>

$$B_P = .73d$$

<u>Substantial Palletization</u>

$$B_P = .6d$$

<u>No Palletization</u>

$$B_P = .4d$$

B_P = break-bulk productivity, short tons per gang hour
d = density of the cargo, pounds per cubic foot

The equations for a number of sets of gear and the number of gangs are:

<u>Number of Sets of Gear</u>

$$S_G = .0154\left(\frac{B_C}{1000}\right)$$

<u>Number of Gangs</u>

$$N_G = .01153\left(\frac{B_C}{1000}\right), \quad N_G \geq 1$$

S_G = the number of sets of cargo gear aboard a vessel
N_G = the number of gangs of longshoremen working
B_C = the bale cubic of the vessel, cubic feet

The above equations are plotted in Exhibits I-6 and I-7.

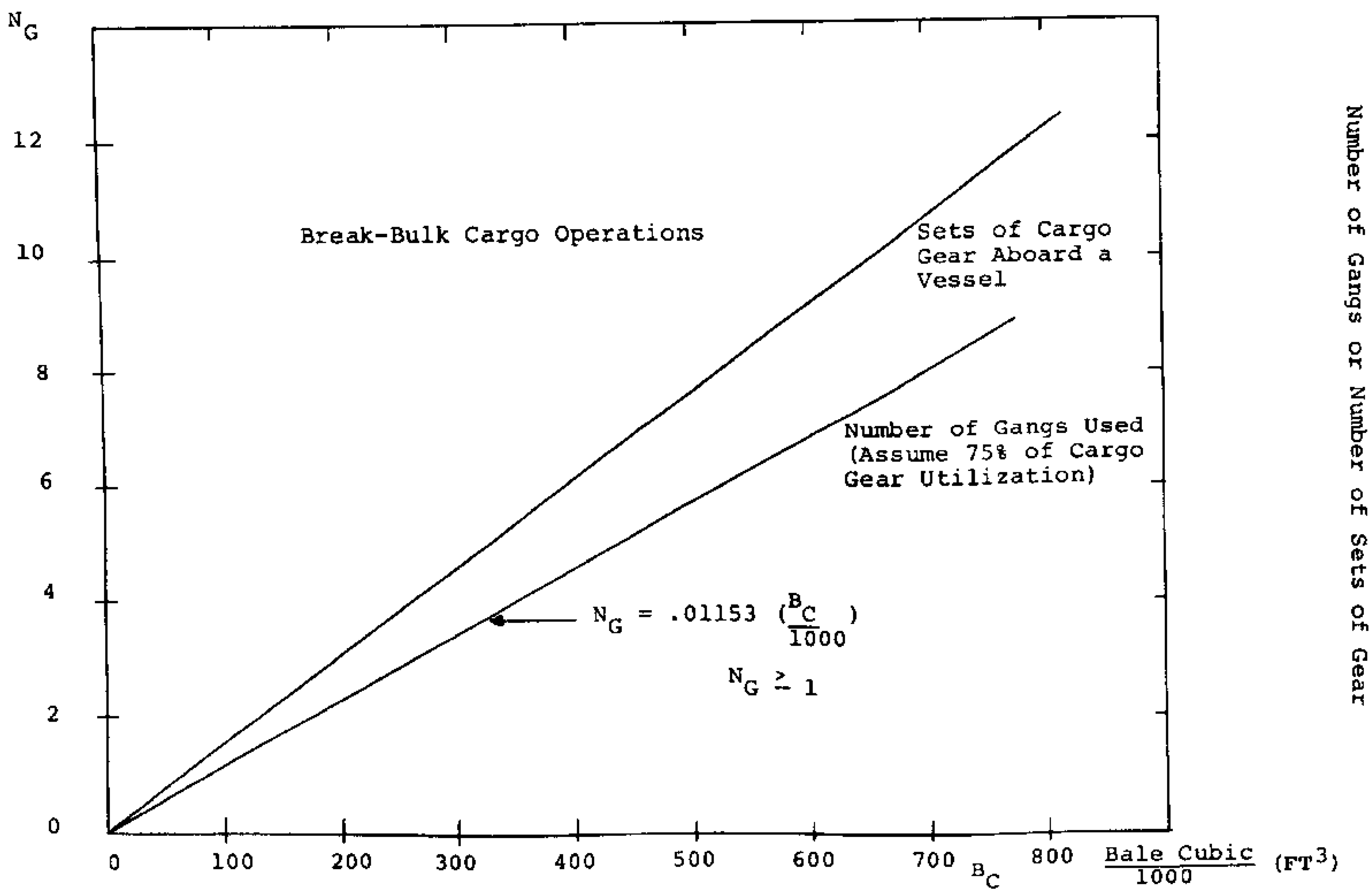
We have derived a break-bulk cargo-handling cost of $20 per short ton (loaded or discharged). This figure refers to a density of 35 pounds per cubic foot. We found that approximately 85 percent of this cost will vary directly with the labor rate and that approximately 15 percent would remain fixed. Because of this, we adjust the cost for different regions by adjusting the labor rate as indicated in the equation below (labor adjustment ratios from Port Cost section):

$$C_{TR} = 20\ (.15 + .85\ L_R)$$
$$= 3 + 17\ L_R$$

C_{TR} = the loading or discharging costs per short ton in region R, $

L_R = the wage rate of the region to the wage rate in the United States (U.S. = 1)

Exhibit I-6: Work Force
Aboard the Vessel



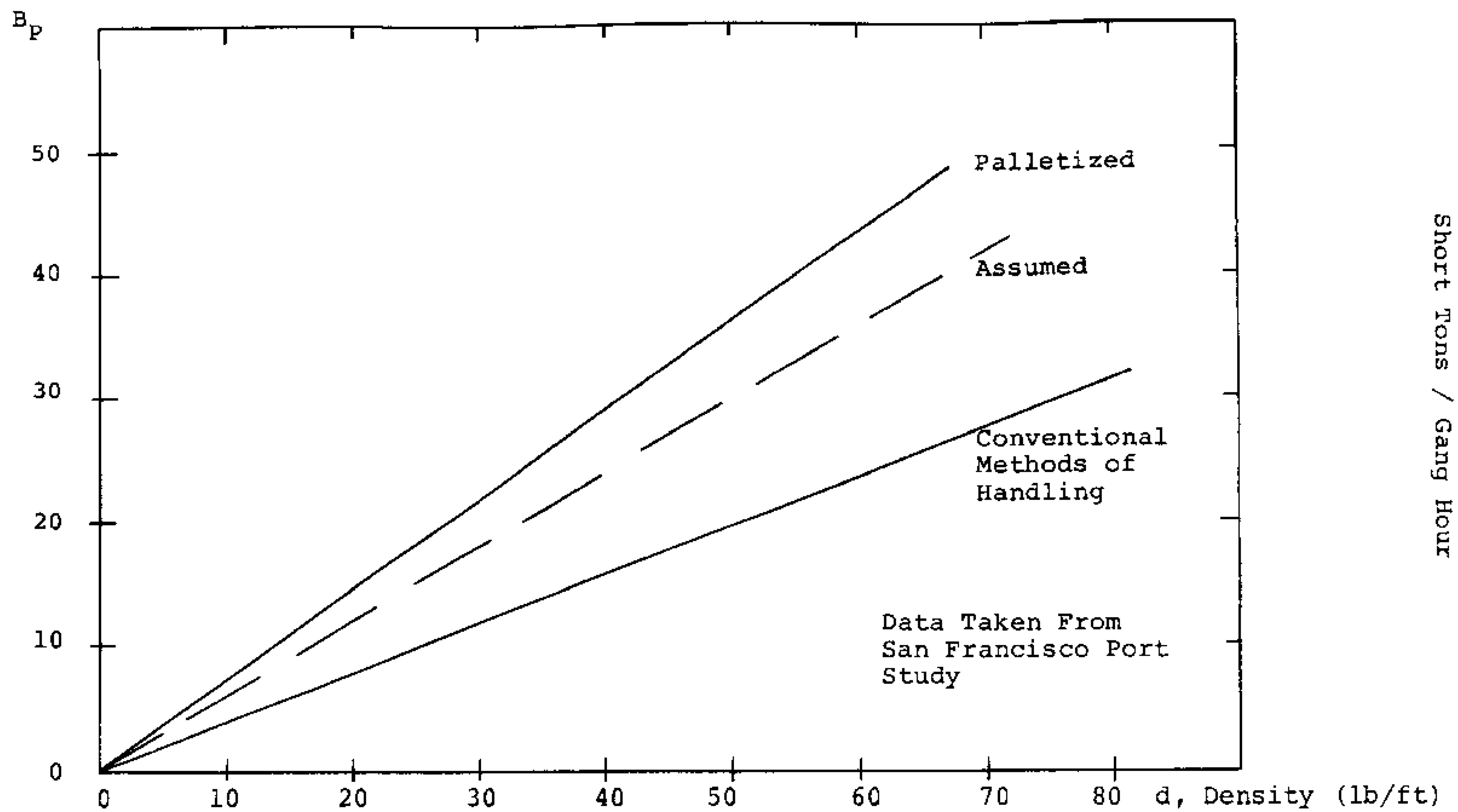


Exhibit I-7: BREAK-BULK PRODUCTIVITY

We then adjust this cost further by varying the density from the norm of 35 pounds per cubic foot. This equation is:

$$C_{TR} = (3 + 17L_R)\,\frac{35}{d}$$
$$= (105 + 595L_R)/d, \; 15 \leq d \leq 80$$

d = density in pounds per cubic foot

It appeared unrealistic to let the equation operate over the entire range of densities since the costs became distorted, and did not conform to our cost information. Because of this, we restrict the density to being greater than or equal to 15 pounds per cubic foot, and less than or equal to 80 pounds per cubic foot. This is not a serious constraint because most of the break-bulk trades have average densities ranging from 20 to 40 pounds per cubic foot.

The time that the cargo spends waiting at the terminal prior to loading aboard the vessel and after discharge from the vessel is explained fully in the Cargo Terminal Time section.

5. <u>Barge Carrier</u>. There are several stages in calculating the in-port productivity and costs of a barge-carrying vessel: (1) determine the location of the vessel when loading and discharging barges (moored in the stream or at a dock); (2) ascertain if the barges are to be transported away from the immediate port area; (3) determine the load/discharge rate of cargo onto (or off) the barge; (4) determine the vessel's load/discharge rate of barges; and (5) attach costs to these elements.

The vessel's location, when working cargo in port, is assumed to be moored in the stream, not at the dock. This conforms to most of the discussions in the literature regarding barge carriers. The reasoning is that there is more open area around the stern of the vessel for moving barges under and away from the vessel's crane. This mooring location means that tugs are needed to move the barges away from the vessel to a consolidation point at a dock and vice versa. Two cost equations were generated for this activity--one for a United States operation and the other for a United Kingdom operation. Given the labor rate factors from the Port Cost section, the equations can be adjusted for other port or trade areas. The base equations are:

<u>U.S. Operations</u>

$$H_{BC} = 45 + \frac{500}{N_B}$$

<u>U.K. Operations</u>

$$H_{BC} = 24 + \frac{300}{N_B}$$

H_{BC} = the cost per barge of offloading it from the vessel, moving it to the barge consolidation point at the shore, disconnecting and leaving it moored to the shore, and then returning for another barge from the vessel. For loading operations, the cycle is reversed.

N_B = the number of barges to be discharged plus the number of barges to be loaded.

The equation used to derive barge-handling costs for each trade area by varying the labor rate is:

$$H_{BC} = 6.8 + 38.2\ L_R + \frac{1}{N_B}\left(136 + 364\ L_R\right)$$

H_{BC} = as above

L_R = the labor ratio of the region

The base U.S., U.K. equations are plotted on Exhibit I-8.

The vessel has a barge-handling rate of about four barges loaded on (or discharged from) the vessel per hour; and it is assumed the ratio of vessel time spent working cargo to time moored is the same as the container vessel ratio, e.g., 7/12. The average waiting period for a barge after it is discharged from the vessel and before it begins its inland journey is estimated at 1/2 day, and the waiting time at the consolidation point being loaded aboard the vessel is taken as one day.

For the loading and discharging of cargo from the barges, we use the productivities and costs given in the Break-Bulk section. The time that the cargo waits at the barge terminal is given in the Cargo Terminal Time section.

E. Port Costs. A vessel generates two types of costs when calling at a port. One cost is associated with the cost of entering and exiting the port, such as pilotage and towage. The second is related to the time a vessel stays in the port. These are daily charges for berthing privileges, watchman fees, utility hookups for water and electricity at the pier, etc.

We have found that both the above costs could be correlated to the size of the vessel and the wage rate in the foreign trade area where the port is located. This wage rate is expressed as a ratio, i.e., wage rate in the foreign country to wage rate in the United States. A surrogate value for this labor factor was derived by using the per capita income of the foreign area divided by the per capita income in the United States. The size parameter is the gross registered tonnage of the vessel and is the figure that is generally used in port tariff schedules for assessing towage, dockage, pilotage, etc., costs.

A table describing the trade area and the labor factor asso-

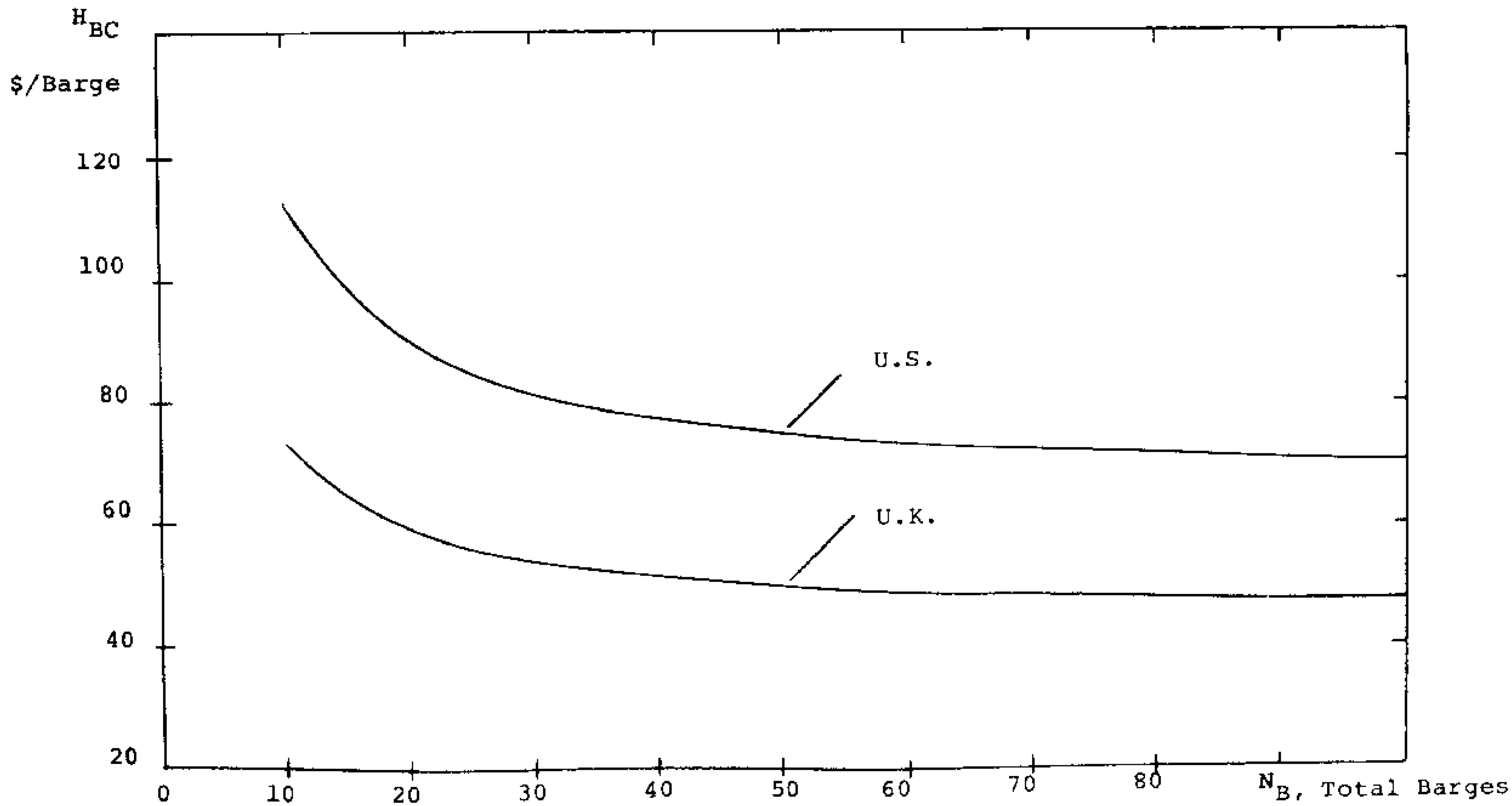


Exhibit I-8: Barge Handling Costs

ciated with each trade area is given in Exhibit I-11. In arriving at the two base regression equations given below, over 36 separate foreign ports were examined and not less than two ports in each foreign trade area. Additionally, at least two ports for each of the U.S. costs were examined. Even though the multiple correlation coefficients obtained in each regression were greater than 0.9, the magnitude of the variation was extremely large. As such, a discriminate variable was added to each equation to aid in characterizing port costs. This was done by leaving the intercept term and the exponents unadjusted and accounting for the variation by scaling the coefficients on the variable terms. These equations are:

Entry and Exit Costs

$$P_E = k_i e^L G^{.585} \quad ; \quad i = 1,2,3,4,5$$

P_E = \$ cost to enter and exit the port

L = labor ratio in the trade area, $0 < l \leq 1$

G = the gross registered tonnage of the vessel

Daily Costs

$$P_C = 17 + k_i L^{.5} G^{.67} \quad ' \quad i = 1,2,3,4,5$$

P_C = \$ cost for each day a vessel is in port

L = as above

G = as above

The "k" term shown above in each of the equations was given five values, although it was initially thought that three values would suffice, that is, a high, average and low value. Further examination of the data indicated that two additional values should be included between the high and the average and the low and the average. The table of "k" values by trade area and U.S. coast for each equation is given in Exhibit I-11.

The large variations are due primarily to institutional, geographical, and political factors surrounding each port. Some of these factors are: local or national administrative control; geographical factors such as river transits, canal transits, locks; unquantified economic factors such as equipment age and port efficiency; the income base of the port (whether it is revenue or tax-supported), etc. Another unknown factor is the degree to which the port is competitive with surrounding ports-- those in the same country and outside which vie for cargoes from the same hinterland areas.

The equation for entry and exit cost is shown plotted in Exhibit I-9, and for daily costs in Exhibit I-10. Each is plotted for four vessel sizes against the labor rate for five "k" values.

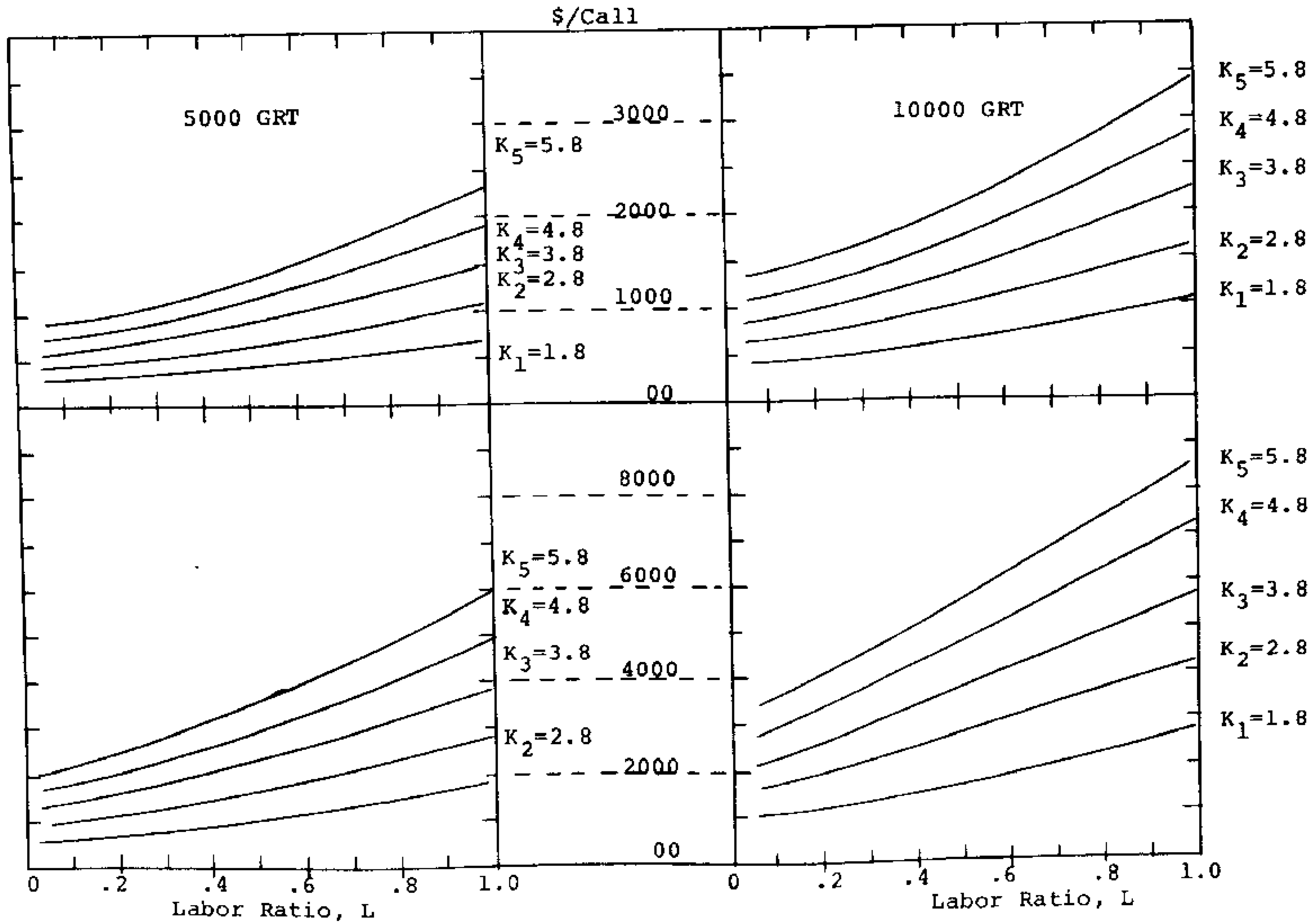


Exhibit I-9: Entry-Exit Costs

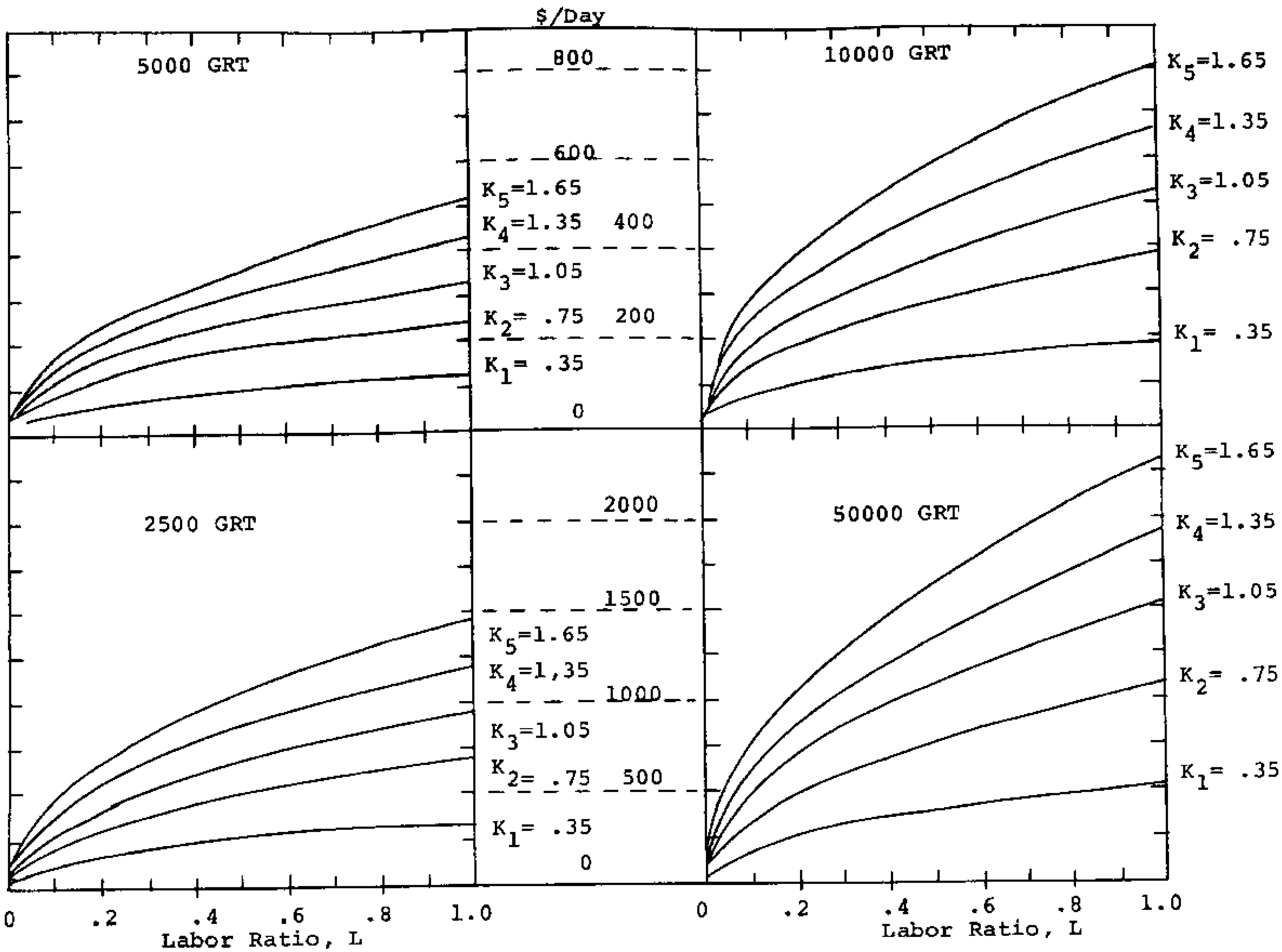


Exhibit I-10: Daily Costs

EXHIBIT I-11. PORT COST CONSTANTS

Part I

Foreign Countries in Trade Area I	I \ J	1	2	3	Ports Examined in Trade Area I
Greenland, Iceland, Ireland, England, Scotland	1	.45	5.8	1.35	London, Dublin
Denmark, Norway, Sweden, Finland	2	.65	1.8	1.05	Gothenburg, Oslo
Common Market Countries (except Italy): W. Germany, France, Benelux	3	.5	3.8	1.35	Bremen, Le Havre, Rotterdam
Portugal, Spain, Italy, Switzerland, Austria, Yugoslavia, Greece, Albania	4	.3	5.8	.75	Genoa, Bilbao
USSR, Poland, Bulgaria, Hungary, Czechoslovakia, E. Germany, Rumania	5	.3	5.8	1.65	Gdynia, Wismar
Turkey, Lebanon, Syria, Iraq, Iran, Israel, Saudi Arabia and Peninsula	6	.1	2.8	.35	Kurramshahr, Beirut
Spanish Sahara, Gambia, Senegal, Mauritania, Guinea, Mali, Niger, Upper Volta, Chad, Nigeria, Togo, Dahomey, Rio Muni, Ghana, Ivory Coast, Liberia, Sierra Leone, Cameroon, Gabon, Congo, Rep. of Congo, Central African Rep.	7	.04	3.8	.35	Lagos, Matadi, Monrovia
Morocco, Algeria, Tunisia, Libya, UAR	8	.1	3.8	.35	Tripoli, Casablanca
Angola, South Africa, Mozambique, Rhodesia	9	.1	4.8	1.05	Capetown, Beira
Sudan, Ethiopia, Somali Republic, Kenya, Tanzania, Uganda, Rwanda, Malagasy Rep., Burundi, Malawi, Zambia	10	.03	5.8	.35	Djibouti, Mombasa
Afghanistan, Pakistan, India, Nepal, Ceylon	11	.02	3.8	1.65	Calcutta, Karachi
Burma, Thailand, Malaysia, Cambodia, S. Viet Nam, Philippines, Indonesia, Caroline Islands	12	.05	2.8	1.05	Tandjong, Priok, Manila
Australia, New Zealand, Oceania	13	.54	3.8	1.65	Auckland, Sydney
Japan, Ryukyus, S. Korea, Taiwan	14	.15	2.8	.35	Keelung, Yokohama

EXHIBIT I-11. PORT COST CONSTANTS (continued)

Part I

Foreign Countries in Trade Area I	I \ J	1	2	3	Ports Examined in Trade Area I
People's Rep. of China, N. Korea, N. Viet Nam	15	.12	2.8	.75	Hong Kong, Singapore
Guatemala, Honduras, Costa Rica, Panama, Nicaragua, Br. Honduras, San Salvador	16	.14	5.8	1.05	Balboa, Kingston
Antilles, Colombia, Venezuela, Surinam, Caracao, Guyana	17	.15	4.8	1.05	La Guaira, Cartagena
Brazil, Uruguay, Paraguay, Argentina, Falkland Islands	18	.13	4.8	1.65	Rio de Janeiro, Montevideo
Ecuador, Peru, Bolivia, Chile	19	.11	5.8	.75	Callao, Valparaiso

Part II

U.S. Coastal Area I	I \ J	1	2	3	Ports Examined Coastal Area I
East Coast	1	1	5.8	1.05	Baltimore, Boston, New York
Gulf Coast	2	1	5.8	1.05	Houston, Mobile, New Orleans
Pacific Coast	3	1	2.8	.75	Los Angeles, Longview, San Francisco, Seattle

J

1 The labor cost ratio of the region, that is, the per capita income of the region divided by the per capita income in the United States.

2 The value of the coefficient used in the entry and exit cost equation--by trade area and the U.S. coast.

3 The value of the coefficient used in the daily cost equation--by trade area and the U.S. coast.

Exhibit I-12 gives the range of per capita incomes by trade area where per capita income, as used, is equivalent to the Gross National Product of the area divided by the population. The range given shows the variation in per capita incomes considered repre-sentive of the area.

F. Equipment Inventory

The equipment inventory required for a barge or container service is the summation of the number of units carried aboard the vessel plus the number required on each side of the ocean. The number of units aboard a vessel is easily determined, it is simply the vessel's designed unit capacity times the maximum load factor on a transocean leg. The inventory required on each end of the ocean is dependent upon three factors: (1) the frequency of the service (days between successive calls at a port); (2) the average turn-time of a unit ashore (the average number of days it takes for a unit to leave and then return to the pier ready for the return transocean trip); and (3) the range of unit turn-times.

EXHIBIT I-12. THE RANGE OF GNP/POPULATION (PER CAPITA INCOME) BY TRADE AREA AT 1967 PRICES

Trade Area	$ Range of GNP/Population
1	1072-1977
2	2199-3041
3	1804-2324
4	822-1279
5	1400-1600
6	283-427
7	85-125
8	191-883
9	71-618
10	67-117
11	92-125
12	104-278
13	2001-2260
14	274-1158
15	335-592
16	514-581
17	336-911
18	350-644
19	283-588
U.S.	4037

NOTE: Where 1967 data was unavailable the figures shown represent the latest year inflated to 1967 levels.

The service frequency is typically determined by calculating the round-trip time for a single vessel and then dividing by the number of vessels in the service. In this case, however, the number of vessels in a given service is not known. As such, an equation is used to determine frequency based upon information on container services published in the trade magazines. The fre- of service was made a function of round-trip time as shown below:

$$F = .565\ R_T^{.85}$$

F = frequency, in days

R_T = round-trip time, in days

To calculate the inventory required on each side of the ocean, given frequency, the distribution of unit turn-times ashore must be known. Our experience indicates that the average turn-time for a container is approximately 12 days with a range of from 4 to 24 days. That is, no container would be back in less than 4 days and the longest time taken by a container would be close to 24 days. For a barge service, it was assumed the average barge turn-time would be 20 days and that no barge would be back in less than 4 days and that all would be back within 48 days.

Two cumulative Beta distributions, one for a container service and one for a barge service, were used to generate the number of unit sets required ashore at each end of the transocean service. A "set" is defined as the number of units aboard a vessel. The parameters for the Beta distribution are the range and the average turn-time. The equations giving the number of sets required at each transocean side as a function of the service frequency are given below.

Container Sets

$$S_C = .46455 + 13.66172/F$$

Barge Sets

$$S_B = .49256 + 20.0102/F$$

where S_C = the number of container sets on one side, $S_C \geq 1$

S_B = the number of barge sets on one side, $S_B \geq 1$

F = the frequency of the service (days), $F \geq 1$

These two equations are shown plotted in Exhibit I-13. The plot of frequency versus round-trip time is given in Exhibit I-14 (the dotted lines indicate the range of values observed).

G. Barge and Container Capital Costs

The method used in calculating barge and container capital

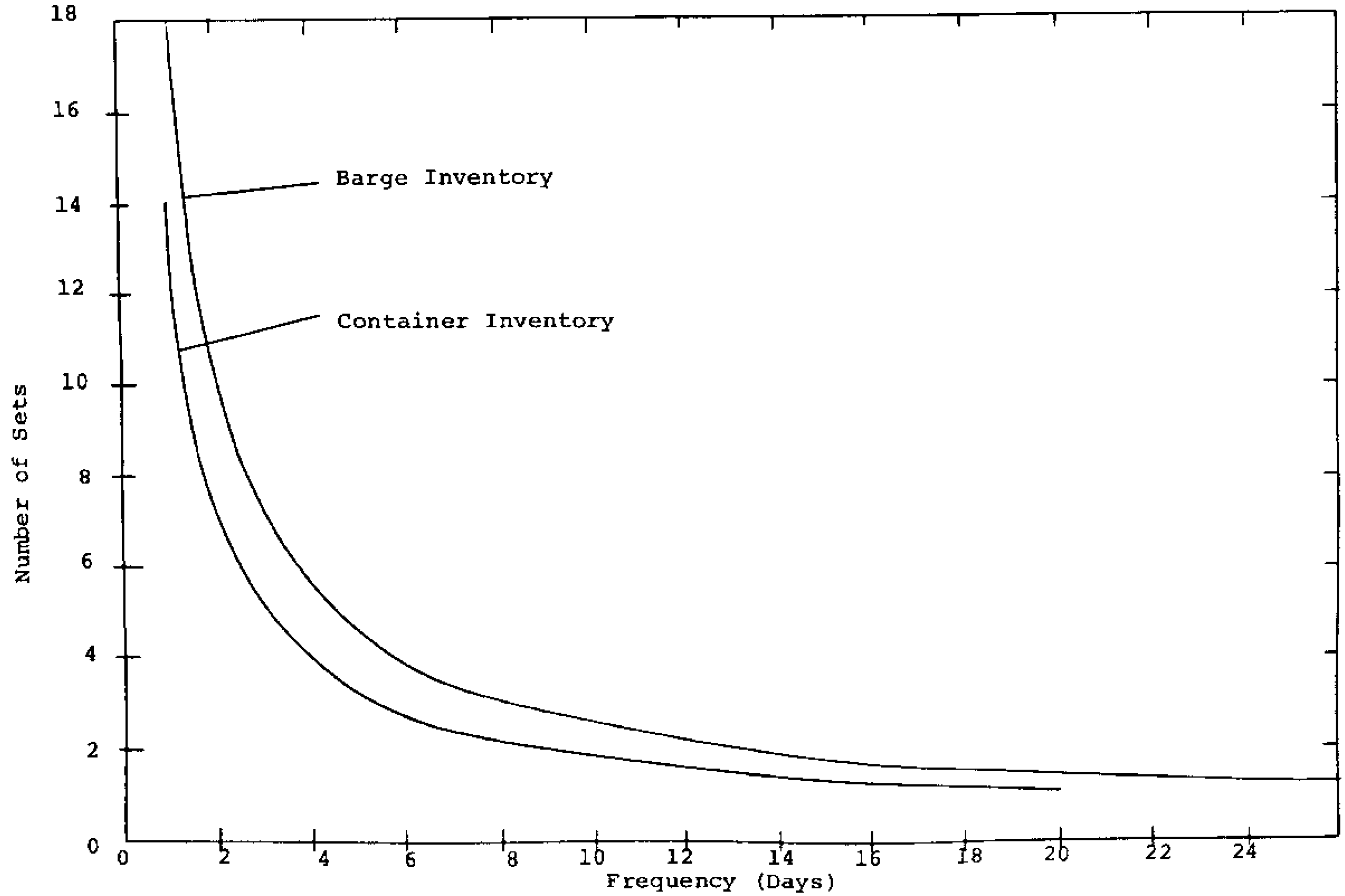


Exhibit I-13: Container and Barge Inventory on Each End of Transoceanic Legs

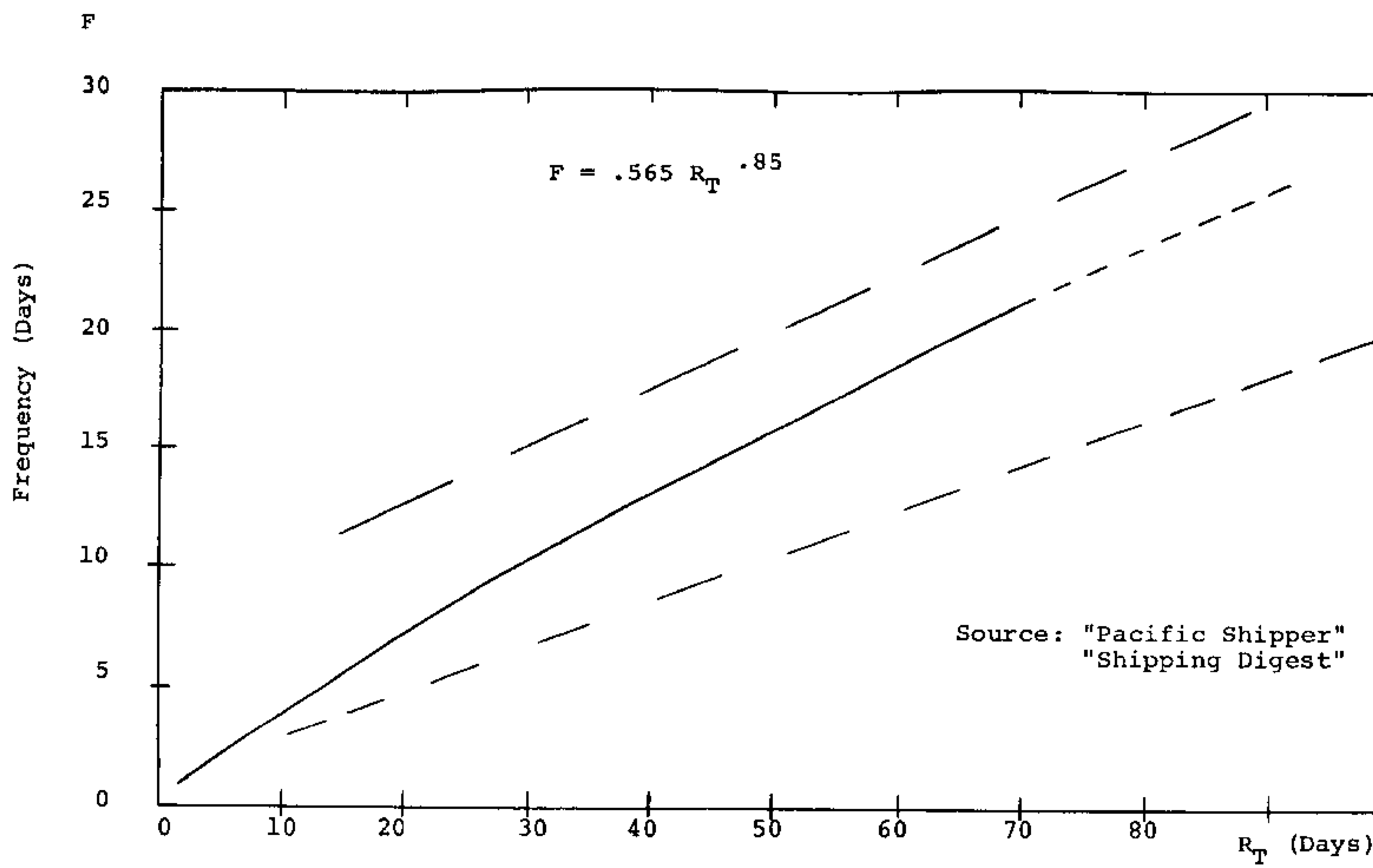


Exhibit I-14: SERVICE FREQUENCY

costs per year is based upon internal funding for these equipment purchases allowing the use of a capital recovery factor (CRF). The method of depreciation is taken as straight-line, with zero salvage value. This latter qualification is generally accepted as standard accounting practice for container services. The three independent parameters needed to operate the CRF equation are: the economic life of the unit; the interest rate the investment is required to earn; and the percentage of profits which are taxed. Given these three factors, CRF value is generated which, when multiplied by the initial cost of the unit, yields the annual capital cost associated with owning that unit. This equation is:

$$CRF = \frac{\left[\dfrac{I}{1 - \left(\dfrac{1}{1 + I}\right)^{N}}\right] - D}{1 - T} + D$$

CRF = capital recovery factor

I = required return on investment

D = percent of investment depreciated each year, $D = 1/N$

N = the depreciating life of the investment, years

T = the percent of profits which are taxed, $T<1$

For container services the life over which a container may be depreciated is generally considered to be eight years. For barges, the study assumed 20 years as the depreciating period. For both, the study used an interest rate of 10 percent to provide a reasonable return on investment and to cover other overhead expenses such as licensing and survey costs. The tax rate on profits is 0.5. When the above factors are substituted in the CRF equation, the CRF for containers is 0.25, and the CRF for barges is 0.185.

The purchase price of an 8' x 8' x 20' container in 1967 averaged $2,000. The initial price of a barge is given as follows:

$$PP_{BAR} = 1.12 \cdot B_{CB}$$

PP_{BAR} = the initial price of the barge, 1967, $

B_{CB} = the bale cubic of the barge, cu ft

H. Equipment Maintenance Costs

1. Barge. The barge and container services require that equipment maintenance and repair (M&R) costs be considered separately from the M&R cost function for a vessel. For barges carried aboard ship, discussions with barge operators indicate

that annual M&R costs can be estimated at about 5 percent of initial barge cost per annum. This figure refers to barges normally used in harbor and river service. Because of the recent inauguration of transocean barge carriage only limited operational data has been obtained on M&R costs. From this limited data a functional equation was derived with the barge bale cubic as the independent variable. This equation is:

$$M_{RB} = 31.1 \left(\frac{B_{CB}}{100}\right)^{.767}$$

M_{RB} = the annual maintenance and repair costs of the barge

B_{CB} = the bale cubic of the barge, cu ft

The daily equation is:

$$M_{RB} = .0852 \left(\frac{B_{CB}}{100}\right)^{.767}$$

M_{RB} = the daily barge M&R costs

B_{CB} = above

The daily M&R equation is plotted on Exhibit I-15.

2. Container. The average M&R costs for an 8' x 8' x 20' dry container in 1967 ranged from approximately $100 to $150 per year with an average value of about $120. Since the average purchase price of this container was $2,000 in 1967, maintenance costs are given as 6 percent of initial investment per annum. This figure of 6 percent appears to be rather constant over varying size and container type ranges. That is, 40-footers with a greater initial purchase cost can still be maintained at about 6 percent of their initial cost per year. Experience indicates that this holds true for reefer containers as well.

I. Equipment Insurance Costs. Insurance costs on almost all types of equipment can be related directly to the value of that equipment. These costs are typically represented as percentages of initial value per year. As in the case of maintenance and repair costs, little information is available about insurance costs for barges carried in transocean services. Thus, it is estimated that annual barge insurance cost will be about the same for containers, due principally to the similarity in their operations. It was found that the insurance costs per year for an 8' x 8' x 20' container ranged from 6 to slightly more than 12 percent of initial cost per year with a mean value of 8 percent.

J. Cargo Insurance. Figures for the cost of cargo insurance for various types of services were difficult to find. In fact, those published costs made available from underwriters in the San Francisco Bay area indicated that there was no general rule for determining ocean cargo insurance rates. Published figures in the trade literature were given in terms of average cost per measurement ton over an entire service. This left two critical

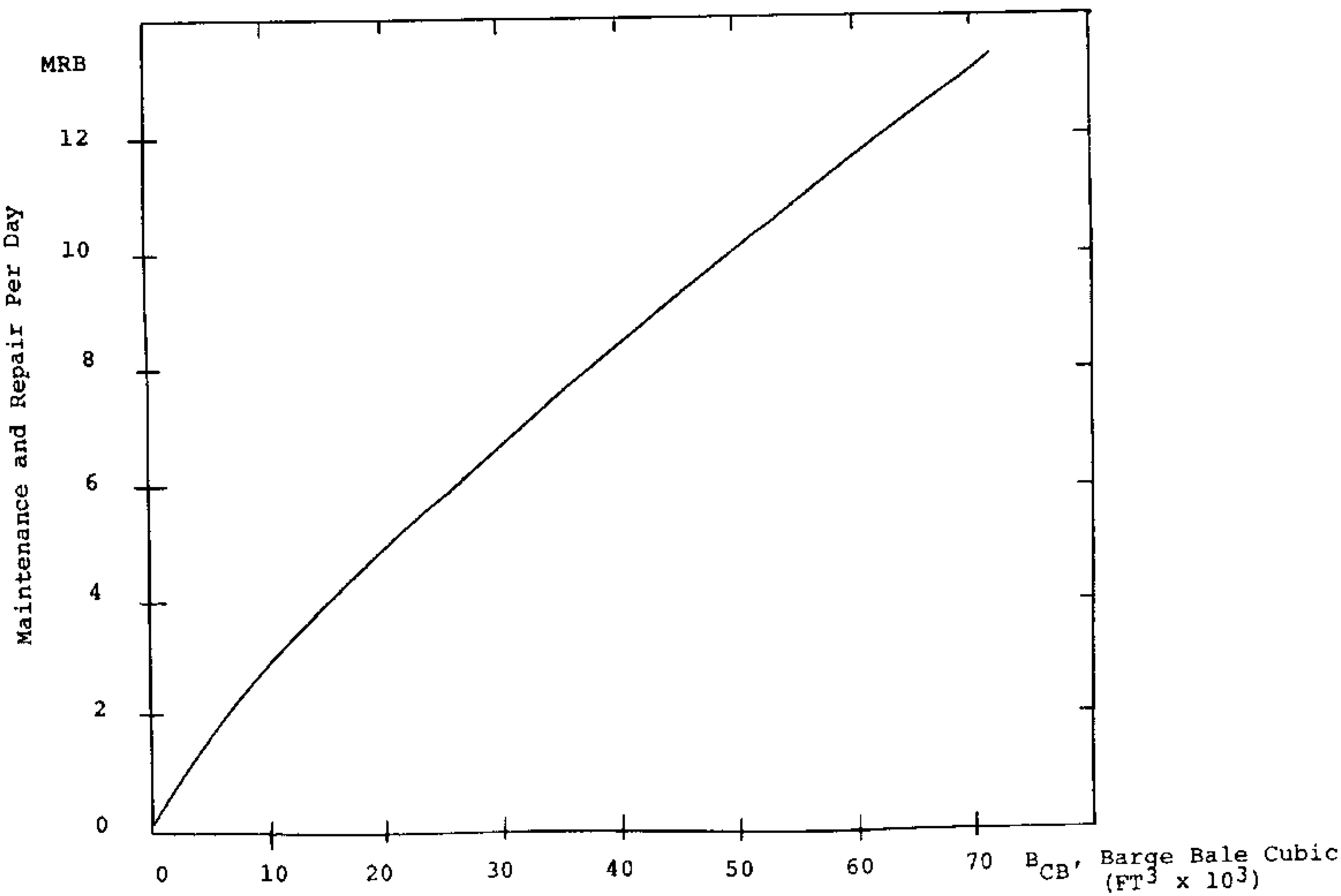


Exhibit I-15: BARGE MAINTENANCE AND REPAIR COSTS PER DAY factors undefined--the density (lbs/cu ft) and the value of the cargo ($/lb). Because of this, we chose to fit a regression equation to ICC data for Class I Railroads (1965, Waybill sample) which identified the average claims cost per short ton by commodity. The density and value per pound of each commodity was entered in the data set, and the equation given below was derived. This regression was based upon 25 commodity types ranging from ores to fresh fruits and vegetables.

$$C_C = 10.4(V/d)^{.62}$$

C_C = claims cost ($/short ton)

V = value/pound of the commodity, $/pound

d = density (pounds/cubic feet)

It was assumed that the exponent (0.62) would be the same for ocean services, and that only the coefficients would change as the type of service varied, i.e., as one went from container to break-bulk, barge carriers, bulk, and tanker. The equations with the adjusted coefficients are:

Bulkers and Tankers

$$C_C = 3.8(V/d)^{.62}$$

Container Vessels

$$C_C = 7.3(V/d)^{.62}$$

Barge Carriers

$$C_C = 12.7(V/d)^{.62}$$

Break Bulk

$$C_C = 18(V/d)^{.62}$$

There is little or no history on cargo insurance or claims for the barge carriers. Because it has elements in common with both the container and break-bulk services, we chose a coeffcient midway between their coefficients. Exhibits I-16 through I-19 show these equations plotted.

K. Administrative and General Costs. The two daily vessel cost figures generated by the Design, Capital Cost, and Operating Cost model exclude administrative and general (A&G) costs. It was decided to represent these costs as a percentage of the direct unsubsidized cost of a vessel operating in a given service. This cost of calculating A&G includes daily vessel costs, port costs, cargo handling costs, cargo insurance costs, container and barge maintenance and insurance costs, etc. In short, it is the total direct cost that the vessel operator encounters and

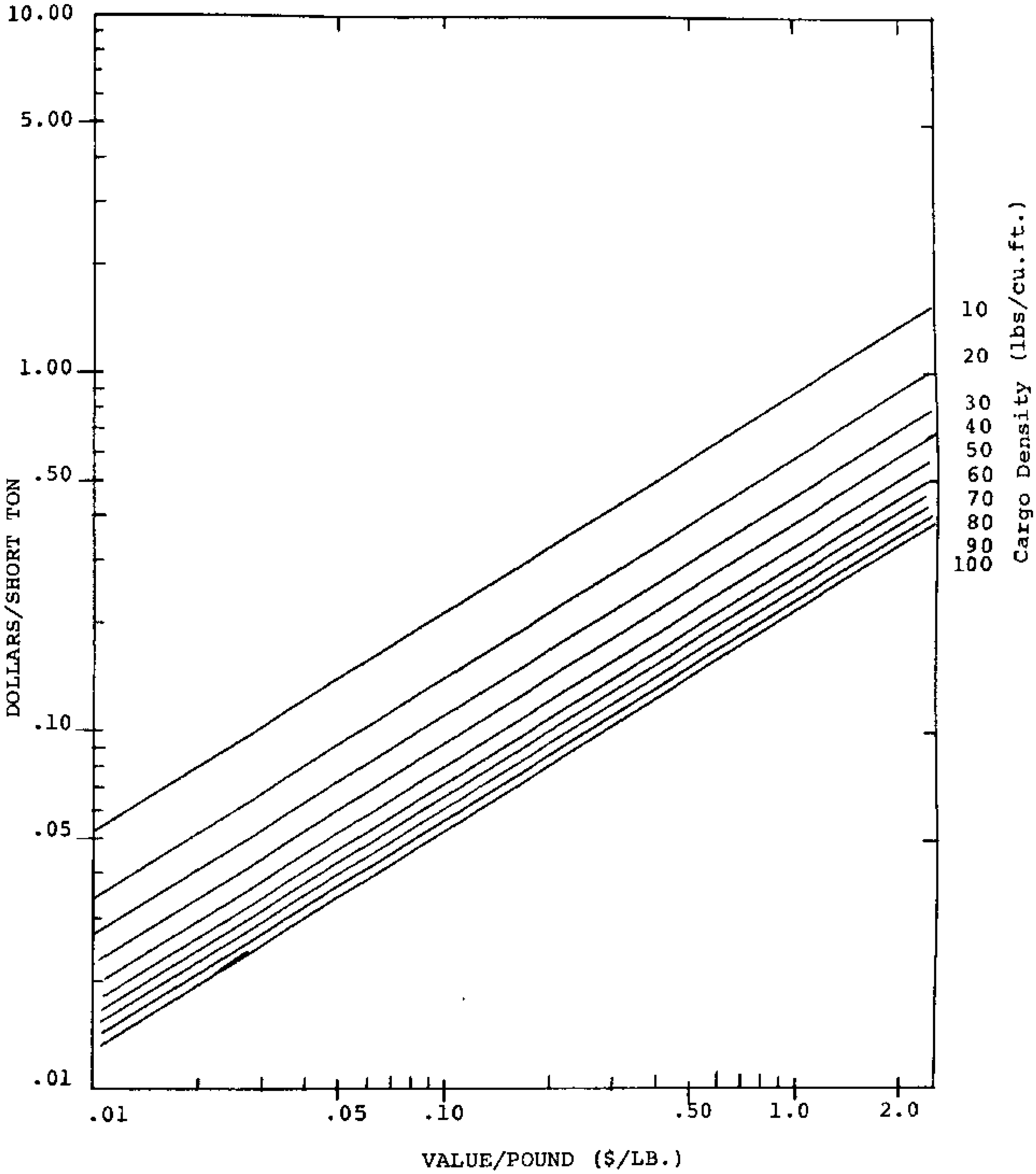


Exhibit I-16: BULK AND TANK CARGOES

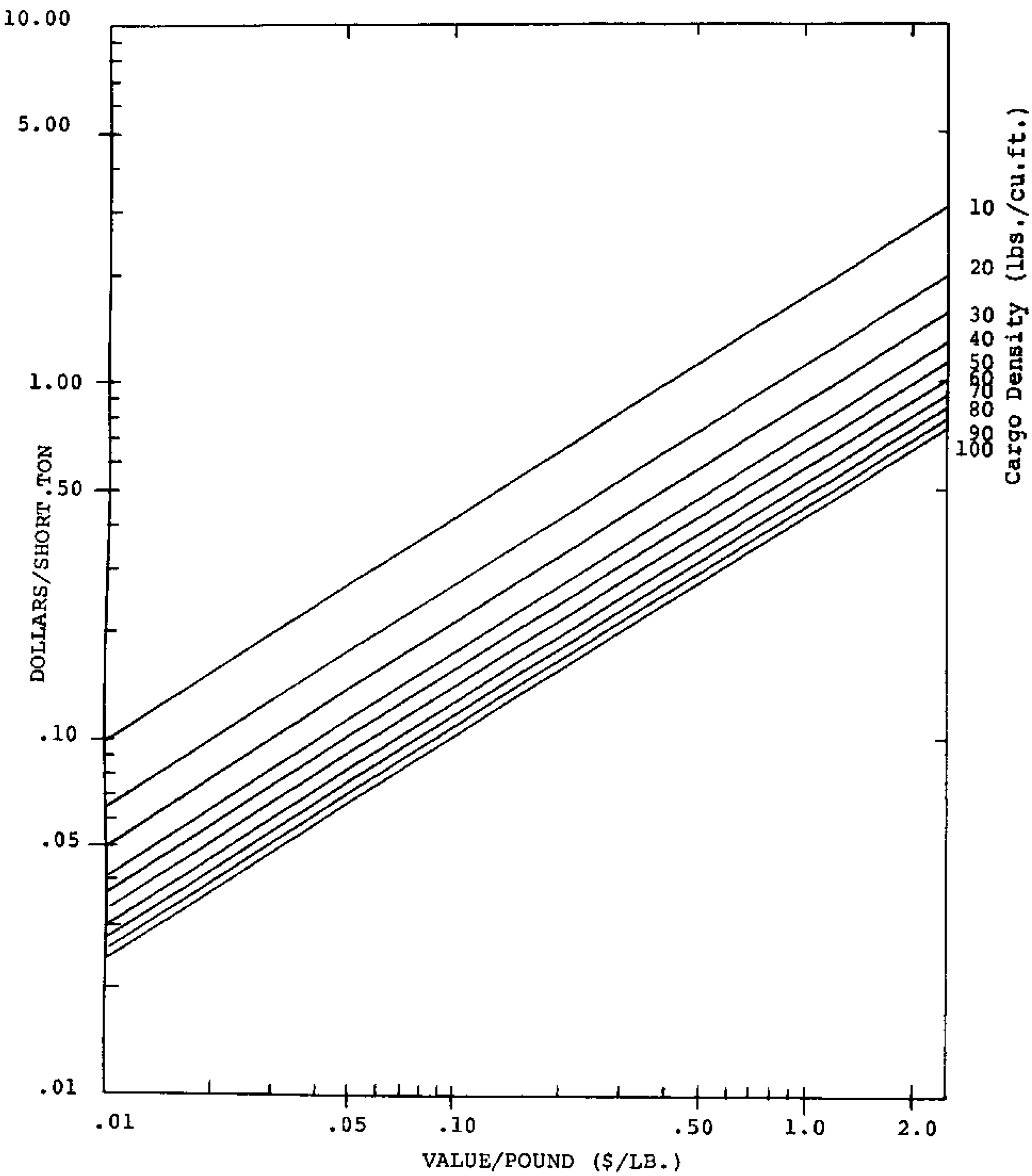


Exhibit I-17: CONTAINER CARGOES

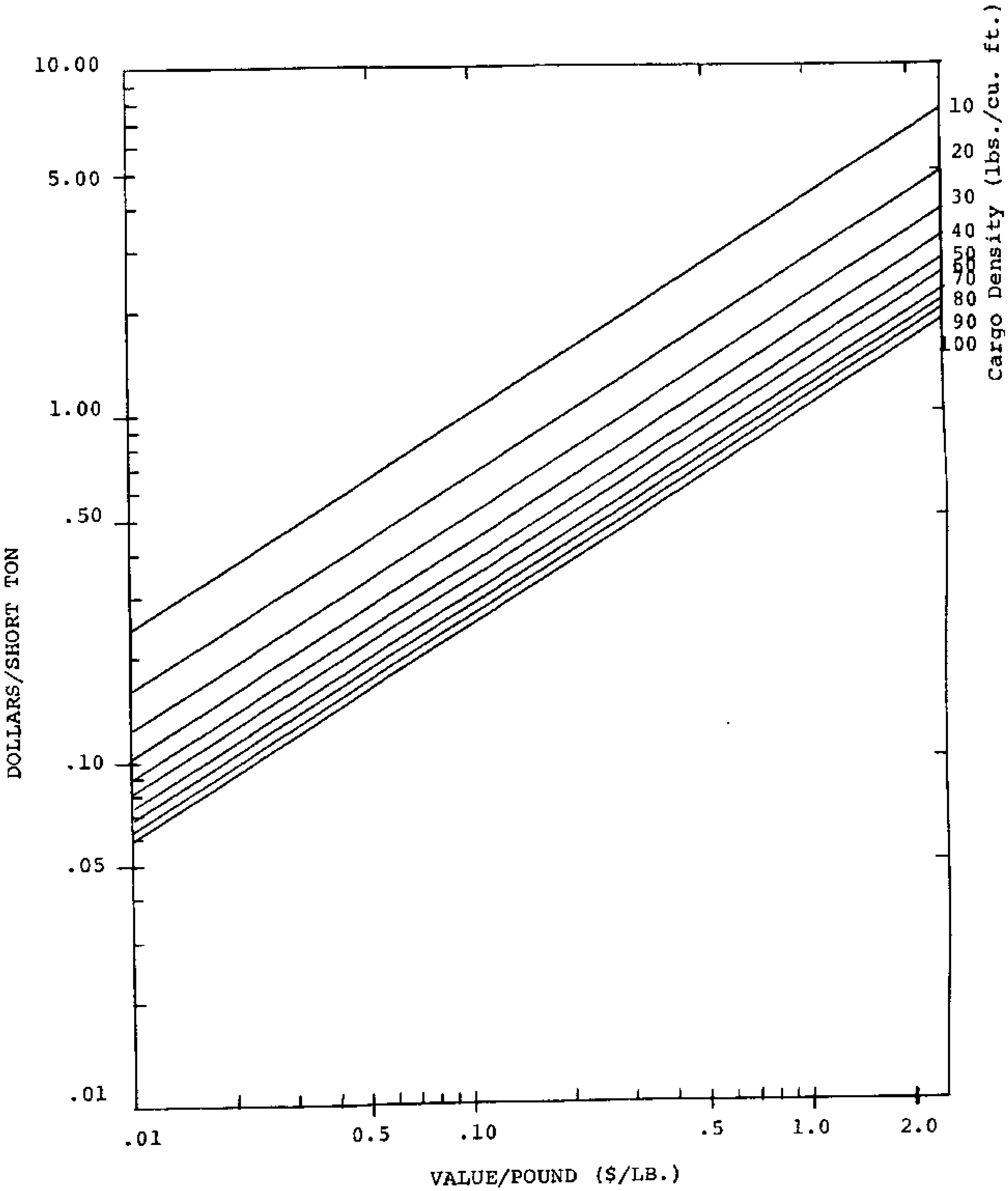


Exhibit I-18: BREAK BULK CARGOES

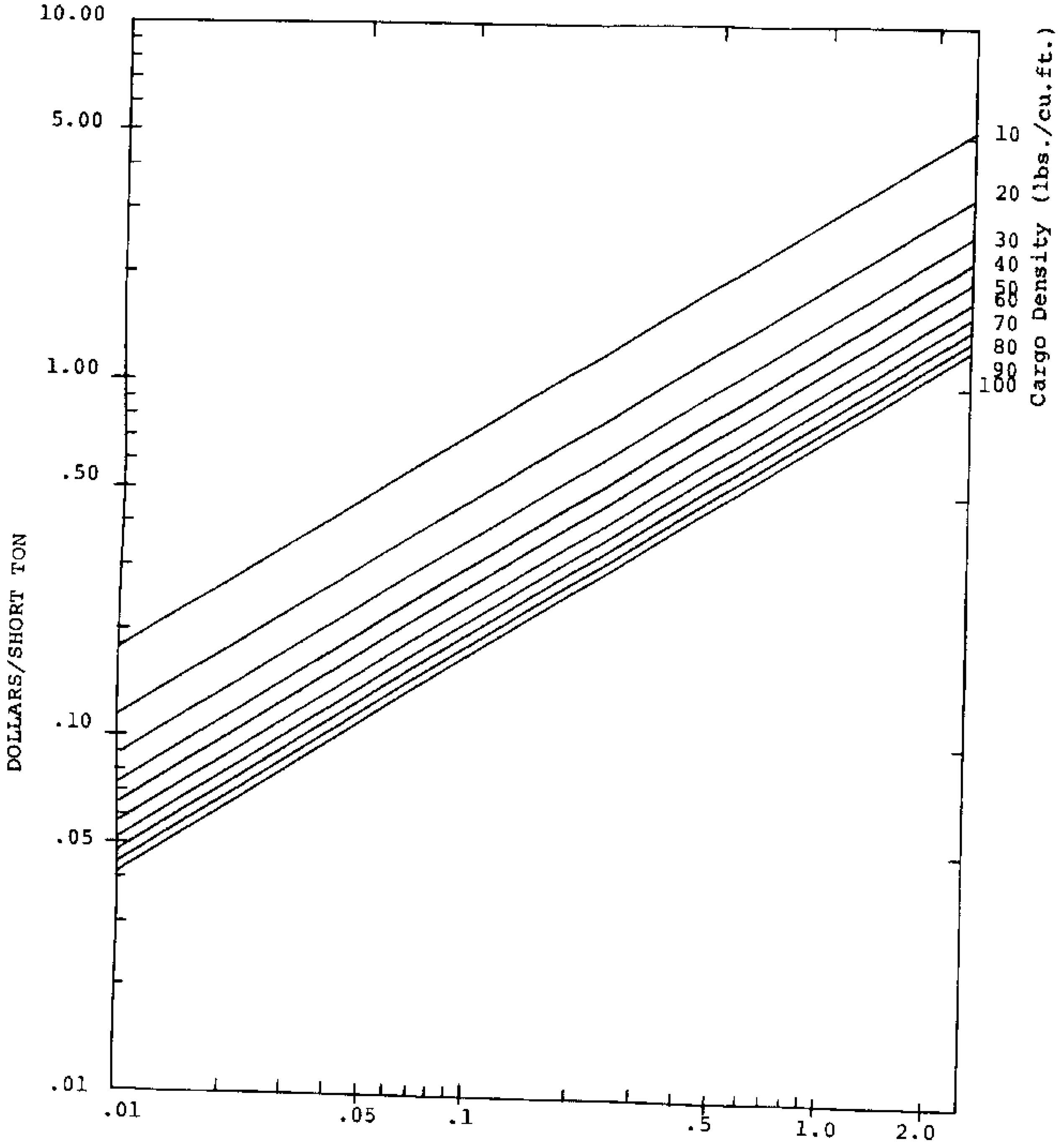


Exhibit I-19: BARGE CARGOES

which he largely controls, when providing a transocean cargo service. The cost elements that are included in A&G are salaries of corporate officers, clerical salaries, cargo commissions, legal fees, office rental, etc. This percentage typically ranges from 10 percent to 20 percent of total cost with the majority of cases falling between 10 and 15 percent. For this reason the study estimates 10 percent for bulk and tanker services, and 12 percent for conventional, barge-carrier, and container services. These figures conform rather closely to those published in Northwestern's study of the U.S. liner trade (1960), and more recent data compiled by Manalytics.

L. Packaging Costs. The packaging costs given in "Inland and Maritime Transportation of Unit Cargo" show a packaging cost for break-bulk movements of $32 per 40 cubic feet, $20 per 40 cubic feet for container movements, and $22.54 per 40 cubic feet for pallets. Because of the date of the study, these figures have been upgraded by 25 percent and adjusted as follows: (1) break-bulk and palletized packaging costs have been added together, multiplied by 1.25, then divided by 2 to give an average value of $34 per 40 cubic feet (or approximately $0.85 per cubic foot); (2) container shipments using domestic packaging, the $20 has been multiplied by 1.25 to give $25 per 40 cubic feet (or $0.625 per cubic foot). Barge carriers are assumed to have the same packaging costs associated with them as break-bulk vessels.

M. Documentation Costs. There was little information on the costs of documenting a foreign-borne shipment. We chose a surrogate value--the average out-of-pocket billing costs for truck shipments which we then increased by 100 percent because of the multitude of papers that follow a foreign movement. To reduce this to a cost per short ton (or per container) basis, the study took the average shipment size as an 8' x 8' x 20' container-sized lot. At average density, this made the weight of a shipment equal to 10 short tons.

The escalated billing cost is given as $0.734 x 2 = $1.468, the assumed cost of documentation for an ocean shipment. Since the average weight of the shipment is 10 short tons, the cost of documentation, per short ton, is about $0.15.

This applies only to container, break-bulk, and barge carriers. There are negligible documentation costs for bulker or tanker cargoes.

N. Cargo Waiting Time at the Ocean Terminal. The cargo waiting time in port after the discharge of cargo from the vessel is dependent upon the warehousing requirements, custom delays, inland transport availability, etc. These delays were categorized in the "S.S. Warrior" study for a break-bulk vessel carrying government cargo (reproduced in simplified form in Exhibit I-20). Since this movement was closely controlled and devoid of the normal delays encountered by commercial shipments, an average waiting time of 1.5 days is used--or roughly twice the time shown in

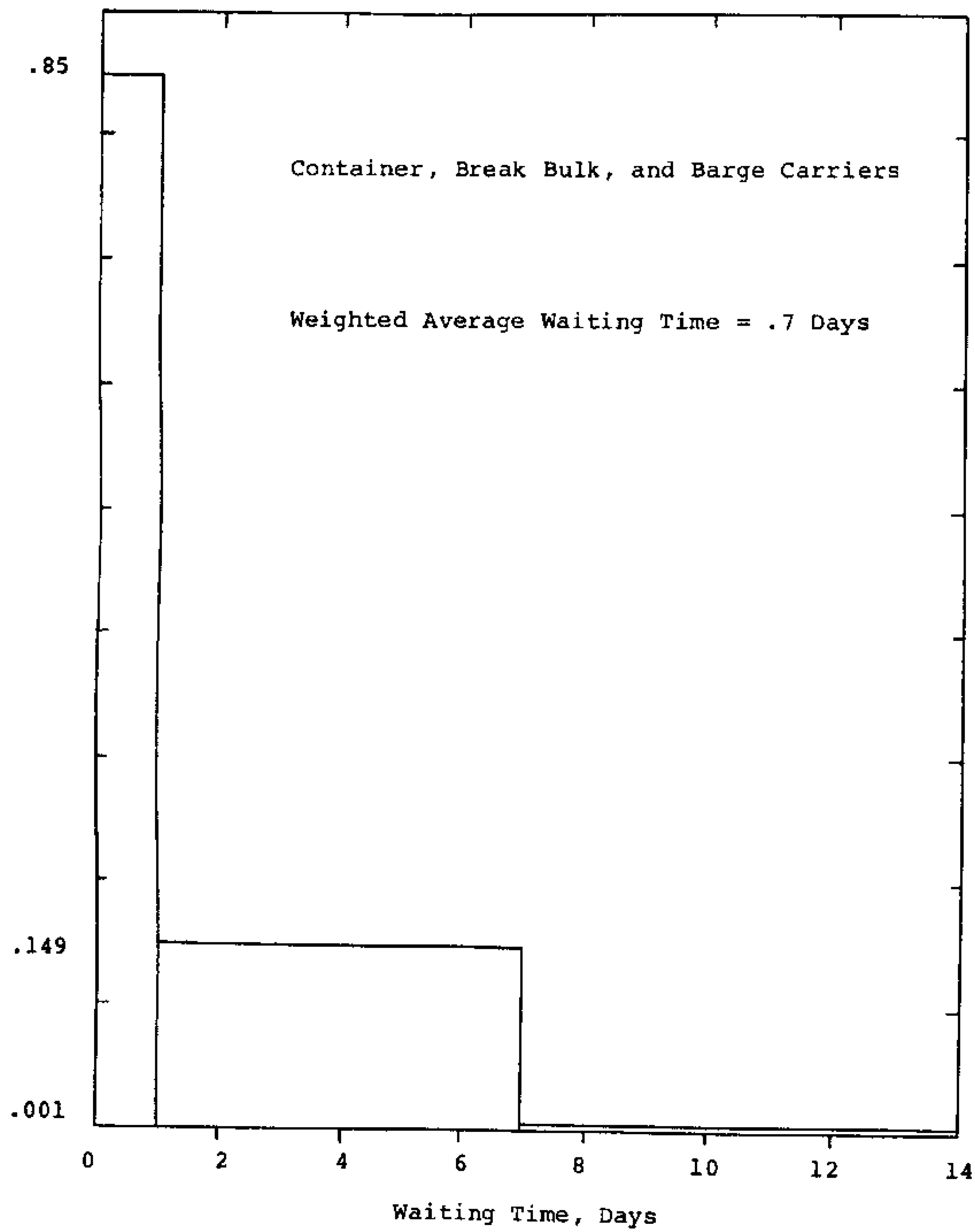


Exhibit I-20: HISTOGRAM OF CARGO WAITING TIME IN PORT (AFTER DISCHARGE FROM VESSEL)

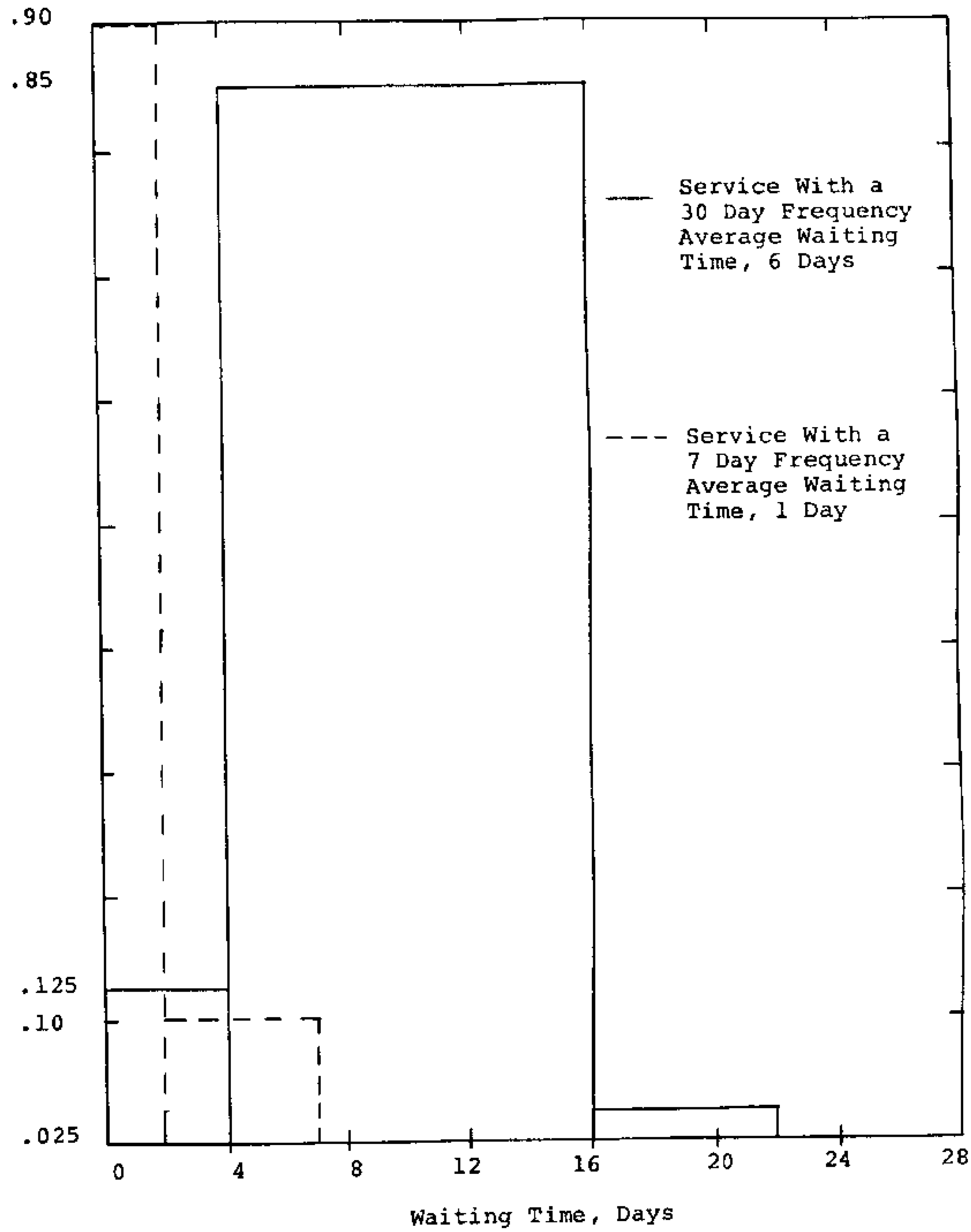


Exhibit I-21: CARGO WAITING TIME PRIOR TO LOADING ABOARD THE VESSEL

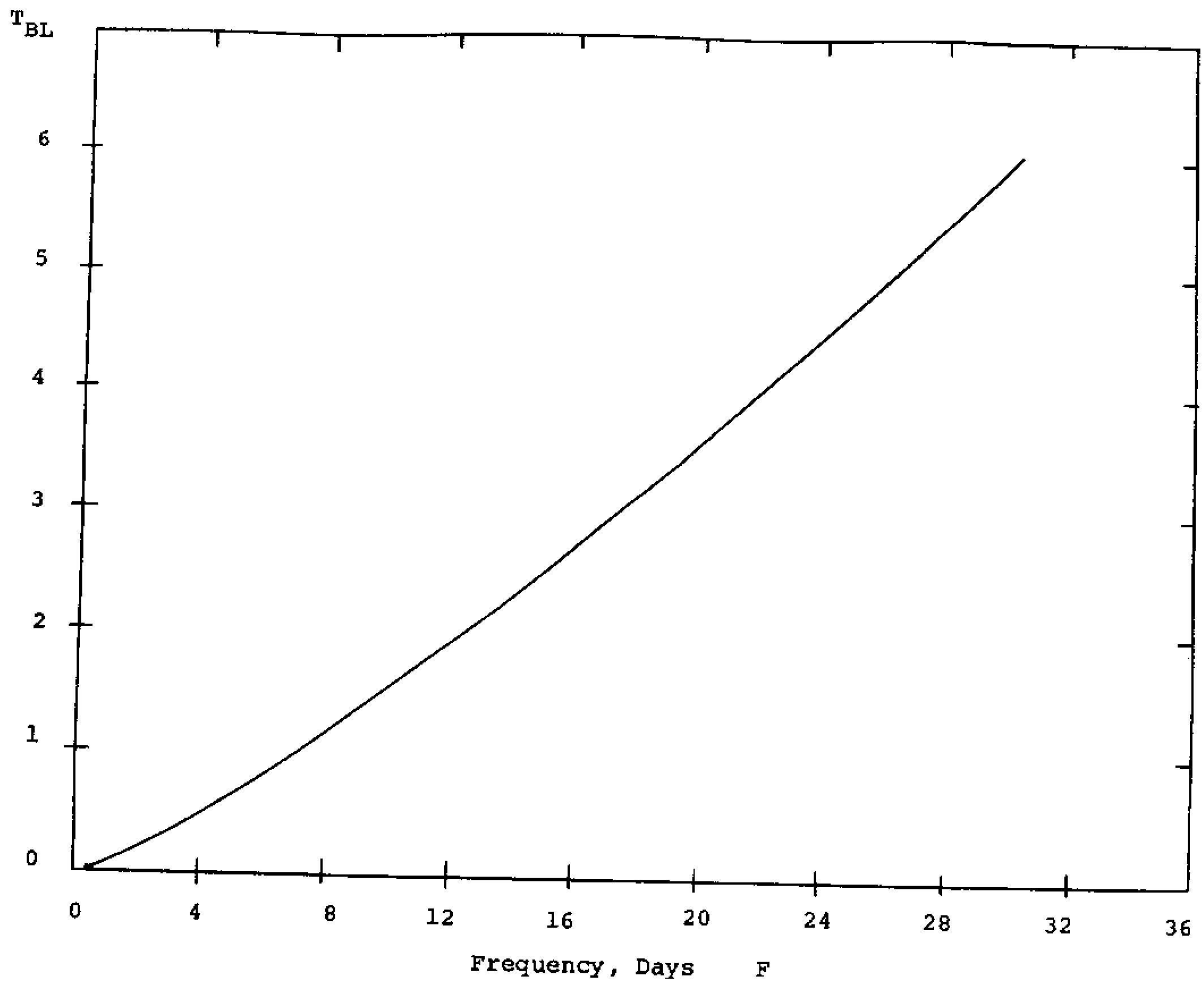


Exhibit I-22: AVERAGE WAITING TIME OF THE CARGO BEFORE LOADING ABOARD THE VESSEL

Exhibit I-20. This is a conservative figure and is based upon an estimate of conditions causing delays at an ocean terminal.

For waiting times prior to loading, Manalytics observed the approximate patterns shown in Exhibit I-21. The study took these two average times (1 and 6 days) and derived a simple equation for average waiting time as a function of the service frequency. This equation is given below:

$$T_{BL} = .091\ F^{1.23}$$

T_{BL} = the waiting time at the pier before loading, days
F = the frequency of service, days

The plot of this equation is shown in Exhibit I-22.

The foregoing discussion refers only to container, break-bulk, and barge carrier cargo. For tankers and bulkers, because of the nature of their operation, a nominal figure of 2 days' waiting time on the pier (before loading and after discharge) is assigned.

The labor and material segments of each equation are adjusted by the "E_{IJ}" values given in Exhibit I-23. These values were derived from *Survey of Current Business* and *Business Statistics* and represent hand-drawn linear extrapolations of the trends apparent in the data.

The escalation rate for material prices appeared to be approximately one-half the rate for labor.

The escalation factors have been reduced to unity for 1967 because the costs were generated at 1967 base-year levels.

EXHIBIT I-23. ESCALATION (E_{IJ}) FACTORS

I	YEAR	LABOR J=1	MATERIAL J=2
1	1967	1.0	1.0
2	1968	1.033	1.017
3	1969	1.065	1.032
4	1970	1.097	1.048
5	1971	1.129	1.063
6	1972	1.161	1.08
7	1973	1.193	1.096
8	1974	1.224	1.111
9	1975	1.257	1.127
10	1976	1.288	1.143
11	1977	1.319	1.159
12	1978	1.352	1.175
13	1979	1.381	1.19
14	1980	1.41	1.205

O. Transocean Cost Equations

1. Sea Speed

- **Bulkers**

$$P_L = S_{1_2} \cdot d_C \cdot B_C \cdot (.95)/2240 \tag{1}$$

$$V_L = V_D/[(P_L + D_L)/D_D]^{.163} \tag{2}$$

P_L = Payload in loaded direction, long tons

S_{1_2} = Constant from service constants matrix

d_C = Current density, lbs./cu. ft.

B_C = Bale cubic of the vessel, cu. ft.

V_L = Sea speed, knots, on loaded leg

V_D = Design sea speed, knots

D_L = Light displacement of the vessel, long tons

D_D = Design displacement, long tons

$$P_R = S_{1_3} \cdot d_C \cdot B_C \cdot (.95)/2240 \tag{3}$$

$$V_R = V_D/[(P_R + D_L)/D_D]^{.163} \tag{4}$$

P_R = Payload in return direction, long tons

V_R = Sea speed, knots, in return leg

where $P_L, P_R \leq P_C$

and $V_L, V_R \leq 1.2 \cdot V_D$

P_C = Critical payload, long tons

- **Tankers**

$$P_L = S_{2_2} \cdot d_C \cdot B_C \cdot (.95)/2240 \tag{5}$$

$$V_L = V_D/[(P_L + D_L)/D_D]^{.163} \tag{6}$$

$$P_R = S_{2_3} \cdot d_C \cdot B_C \cdot (.95)/2240 \quad (7)$$

$$V_R = V_D/[(P_R + D_L)/D_D]^{.163} \quad (8)$$

where $V_R, V_L \leq 1.2 \cdot V_D$; $P_L, P_R \leq P_C$

- <u>Containers</u>

$$P_L = N_C \cdot [(S_{3_2} \cdot B_{CTR} \cdot d_C \cdot (.85)/2240) + MX_D \cdot C_{TAR}] \quad (9)$$

$$V_L = V_D/[(P_L + D_L)/D_D]^{.163} \quad (10)$$

$$P_R = N_C \cdot [(S_{3_3} \cdot B_{CTR} \cdot d_C \cdot (.85)/2240) + MX_D \cdot C_{TAR}] \quad (11)$$

$$V_R = V_D/[(P_R + D_L)/D_D]^{.163} \quad (12)$$

N_C = number of containers, designed capacity

B_{CTR} = bale cubic of the container, cu. ft.

C_{TAR} = tare weight of the container, long tons

MX_D = maximum value of either S_{3_2}, S_{3_3}. MX_D is maximum load factor (space utilization) on either the inbound or outbound ocean legs. It is used to determine equipment inventory, etc., since empty containers will be carried in the less utilized direction.

$$d_C \leq d_{CR}$$

$$V_R, V_L \leq 1.2 \cdot V_D$$

d_{CR} = critical density of container cargo, lb./cu. ft.

- <u>Break-Bulk (Conventional) Liners</u>

$$P_L = S_{4_2} \cdot d_C \cdot B_C \cdot (.85)/2240 \quad (13)$$

$$V_L = V_D/[(P_L + D_L)/D_D]^{.163} \quad (14)$$

$$P_R = S_{4_3} \cdot d_C \cdot B_C \cdot (.85)/2240 \qquad (15)$$

$$V_R = V_D/[(P_R + D_L)/D_C]^{.163} \qquad (16)$$

where $P_R, P_L \leq P_C$

$V_L, V_R \leq 1.2 \cdot V_D$

$d_C \leq d_{CR}$

- <u>Barge Carriers</u>

$$P_L = S_{5_2} \cdot N_B \cdot B_{CB} \cdot d_C \cdot (\frac{.85}{2240}) + B_{TAR} \cdot N_C \cdot MX_D \qquad (17)$$

$$V_L = \frac{V_D}{[(P_L + D_L)D_D]^{.163}}$$

$$P_R = MX_D \cdot N_B \cdot B_{TAR} + S_{5_3} \cdot N_B \cdot B_{CB} \cdot d_C \cdot \frac{.85}{2240} \cdot \qquad (19)$$

$$V_R = \frac{V_D}{[(P_R + D_L)/D_D]^{.163}} \qquad (20)$$

N_B = the number of barges, designed capacity

B_{CB} = the barge bale cubic, cu. ft.

B_{TAR} = the barge tare weight, long tons

MX_D = the maximum value of either S_{5_3} or S_{5_2}

where MX_D assumes that one direction is more space utilized than the other, and empties are carried to account for the difference in space utilization,

and $d_C \leq d_{CR}$

$V_R, V_L \leq 1.2 \cdot V_D$

d_{CR} = the critical density of barge cargo, lb./cu. ft.

2. <u>Port Time Working Cargo</u>

- <u>Bulkers</u>

$$C_{HRL} = 4.5 \cdot P_D/d_C \tag{21}$$

$$C_{HRD} = 2.25 \cdot P_D/d_C \tag{22}$$

$$P_{TL} = (P_L + P_R) \; / \; [C_{HRL} \cdot 24 \cdot (7/12)] \tag{23}$$

$$P_{TD} = (P_L + P_R) \; / \; [C_{HRD} \cdot 24 \cdot (7/12)] \tag{24}$$

C_{HRL} = cargo handling rate when actually loading, long tons per hour

C_{HRD} = cargo handling rate when actually discharging, long tons per hour

P_D = design payload, long tons

P_{TL} = port time, days, spent loading per voyage (round trip)

P_{TD} = port time, days, spent discharging per voyage (round trip)

where "7/12" is the ratio of actual working time to time at berth

- Tankers

$$C_{HRL} = 4.5 \cdot P_D/d_C \tag{25}$$

$$P_{TL} = 2 \cdot (P_L + P_R) \; / \; [C_{HRL} \cdot 24 \cdot (11/12)] \tag{26}$$

where the loading a discharging rates for tankers are the same, and the ratio "11/12" is the ratio of actual working time to time at berth.

- Container Vessels

$$C_{HRU} = 22.5 + .045 \cdot (S_{3_3} \cdot N_C/S_{3_4}) \tag{27}$$

$$C_{HRF} = 22.5 + .045 \cdot (S_{3_2} \cdot N_C/S_{3_5}) \tag{28}$$

$$C_{HES} = 2 \cdot MX_D \cdot N_C \tag{29}$$

$$P_{THC} = [C_{HES} \; / \; C_{HRU} + C_{HES}/C_{HRF}] \; / \; [24 \cdot (7/12)] \tag{30}$$

C_{HRU} = The container handling rate, ctrs/hr., on the U.S. side.

C_{HRF} = The container handling rate, ctrs/hr., on the foreign side.

S_{3_4} = The number of U.S. port calls.

S_{3_5} = The number of foreign port calls.

C_{HES} = The number of container handlings on each transocean side.

P_{THC} = The total time in port, days, due to container handling (per voyage).

Where MX_D is the largest load factor on a transocean leg; and the "7/12" ratio is the ratio of actual working time to time on berth.

Break-Bulk (Conventional) Liner

$$N_G = .01153 \cdot (B_C/1000),\ N_G \geq 1 \quad (31)$$

$$C_{HR} = (.535) \cdot d_c \cdot N_G \quad (32)$$

$$P_{THC} = 2 \cdot (P_L + P_R)/[C_{HR} \cdot 24 \cdot (.4256)] \quad (33)$$

N_G = The number of longshore gangs aboard the vessel.

C_{HR} = Cargo handling rage, long tons/hour.

P_{THC} = The total time spent in port per voyage (roundtrip) due to cargo handling.

Where "0.4256" is the ratio of time actually spent working cargo to time on berth.

Barge Carriers

$$B_{HR} = 4 \quad (34)$$

$$P_{THB} = 4 \cdot MX_D \quad B_{HR} \cdot 24 \cdot (7/12) \quad (35)$$

B_{HR} = The barges handled per hour (loaded or discharged)

P_{THB} = The total port time per voyage spent handling barges, days.

Where MX_D is the maximum transocean load factor used to determine the number of barges actually carried; and, "7/12" is the ratio of actual barge handling time to time on berth (or at mooring).

(3) Days at Sea and Days in Port Per Voyage

(a) Days at Sea Per Roundtrip

Bulkers

$$D_{AS} = \left[D_{IST} \; [1/V_L + 1/V_R + (S_{1_4} \cdot S_{1_7} + S_{1_5} \cdot S_{1_8})/(.5 \cdot (V_L + V_R))] \right] / 24 + S_{1_6} \cdot (S_{1_4} + S_{1_5}) \qquad (36)$$

Tankers

$$D_{AS} = \left[D_{IST} \; [1 \; V_L + 1 \; V_R + (S_{2_4} \cdot S_{2_7} + S_{2_5} \cdot S_{2_8}) \; (.5 \cdot (V_L + V_R))] \right] / 24 + S_{2_6} \cdot (S_{2_4} + S_{2_5}) \qquad (37)$$

Container Vessels

$$D_{AS} = \left[D_{IST} \; [1 \; V_L + 1 \; V_R + (S_{3_4} \cdot S_{3_7} + S_{3_5} \cdot S_{3_8}) \; (.5 \cdot (V_L + V_R))] \right] / 24 + S_{3_6} \cdot (S_{3_4} + S_{3_5}) \qquad (38)$$

Break-Bulk (Conventional) Liner

$$D_{AS} = \left[D_{IST} \; [1 \; V_L + 1 \; V_R + (S_{4_4} \cdot S_{4_7} + S_{4_5} \cdot S_{4_8}) \; (.5 \cdot (V_L + V_R))] \right] / 24 + S_{4_6} \cdot (S_{4_4} + S_{4_5}) \qquad (39)$$

Barge Carriers

$$D_{AS} = \left[D_{IST} \; [1 \; V_L + 1 \; V_R + (S_{5_4} \cdot S_{5_7} + S_{5_5} \cdot S_{5_8}) \; (.5 \cdot (V_L + V_R))] \right] / 24 + S_{5_6} \cdot (S_{5_4} + S_{5_5}) \qquad (40)$$

For all vessels (except tankers) if a transit of the Panama Canal is made, then--

$$D_{AS} = D_{AS} + 1 \qquad (41)$$

It is assumed that tankers are too large for a Panama Canal transit.

D_{AS} = The total number of days spent at sea during a roundtrip, for each vessel type.

D_{IST} = The one-way transocean distance, in nautical miles.

(b) Days in Port per Roundtrip

Bulkers

$$D_{IP} = P_{TL} + P_{TD} + S_{1_1} \cdot [(D_{AS} + P_{TL} + P_{TD})/365] \quad (42)$$

Tankers

$$D_{IP} = P_{TL} + S_{2_1} \cdot [(D_{AS} + P_{TL})/365] \quad (43)$$

Containers

$$D_{IP} = P_{THC} + S_{3_1} \cdot [(D_{AS} + P_{THC})/365] \quad (44)$$

Break-Bulk (Conventional) Liner

$$D_{IP} = P_{THC} + S_{4_1} \cdot [(D_{AS} + P_{THC})/365] \quad (45)$$

Barge Carrier

$$D_{IP} = P_{THB} + S_{5_1} \cdot [(D_{AS} + P_{THC} /365] \quad (46)$$

D_{IP} = The total vessel days in port per roundtrip.

(4) Annual Tonnage Flows

Bulkers, Tankers From the enclosed table of "S" values in Exhibit 1, it is obvious that the services characterized have one fully loaded transocean leg, and then a return in ballast.

$$A_{TL} = P_L \cdot 365/(D_{AS} + D_{IP}) \quad (47)$$

$$A_{TR} = P_R \cdot 365/(D_{AS} + D_{IP}) \quad (48)$$

A_{TL} = The annual tonnage, long tons, moved in the primary direction.

A_{TR} = The annual tonnage, longstons, moved in the return direction (may be zero, as in the current case.)

Container Vessels The annual throughput in each direction is measured in full containers (where the notional container is taken as the standard 8' x 8' x 20' dry container).

$$A_{TL} = S_{3_2} \cdot N_C \cdot 365/(D_{AS} + D_{IP}) \quad (49)$$

$$A_{TR} = S_{3_3} \cdot N_C \cdot 365/(D_{AS} + D_{IP}) \quad (50)$$

A_{TL} = The number of full containers moving on the outbound (export) leg per year.

A_{TR} = The number of full containers moving on the inbound (import) leg per year.

To determine the annual tonnage in each direction:

$$A_{CTL} = A_{TL} \cdot B_{CTR} \cdot d_c \cdot (.85)/2240 \quad (51)$$

$$A_{CTR} = A_{TR} \cdot B_{CTR} \cdot d_c \cdot (.85)/2240 \quad (52)$$

Where $d_c \leq d_{CR}$

A_{CTL} = The annual tonnage carried on the outbound (export) transocean leg (long tons).

A_{CTR} = The annual tonange carried on the inbound (import) transocean leg (long tons).

Barge Carrier The annual tonnage for this service is measured in long tons per vessel per year.

$$A_{TL} = S_{5_2} \cdot B_{CB} \cdot N_B \cdot d_c \cdot (.85) \cdot 365/ [2240 (D_{AS} + D_{IP})] \quad (53)$$

$$A_{TR} = S_{5_3} \cdot A_{TL} /S_{5_2} \quad (54)$$

A_{TL} = The annual outbound (export) tonnage, long tons, per vessel.

A_{TR} = The annual inbound (import) tonnage, long tons, per vessel.

where $d_c \leq d_{CR}$

Break Bulk The annual tonnage for this service is given in long tons per vessel year.

$$A_{TL} = P_L \cdot 365 /(D_{AS} + D_{IP}) \quad (55)$$

$$A_{TR} = P_R \cdot 365 /(D_{AS} + D_{IP}) \quad (56)$$

A_{TL} = The annual tonnage, long tons, moved in the primary, or export direction per year.

A_{TR} = The annual tonnage, long tons, moved in the return direction.

(5) Port Costs Assessed on a Daily Basis All vessel types utilize the equations given below. An additional distinction must be made for the bulk service because of the difference between cargo loading and discharging rates.

$$D_{RTU} = D_{IP} \cdot [17 + M_{i3} \cdot M_{i1}^{.5} \cdot G_{RT}^{.67}] \quad (57)$$

$$D_{RTF} = D_{IP} \cdot [17 + K_{i3} \cdot K_{i1}^{.5} \cdot G_{RT}^{.67}] \quad (58)$$

Bulk

Import Cargo

$$D_T = (2 \cdot D_{RTU} + D_{RTF})/3 \quad (59)$$

Export Cargo

$$D_T = (D_{RTU} + 2 \cdot D_{RTF})/3 \quad (60)$$

Tanker, Container, Break-Bulk, Barge Carrier

$$D_T = (D_{RTU} + D_{RTF})/2 \quad (61)$$

D_{RTU} = The total daily port expense for a roundtrip if only U.S. ports were called at, \$.

D_{RTF} = The total daily port expense for a roundtrip if only foreign ports were called at, \$.

M_{i1}, M_{i3}, k_{i1}, k_{i3} = Defined the same M_{ij}, K_{ij} terms in the Port Entry and Exit Costs section.

D_T = The total daily port costs for a roundtrip, \$.

(6) Port Entry and Exit Costs The costs of entering and exiting ports are calculated from the same equations for all vessel types.

$$E_{RTU} = S_{k_4} \cdot \left[M_{i_2} \cdot e^{M_{i_1}} \cdot G_{RT}^{.585} \right] \quad (62)$$

$$E_{RTF} = S_{k_5} \cdot \left[K_{i_2} \cdot e^{K_{i_1}} \cdot G_{RT}^{.585} \right] \quad (63)$$

E_{RTU} = The entry and exit costs for the U.S. ports per roundtrip, \$.

E_{RTF} = The entry and exit costs for the foreign ports per roundtrip, \$.

S_{k_4}, S_{k_5} = The appropriate S_{ij} value from Exhibit I-1, where the "k" subscript identifies the vessel type, and the numeric subscript identifies the column.

M_{i_1}, M_{i_2} = The appropriate M_{ij} value from Exhibit I-11, where the "i" subscript refers to the U.S. coast and the numeric subscript identifies the appropriate column.

K_{i_1}, K_{i_2} = The appropriate K_{ij} value from Exhibit I-11, where the "i" subscript refers to the trade area where the port region is located, and the numeric subscript identifies the appropriate column.

e = Constant, 2.71828

(7) Direct Vessel Operating Costs This section calculates the direct vessel costs for one roundtrip, and is the same equation for all vessel types. It takes the input values for daily vessel costs and adds them together based upon the roundtrip days spent at sea and in port.

$$S_{CRT} = C_{SDS} \cdot D_{AS} + C_{PDS} \cdot D_{IP} \tag{64}$$

$$U_{CRT} = C_{SDU} \cdot D_{AS} + C_{PDU} \cdot D_{IP} \tag{65}$$

S_{CRT} = The direct vessel costs for the roundtrip, subsidized.

U_{CRT} = The direct vessel costs for the roundtrip, unsubsidized.

(8) Cargo Handling Costs The cargo handling costs require different equations for each vessel type because of their disparate methods of operation. The basis for these equations are explained in the text.

(a) Bulk The bulk system requires a separation between import and export flows to identify the different costs elements for each terminal throughput level. We use throughput levels of 5,000,000 short tons and 1,000,000 short tons per year for loading and discharging terminals, respectively.

Import

$$CH_{BL} = 1.12 \cdot P_L \cdot (.7+.3\cdot K_{i1}) \cdot 4540/\ (5{,}000{,}000)^{.56} d_C^{\ .43}$$

$$= P_L \cdot (.6309+.2704\cdot K_{i1})/d_C^{\ .43} \tag{66}$$

$$CH_{BD} = 1.12 \cdot P_L \cdot 16{,}500/\ (1{,}000{,}000)^{.56} d_C^{\ .43} \tag{67}$$

$$= 8.064 \cdot P_L/d_C^{\ .43}$$

Export

$$CH_{BL} = .9013 \cdot P_L/d_C^{\ .43} \tag{68}$$

$$CH_{BF} = P_L \cdot (5.645+2.419\cdot K_{i1})/d_C^{\ .43} \tag{69}$$

CH_{BL} = The cargo handling cost incurred for loading the cargo aboard the vessel per roundtrip, $.

CH_{BD} = The cargo handling cost incurred when discharging the cargo from the vessel per roundtrip, $.

P_L = The tonnage carried in the loaded direction, long tons.

d_C = The current density of the cargo being carried, lbs./cu. ft.

K_{i1} = The "K_{i1}" value from Exhibit I-11, Part I, giving the labor ratio of the foreign area (area i).

(b) Tanker This service also assumes one empty trans-ocean leg. A distinction is made between loading and discharging terminals because loading terminals typically have higher throughputs--thus requiring a separation between import and export flows. The throughputs which we use for these terminals are: 20,000,000 short tons per year, loading; and 5,000,000 short tons per year, discharging.

Import

$$CH_{TL} = P_L \cdot (.2903 + .1244 \cdot Kil)/d_C^{.43} \quad (70)$$

$$CH_{TD} = .9013 \cdot P_L/d_C^{.43} \quad (71)$$

Export

$$CH_{TL} = .4147 \cdot P_L/d_C^{.43} \quad (72)$$

$$CH_{TD} = P_L \cdot (.6309 + .2704 \cdot K_{i1})/d_C^{.43} \quad (73)$$

CH_{TL} = The total loading cost, \$.

CH_{TD} = The discharging cost, \$.

P_L = The cargo tonnage carried in the loaded direction, long tons.

d_C = The density of the cargo, cu. ft., where d_C d_{CR} (critical density).

K_{i1} = The labor ratio from Exhibit I-11, Part I.

(c) Container The cargo handling costs are determined on a per-container basis. These costs are additionally converted into costs per long ton for convenience when comparing different services. No distinction is required between import and export flows.

$$CH_{CLU} = 80 \cdot N_C \cdot S_{3_2} \tag{74}$$

$$CH_{CDU} = 80 \cdot N_C \cdot S_{3_3} \tag{75}$$

$$CH_{CLF} = (28 + 52 \cdot K_{i1}) \cdot N_C \cdot S_{3_3} \tag{76}$$

$$CH_{CDF} = (28 = 52 \cdot K_{i1} \cdot N_C \cdot S_{3_2} \tag{77}$$

Where $N_C \cdot (S_{3_2} + S_{3_3})$ is the number of full containers handled on each side; and, $N_C \cdot (S_{3_2} + S_{3_3}) \cdot (0.85) \cdot B_{CTR} \cdot d_C/2240$ is the number of long tons loaded and discharged on each side.

CH_{CLU} = The total costs of loading containers aboard the vessel on the U.S. side, \$.

CH_{CDU} = The total cost of discharging containers from the vessel on the U.S. side, \$.

CH_{CLF} = The total cost of loading containers from the vessel on the foreign side, \$.

CH_{CDF} = The total cost of discharging containers from the vessel on the foreign side, \$.

K_{i1} = The labor ratio from Exhibit I-11, Part I, where i refers to the foreign trade area.

N_C = The designed capacity of the vessel, containers

S_{3_2}, S_{3_3} = The "S_{IJ}" value from Exhibit I-1

d_C = The density of the cargo, cu. ft., where this density is the critical density (d_{CR}).

B_{CTR} = The bale cubic of the container, cu. ft.

Break Bulk

$$CH_{LU} = 784 \cdot P_L/d_C \tag{78}$$

$$CH_{DU} = 784 \cdot P_R/d_C \tag{79}$$

$$CH_{LF} = (117.6 + 666.4 \cdot K_{i1}) \cdot P_L/d_C \tag{80}$$

$$CH_{DF} = (117.6 + 666.4 \cdot K_{i1}) \cdot P_R/d_C \tag{81}$$

CH_{LU} = The total cost of loading cargo on the U.S. side per round trip, \$.

CH_{DU} = The total cost of discharging cargo on the U.S. side per round trip, \$.

CH_{LF} = The total cost of loading cargo on the foreign side per round trip, \$.

CH_{DF} = The total cost of discharging cargo on the foreign side per round trip, \$.

P_L = The cargo payload carried on the outbound leg from the U.S., long tons.

P_R = The cargo payload carried on the inbound leg to the U.S., long tons.

K_{i1} = The labor ratio from Exhibit I-11, Part I.

d_C = The density of the cargo, lbs./cu. ft., where $15 \leq d_C \leq 80$ lbs./cu.ft.

(e) Barge Carrier The cargo handling cost for barge carriers includes the cost of loading barges on (and discharging from) the vessel, as well as the inland waterway terminal cost for loading the cargo on, or discharging from the barge. While these cost activities may take place hundreds of miles apart (separated by an inland waterway movement), they are still logically occurring at the land-sea interface. The inland waterway movement itself is not included (either for time or cost).

$$BH_U = 500 + 90 \cdot N_B \cdot MX_D \qquad (82)$$

$$BH_{BLU} = .2975 \cdot N_B \cdot S_{5_2} \cdot B_{CB} \qquad (83)$$

$$BH_{BDU} = .2975 \cdot N_B \cdot S_{5_3} \cdot B_{CB} \qquad (84)$$

$$B_{HF} = 136 + 364 \cdot K_{i_1} + (13.6 + 76.4 \cdot K_{i_1}) \cdot N_B \cdot MX_D \qquad (85)$$

$$BH_{BLF} = (.044625 + .252875 \cdot K_{i_1}) \cdot N_B \cdot S_{5_3} \cdot B_{CB} \qquad (86)$$

$$BH_{BDF} = (.044625 + .252875 \cdot K_{i1}) \cdot N_B \cdot S_{5_2} \cdot B_{CB} \qquad (87)$$

BH_U = The cost of loading and discharging barges from the vessel on the U.S. side, \$.

BH_{BLU} = The cost of loading the cargo on the barges on the U.S. side, \$.

BH_{BDU} = The cost of discharging the cargo from the barge on the U.S. side, \$.

BH_F = The cost of loading and discharging the barges from the vessel on the foreign side, \$.

BH_{BLF} = The cost of loading the cargo on the barges on the Foreign side, \$.

BH_{BDF} = The cost of discharging the cargo from the barges on the foreign side, \$.

K_{i1} = The labor ratio from Exhibit I-11, Part I.

N_B = The number of barges the vessel is designed to carry.

B_{CB} = The bale cubic of a barge, cu. ft.

S_{5_2}, S_{5_3} = The "S_{IJ}" value from Exhibit I-1.

MX_D = The maximum value of S_{5_2} or S_{5_3}.

(9) Additional Container and Barge System Costs

$$R_T = D_{AS} + D_{IP} \quad (88)$$

$$F = .565 \cdot R_T^{.85} \quad (89)$$

R_T = The roundtrip time, days.

D_{AS} = Days spent at sea per roundtrip.

D_{IP} = Days spent in port per rountrip.

F = The frequency of service (days between successive vessel calls at a port), days.

(a) Inventory Given the round trip time and frequency from above, the equipment inventory (containers and barges) required is as follows:

Container

$$I_{CTR} = N_C \cdot MX_D \cdot \left[1 + [2 \cdot S_C / (R_T/F)]\right] \quad (90)$$

where

$$S_C = .46455 + 13.66172/F$$

$$S_C \geq 1$$

Barges

$$I_{BAR} = N_B \cdot MX_D \cdot \left[1 + [2 \cdot S_B / (R_T\ F)]\right] \qquad (91)$$

where

$$S_B = .49256 + 20.0102/F$$

$$S_B \geq 1$$

I_{CTR} = The total number of containers that the vessel requires.

N_C = The design container capacity of the vessel.

S_C = The number of sets of containers required on each side of the ocean. (See text)

I_{BAR} = The total number of barges that the vessel requires.

N_B = The design barge capacity of the vessel.

S_B = The number of sets of barges required on each side of the ocean. (See text)

MX_D = The maximum value of: for containers, S_{3_2} or S_{3_3}; for barges, S_{5_2} or S_{5_3}.

(b) Capital Cost

Container

$$CC_{CTR} = CRF_C \cdot PP_{CTR} \cdot I_{CTR} \cdot R_T / 365 \qquad (92)$$

where

CRF_C = .25

PP_{CTR} = 2000

CRF_C = The capital recovery factor for containers (see text).

PP_{CTR} = The initial purchase price of an 8' x 8' x 20' container in 1967 (see text).

then

$$CC_{CTR} = 500 \cdot I_{CTR} \cdot R_T / 365$$
$$= 1.37 \cdot I_{CTR} \cdot RT$$

CC_{CTR} = The total container capital cost per vessel round trip.

Barges

$$CC_{BAR} = CRF_B \cdot PP_{BAR} \cdot I_{BAR} \cdot R_T/365 \quad (93)$$

where

$CRF_B = .185$; $PP_{BAR} = 1.12\ B_{CB}$

then

$$CC_{BAR} = .0005677 \cdot B_{CB} \cdot I_{BAR} \cdot R_T$$

CC_{BAR} = The total barge capital cost per vessel found trip, \$.

B_{CB} = The bale cubic of the barge, cu. ft.

CRF_B = The capital recovery factor for barges (see text).

PP_{BAR} = The purchase price of the barge (see text), \$.

(c) Maintenance and Repair Costs

Containers

$$R_{CTR} = .06 \cdot PP_{CTR} \cdot I_{CTR} \cdot R_T /365 \quad (94)$$
$$= (.06) \cdot (2000) \cdot I_{CTR} \cdot R_T /365$$
$$= .3288 \cdot I_{CTR} \cdot R_T$$

R_{CTR} = The maintenance and repair cost of the containers per vessel round trip, \$.

Barges

$$R_{BAR} = .0852 \cdot (B_{CB} / 100)^{.767} \cdot I_{BAR} \cdot R_T \quad (95)$$

R_{BAR} = The maintenance and repair cost of the barges per vessel round trip, \$.

(d) Insurance Costs

Containers

$$IN_{CTR} = .08 \cdot PP_{CTR} \cdot R_T / 365 \qquad (96)$$

$$= .4384 \cdot I_{CTR} \cdot R_T$$

IN_{CTR} = The insurance costs on the containers per vessel round trip, \$.

Barges

$$IN_{BAR} = .08 \cdot (1.12 \cdot B_{CB}) \cdot I_{BAR} \cdot R_T / 365 \qquad (97)$$

$$= .000241 \cdot B_{CB} \cdot I_{BAR} \cdot R_T$$

IN_{BAR} = The insurance costs on the barges per vessel round trip, \$.

(10) Panama Canal Transit

Bulkers

$$P_{CAN} = 960 + 1.6733 \cdot (B_C / 100) \qquad (98)$$

Container, Break Bulk, Barge Carrier

$$P_{CAN} = 960 + 1.8534 \cdot (B_C / 100) \qquad (99)$$

P_{CAN} = The total cost of transiting the Panama Canal per round trip (for bulkers there is one loaded and one in-ballast transit), \$.

If there is not Canal transit, $P_{CAN} = 0$.

(11) Cargo Insurance The cargo insurance equations below are explained fully in the text. An equation is given for each type, adjusted on a \$ per long ton basis.

Bulker, Tankers

$$CAR_{INS} = 4.256 \cdot (P_L + P_R) \cdot (V / d_C)^{.62} \qquad (100)$$

Container

$$CAR_{INS} = .0031 \cdot N_C \cdot (S_{3_2} + S_{3_3}) \cdot B_{CTR} \cdot d_C^{.38} V^{.62} \qquad (101)$$

Break Bulk

$$CAR_{INS} = 20.16 \cdot (P_L + P_R) \cdot (V / d_C)^{.62} \qquad (102)$$

Barge Carrier

$$CAR_{INS} = .0054 \cdot N_B \cdot (S_{5_2} + S_{5_3}) \cdot B_{CB} \cdot d_C^{.38} V^{.62} \qquad (103)$$

$$d_C \leq d_{CR}$$

CAR_{INS} = The total cargo insurance cost per vessel roundtrip, $.

V = The value per pound of the cargo, $/lb.

d_C = The density of the cargo, lbs./cu.ft.

d_{CR} = The critical density of the vessel type, lbs./cu.ft.

(12) Administrative and General Costs

Bulkers

$$AG_B = .1 \cdot (U_{CTR} + E_{RTU} + E_{RTF} + D_T + CH_{BL} + CH_{BD} + CAR_{INS} + P_{CAN}) \qquad (104)$$

AG_B = The administrative and general costs per roundtrip for a bulk vessel, $.

Tankers

$$AG_T = .1 \ (U_{CRT} + E_{RTU} + E_{RTF} + D_F + CH_{TL} + CH_{TD} + CAR_{INS}) \qquad (105)$$

AG_T = The administrative and general costs per roundtrip for a tanker.

Container

$$AG_C = .12 \cdot (U_{CRT} + E_{RTU} + E_{RTF} + D_T + CH_{CLU} + CH_{CDU} + CLF + CH_{CDF} + CC_{CTR} + R_{CTR} + IN_{CTR} + CAR_{INS} + P_{CAN}) \quad (106)$$

AG_C = The administrative and general costs per roundtrip for a container vessel, $.

Break Bulk

$$AG_{BB} = .12 \cdot (U_{CRT} + E_{RTU} + E_{RTF} + D_T + CH_{LU} + CH_{DU} + CH_{LF} + CH_{DF} + CAR_{INS} + P_{CAN}) \quad (107)$$

Barge Carrier

$$AG_{BC} = .12 \cdot (U_{CRT} + E_{RTU} + E_{RTF} + D_T + BH_U + GH_{BLU} + BH_{BDU} + BH_F + BH_{BLF} + BH_{BDF} + CC_{BAR} + R_{BAR} + IN_{BAR} + CAR_{INS} + P_{CAN}) \quad (108)$$

AG_{BC} = The administrative and general costs per round trip for barge carriers, $.

(13) Total Ocean Freight Per Ton

Bulker

$$DPT = S_{CRT} + E_{RTU} + E_{RTF} - D_T + CH_{BL} + CH_{BD} + P_{CAN} + AG_B) / (1.12 \cdot P_L) \quad (109)$$

Tanker

$$DPT = S_{CRT} + E_{RTU} + D_T + CH_{TL} + CH_{TD} + AG_T) / (1.12 \cdot P_L) \quad (110)$$

Container

$$DPC = (S_{CRT} + E_{RTU} + E_{RTF} + D_T + CH_{CLU} + CH_{CDU} + CH_{CLF} + CH_{CDF} + CC_{CTR} + R_{CTR} + IN_{CTR} + P_{CAN} + AG_C / \left[(S_{3_2} + S_{3_3} \cdot N_C\right] \quad (111)$$

Break Bulk

$$DPT = (S_{CRT} + E_{RTU} + E_{RTF} + D_T + CH_{LU} + CH_{DU} + CH_{LF} + CH_{DF} + P_{CAN} + AG_{BB}) \,/\, \left[1.12 \cdot (P_L + P_R)\right] \quad (112)$$

Barge Carrier

$$DPT = (S_{CRT} + E_{RTU} + E_{RTF} + D_T + BH_U + BH_{BLU}\; BH_{BDU} + BH_F + BH_{BLF} + BH_{BDF} + CC_{BAR} + R_{BAR}\; IN_{BSR} + P_{CAN} + AG_{BC}) \,/\, \left[.003068 \cdot (A_{TL} + A_{TR}) \cdot R_T\right] \quad (113)$$

DPT = The ocean freight, \$/short ton.

DPC = The ocean freight, \$/(8' x 8' x 20') ctr.

A_{TL} = The annual tonnage carried in outbound direction, long tons (barge carrier).

A_{TR} = The annual tonnage carried in the inbound direction, long tons (barge carrier).

(14) Documentation Costs

Bulkers, Tankers

$$DOC = 0 \quad (114)$$

Containers, Break Bulk, Barge Carrier

$$DOC = .15 \quad (115)$$

DOC = The documentation costs per short ton, import or export, \$/short ton.

(15) Packaging Costs, Cargo

Bulkers, Tankers There is no packaging cost for these vessels:

$$P_{CC} = 0$$

<u>Container</u>

$$P_{CC} = 1250/d_C \tag{117}$$

<u>Break Bulk, Barge Carrier</u>

$$P_{CC} = 1700/d_C \tag{118}$$

P_{CC} = The packaging cost per short ton of cargo, imported or exported, \$/short ton.

(16) <u>Cargo Transit Time</u> The transit time for cargo is separated into the following elements: (a) average time aboard the vessel; (b) average time spent waiting at the ocean terminal--between delivery by the inland mode and loading aboard the vessel; (c) average time spent waiting at the ocean terminal--between discharge from the vessel and loading aboard the inland mode. Each of the above elements is considered separately for each vessel type.

The total transit time of the cargo while in the ocean pipeline is given in the following equation for all vessel types:

$$T_{TT} = T_{TAV} + T_{TLT} + T_{TDT}$$

T_{TT} = Total cargo time spent in the transocean pipeline, days.

T_{TAV} = The time the cargo spends aboard the vessel during transit, days.

T_{TLT} = The time the cargo spends waiting at the loading terminal, days.

T_{TDT} = The time the cargo spends waiting at the discharging terminal, days.

The value of T_{TAV} is generated from the same equation for all vessels, and is:

$$T_{TAV} = .5(D_{AS} + D_{IP})$$

where

D_{AS} = The days spent at sea per vessel round trip

D_{IP} = The days spent in port per vessel round trip

Then by substitution:

$$T_{TT} = .5(D_{AS} + D_{IP}) + T_{TLT} + T_{TDT} \tag{119}$$

The T_{TLT} and T_{TDT} terms are given by vessel type below.

Bulkers, Tankers The T_{TDT} and T_{TDT} terms are constants for these two services since their cargo waiting time at ocean terminals is dependent upon physical distribution factors outside the scope of this study. These terms are given the following nominal values:

$$T_{TLT} = 2 \tag{120}$$

$$T_{TDT} = 2 \tag{121}$$

Container, Breakbulk

$$T_{TLT} = .047(D_{AS} + D_{IP})^{1.046} \tag{122}$$

$$T_{TDT} = 1.5 \tag{123}$$

Barge Carrier The barge carrier is a special case because there are, in effect, two water-land terminal interfaces which the cargo passes through. One is the inland dock (perhaps on a river or in the port itself) where the cargo begins or ends its land journey. The second is the barge consolidation or marshalling area in the port where the cargo aboard the barge begins or ends its inland waterway movement.

The waiting times while in the marshalling area were given constant values based upon our estimate of what the controlling elements would be. The time spent waiting at the land terminus is assumed to be similar to the waiting times at a break bulk terminal, plus the time spent loading or discharging the barge itself. The equations are given below:

$$T_{TLT} = 1 + .047 \cdot (D_{AS} + D_{IP})^{1.046} + .000035 \cdot B_{BC} \tag{124}$$

$$T_{TDT} = 2 + .000035 \cdot B_{BC} \tag{125}$$

B_{BC} = The bale cubic of the barge, cu. ft.

(P) Cost Equations with Escalation Terms

The cost equations given in the preceding section relate to 1967 base-year price and wage levels. As such, many of these must be upgraded to reflect changes in these factors. This upward revision is accomplished by incorporating the labor and material escalator terms from Exhibit I-23 into each equation. The equations in their revised form are given below.

EXHIBIT I-24

1967

Vessel Type	V_D	B_C	P_C	d_{CR}	D_L	D_D	P_D	N_C	B_{CTR}	C_{TAR}	N_B	B_{CB}	B_{TAR}
Bulker	15	2613331	50987	46	16409	66409	50000	0	0	0	0	0	0
Tanker	15	8552717	201303	55	58318	258318	200000	0	0	0	0	0	0
Container	21	812544	13959	43	9566	19026	8098	800	1067	2	0	0	0
Break Bulk	23	1236500	19700	41	12000	24000	12000	0	0	0	0	0	0
Barge Carrier	20	1660600	23245	42	14074	33880	13986	0	0	0	38	38800	153

EXHIBIT I-25

1970

Vessel Type	V_D	B_C	P_C	d_{CR}	D_L	D_D	P_D	N_C	B_{CTR}	C_{TAR}	N_B	B_{CB}	B_{TAR}
Bulker	15	2613331	50978	46	16409	66409	50000	0	0	0	0	0	0
Tanker	15	8552717	201303	55	58318	258318	200000	0	0	0	0	0	0
Container	23	1396558	25608	42	15042	32779	15184	1500	1067	2	0	0	0
Break Bulk	23	1545600	22600	38	13880	28800	15000	0	0	0	0	0	0
Barge Carrier	20	1660600	23245	42	14074	33880	13986	0	0	0	38	38800	153

EXHIBIT I-26

1975

Vessel Type	V_D	B_C	P_C	d_{CR}	D_L	D_D	P_D	N_C	B_{CTR}	C_{TAR}	N_B	B_{CB}	B_{TAR}
Bulker	15	4276358	124041	68	20867	120867	100000	0	0	0	0	0	0
Tanker	14	12829076	301905	55	84317	384317	300000	0	0	0	0	0	0
Container	23	1396558	25608	42	15042	32779	15184	1500	1067	2	0	0	0
Break Bulk	25	1854720	25920	36	17029	35029	18000	0	0	0	0	0	0
Barge Carrier	20	1660600	23245	42	14074	33880	13986	0	0	0	38	38800	153

EXHIBIT I-27

1980

Vessel Type	V_D	B_C	P_C	d_{CR}	D_L	D_D	P_D	N_C	B_{CTR}	C_{TAR}	N_B	B_{CB}	B_{TAR}
Bulker	15	6414536	168917	61	29561	179561	150000	0	0	0	0	0	0
Tanker	14	12829076	301905	55	84317	384317	300000	0	0	0	0	0	0
Container	23	1396558	25608	42	15042	32779	15184	1500	1067	2	0	0	0
Break Bulk	25	1854720	24938	35	16890	34890	18000	0	0	0	0	0	0
Barge Carrier	20	1660600	23245	42	14074	33880	13986	0	0	0	38	38800	153

EXHIBIT I-28

1967

Vessel Type	C_{SDS}	C_{PDS}	C_{SDU}	C_{PDU}	G_{RT}
Bulker	4802	3853	9796	8846	29603
Tanker	12462	10516	25323	23376	94832
Container	5331	4100	10721	9489	9948
Break Bulk	7097	5441	14044	12388	14294
Barge Carrier	6967	5635	14159	12827	19118

EXHIBIT I-29

1970

Vessel Type	C_{SDS}	C_{PDS}	C_{SDU}	C_{PDU}	G_{RT}
Bulker	5192	4137	10578	9523	29603
Tanker	13443	11280	27254	25092	94832
Container	8123	6098	15882	13858	16574
Break Bulk	8367	6420	16528	14582	17614
Barge Carrier	7469	5988	15142	13661	19118

EXHIBIT I-30

1975

Vessel Type	C_{SDS}	C_{PDS}	C_{SDU}	C_{PDU}	G_{RT}
Bulker	7501	5674	14729	12901	48137
Tanker	19672	16478	39731	36538	140477
Container	9304	6756	17927	15379	16574
Break Bulk	11961	8562	22659	19259	21101
Barge Carrier	8421	6555	16856	14990	19118

EXHIBIT I-31

1980

Vessel Type	C_{SDS}	C_{PDS}	C_{SDU}	C_{PDU}	G_{RT}
Bulker	10269	7750	19981	17462	71167
Tanker	21707	18108	43768	40169	140477
Container	10268	7396	19748	16876	16574
Break Bulk	13083	9266	24698	20881	21101
Barge Carrier	9225	7122	18433	16330	19118

This section was separated from the base-year equation section in an attempt to improve the structural quality of the model. The addition of up to two additional variables, in each cost equation, would have unnecessarily complicated these equations.

The "E_{IJ}" terms are described in the portion of the text describing the derivation of the labor and material escalation rates. Each equation is identified by its corresponding number appearing to the right.

$$D_{RTU} = D_{IP} \cdot E_{1_2} \cdot \left[17 + M_{i3} \cdot (M_{i_1} \cdot E_{I_1})^{.5} \cdot G_{RT}{}^{.67} \right] \qquad (57)$$

$$D_{RTF} = D_{IP} \cdot E_{I2} \cdot \left[17 + Ki_3 \cdot (Ki_1 \cdot E_{I_1})^{.5} \cdot G_{RT}{}^{.67} \right] \qquad (58)$$

$$E_{RTU} = S_{K_4} \cdot E_{I_2} \cdot \left[M_{i_2} \cdot e^{(Mi1 \cdot EI1)} \cdot G_{RT}{}^{.585} \right] \qquad (62)$$

$$E_{RTF} = S_{K_4} \cdot E_{I_2} \cdot \left[K_{i2} \cdot e^{(Ki1 \cdot EI1)} \cdot G_{RT}{}^{.585} \right] \qquad (63)$$

$$CH_{BL} = P_L \cdot (.6309 \cdot E_{I2} + .2704 \cdot E_{I1} \cdot K_{i1})/d_C{}^{.43} \qquad (66)$$

$$CH_{BD} = P_L \cdot (5,645 \cdot E_{I_2} + 2.419 \cdot E_{I1})/d_C{}^{.43} \qquad (67)$$

$$CH_{BL} = P_L \cdot (.6309 \cdot E_{I_2} + .2704 \cdot E_{I_1})/d_C{}^{.43} \qquad (68)$$

$$CH_{BD} = P_L \cdot (5.645 \cdot E_{I_2} + 2.419 \cdot E_{I_1} \cdot K_{i_1})/d_C{}^{.43} \qquad (69)$$

$$CH_{TL} = P_L \cdot (.2903 \cdot E_{I_2} + .1244 \cdot E_{I_1} \cdot K_{i_1})/d_C{}^{.43} \qquad (70)$$

$$CH_{TD} = P_L \cdot (.6309 \cdot E_{I_2} + .2704 \cdot E_{I_1})/d_C{}^{.43} \qquad (71)$$

$$CH_{TL} = P_L \cdot (.2903 \cdot E_{I_2} + .1244 \cdot E_{I_1})/d_C{}^{.43} \qquad (72)$$

$$CH_{TD} = P_L \cdot (.6309 \cdot E_{I_2} + .2704 \cdot E_{I_1} \cdot K_{i_1})/d_C{}^{.43} \qquad (73)$$

$$CH_{CLU} = N_C \cdot (28 \cdot E_{I_2} + 52 \cdot E_{I_1}) \cdot S_{3_2} \quad (74)$$

$$CH_{CDU} = N_C \cdot (28 \cdot E_{I_2} + 52 \cdot E_{I_1}) \cdot S_{3_3} \quad (75)$$

$$CH_{CLF} = N_C \cdot (28 \cdot E_{I_2} + 52 \cdot E_{I_L} \cdot K_{i_1}) \cdot S_{3_3} \quad (76)$$

$$CH_{CDF} = N_C \cdot (28 \cdot E_{I_2} + 52 \cdot E_{I_1} \cdot K_{i_1}) \cdot S_{3_2} \quad (77)$$

$$CH_{LU} = P_L \cdot (117.6 \cdot E_{I_2} + 666.4 \cdot E_{I_1})/d_C \quad (78)$$

$$CH_{DU} = P_R \cdot (117.6 \cdot E_{I_2} + 666.4 \cdot E_{I_1})/d_C \quad (79)$$

$$CH_{LF} = P_L \cdot (117.6 \cdot E_{I_2} + 666.4 \cdot E_{I_1} \cdot K_{i_1})/d_C \quad (80)$$

$$CH_{DF} = P_R \cdot (117.6 \cdot E_{I_2} + 666.4 \cdot E_{I_1} \cdot K_{i_1})/d_C \quad (81)$$

$$BH_U = 136 \cdot E_{1_2} + 364 \cdot E_{I_1} + (13.6 \cdot E_{I_2} + 76.4 \cdot E_{I_1}) \cdot N_B \cdot MX_D \quad (82)$$

$$BH_{BLU} = (.044625 \cdot E_{I_2} + .252875 \cdot E_{I_1}) \cdot N_B \cdot S_{5_2} \cdot B_{CB} \quad (83)$$

$$BH_{BDU} = (.044625 \cdot E_{I_2} + .252875 \cdot E_{I_1}) \cdot N_B \cdot S_{5_3} \cdot B_{CB} \quad (84)$$

$$B_{HF} = 136 \cdot E_{I_2} + 364 \cdot E_{I_1} + (13.6 \cdot E_{I_2} + 76.4 \cdot E_{I_1} \cdot K_{i_1}) \cdot N_B \cdot MX_D \quad (85)$$

$$BH_{BLF} = (.044625 \cdot E_{I_2} + .252875 \cdot E_{I_1} . K_{i_1}) \cdot N_B \cdot S_{5_3} \cdot B_{CB} \quad (86)$$

$$BH_{BDF} = (.044625 \cdot E_{I_2} + .252875 \cdot E_{I_1} \cdot K_{i_1}) \cdot N_B \cdot S_{5_2} \cdot B_{CB} \quad (87)$$

$$CC_{CTR} = 1.37 \cdot E_{I_2} \cdot I_{CTR} \cdot R_T \qquad (92)$$

$$CC_{BAR} = .000567 \cdot E_{I_2} \cdot B_{CB} \cdot I_{BAR} \cdot R_T \qquad (93)$$

$$R_{CTR} = (.1644 \cdot E_{I_2} + .1644 \cdot E_{I_1}) \cdot I_{CTR} \cdot R_T \qquad (94)$$

$$R_{BAR} = (.0426 \cdot E_{I_2} + .0426 \cdot E_{I_1}) \cdot (B_{CB}/100)^{.767} \cdot I_{BAR} \cdot R_T \qquad (95)$$

$$IN_{CTR} = .4384 \cdot E_{I_2} \cdot I_{CTR} \cdot R_T \qquad (96)$$

$$IN_{BAR} = .000241 \cdot E_{I_2} \cdot B_{CB} \cdot I_{BAR} \cdot R_T \qquad (97)$$

$$P_{CAN} = E_{I_2} \cdot \left[960 + 1.6733 \cdot (B_C/100)\right] \qquad (98)$$

$$P_{CAN} = E_{I_2} \cdot \left[960 + 1.8534 \cdot (B_C/100)\right] \qquad (99)$$

$$CAR_{INS} = 4.256 \cdot E_{I_2} \cdot (P_L + P_R) \cdot (V/d_C)^{.62} \qquad (100)$$

$$CAR_{INS} = .0031 \cdot E_{I_2} \cdot N_C \cdot (S_{3_2} + S_{3_3}) \cdot B_{CTR} \cdot d_C^{.38} \cdot V^{.62} \qquad (101)$$

$$CAR_{INS} = 20.16 \cdot E_{I_2} \cdot (P_L + P_R) \cdot (V/d_C)^{.62} \qquad (102)$$

$$CAR_{INS} = .0054 \cdot E_{I_2} \cdot N_B \cdot (S_{5_2} + S_{5_3}) \cdot B_{CB} \cdot d_C^{.38} \cdot {}^{.62} \qquad (103)$$

$$DOC = .15 \cdot E_{I_1} \qquad (115)$$

$$P_{CC} = (1000 \cdot E_{I_1} + 250 \cdot E_{I_2})/d_C \qquad (117)$$

$$P_{CC} = (1360 \cdot E_{I_1} + 340 \cdot E_{I_2}) / d_C \qquad (118)$$

CHAPTER II

THE U.S. SUPERPORT CONTROVERSY

In the five years from 1965 to 1970, the number of ships in the world fleet with capacities in excess of 100,000 deadweight tons (DWT) increased from 19 to 319. Before this decade ends, according to the U.S. Maritime Administration, their number should easily exceed 1000. By then the 200,000-300,000 dwt tanker and combination bulk carrier will become the standard workhorse of world bulk trade, as implied by the rapid growth shown in Figure II-1.

This trend to large vessels is inexorable. J.H. Kirby, Managing Director of Shell International says "No matter what, there can be no thought of abandoning big tankers and returning to 50,000 tonners...[the] demand for crude oil is growing at such a rate that it would be impossible to provide sufficient trained crews for [the smaller vessels] even if they could be built. The ports of the world would become hopelessly congested with them. Thus, the 200,000-300,000 tonners are before us and here to stay."

Until recently the world's largest tanker was the 372,700 ton Nisseki Maru of the Tokyo Tanker Company. However, a 477,000 ton tanker has now been constructed in Japan for Globtik Tankers, Ltd., and the same company has a vessel of 500,000-700,000 dwt in the planning stage. Table II-1 shows how the dimensions compare with the standard T-2 tanker of World War II.

A recent study by Soros Associates for the Maritime Administration has documented the cost savings of using large carriers as shown by Figure II-2. Economies of scale in oil transport are such that even allowing for terminal and transshipment cost, an increase in tanker size from 65,000 tons to 325,000 could reduce the overall transportation cost of oil from the Persian Gulf to the U.S. from about $9.93 per ton to $7.42, a savings of over 25 percent.

Bulk shippers with the oil industry in the lead will continue to use large vessels to reduce transportation costs. By using supersized bulk carriers the major industrial nations, particularly Japan and the European countries, have been able to depend increasingly on distant sources for raw materials.

Already, the economies of large ship transportation - particularly in the movement of low-value bulk commodities such as coal, oil, and iron ore - have stimulated the construction and planning of more than 50 foreign deepwater port facilities capable of accommodating vessels of 200,000 dwt and larger. Table II-2 shows recent port development trends in Europe. In the U.S., bulk vessels of 100,000 dwt can presently enter and berth safely at only three developed ports, all on the West Coast. The East and Gulf Coasts have no comparable facilities.

Fig. II-1

Growth of Merchant Ships Over

200,000 DWT in Operation in the World

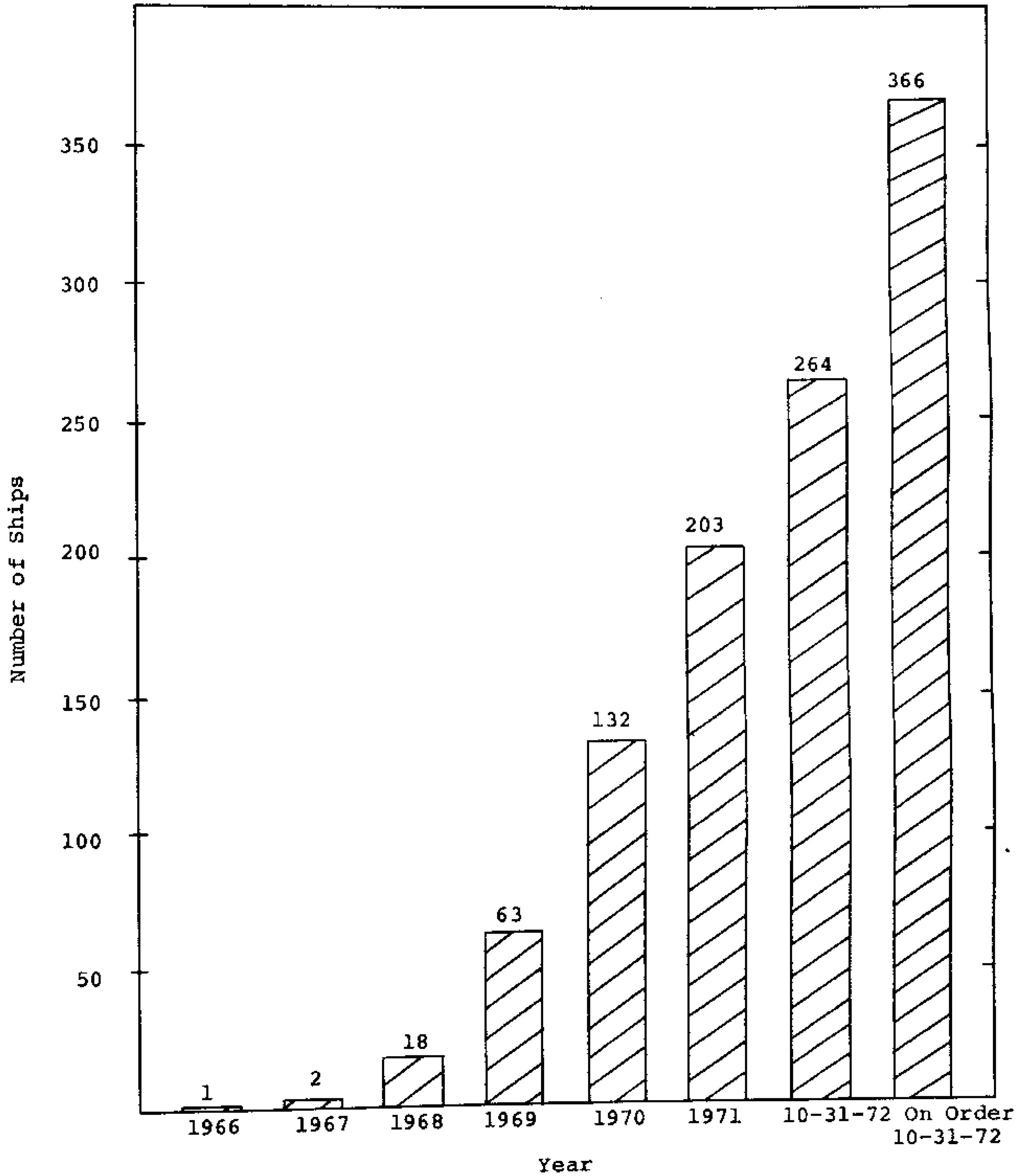


Table II-1

Comparison of Modern Tankers with Standard T-2 Tankers of World War II

	Globtik Tokyo	Nisseki Maru	Universe Ireland	Idemitsu Maru	T-2
Deadweight (tons)	477,000	372,700	326,600	206,000	16,600
Overall Lenght (ft)	1,243	1,138	1,133	1,222	524
Beam (ft)	203	177	175	164	68
Draft (ft)	92	89	81	58	30

Table II-2

Port Development Trends in Europe

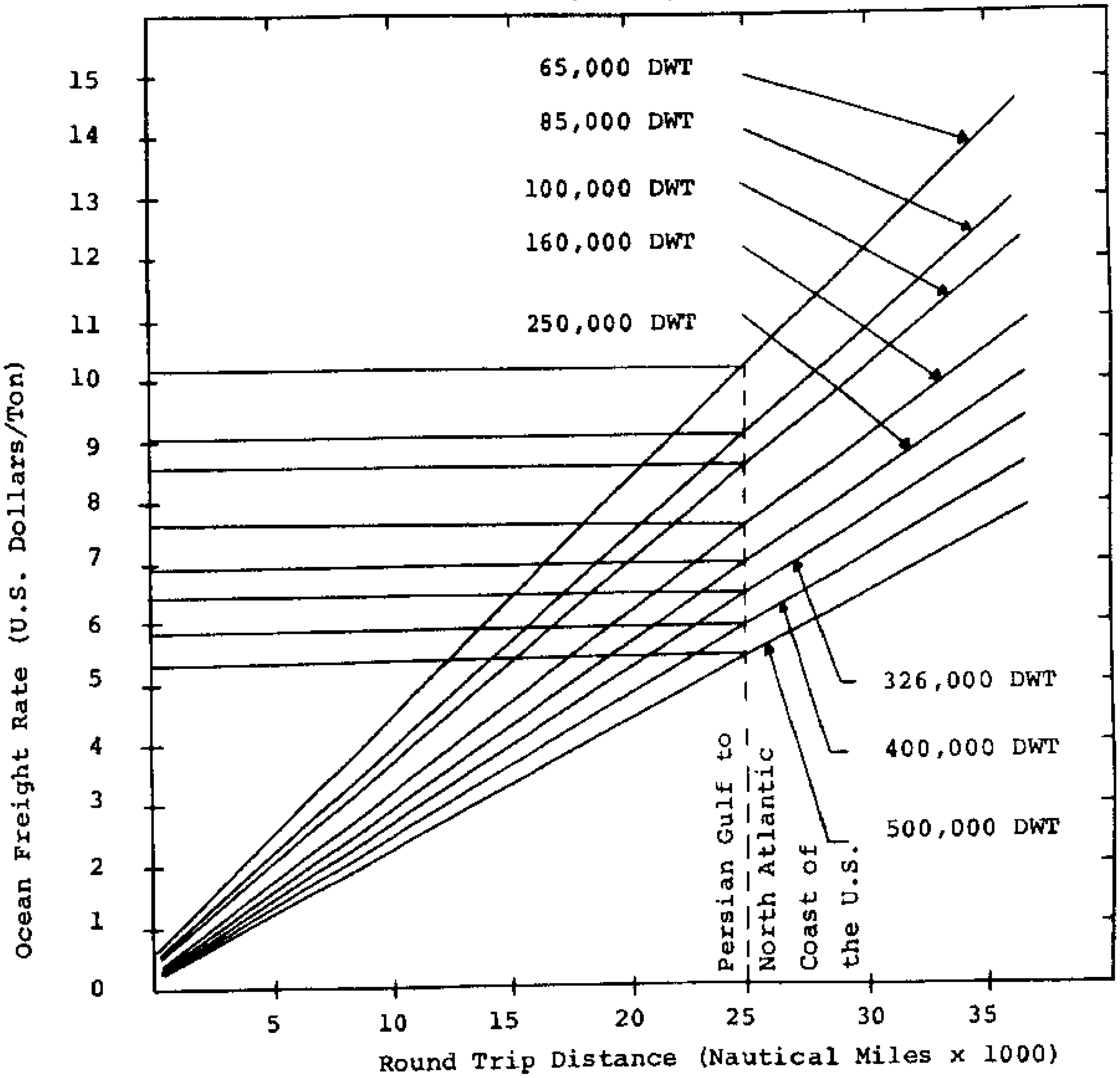
(Capacity in Thousands of DWT)

Port	Current	Planned	Potential
Amsterdam	90	150	150
Antwerp	80	125	125
Dunkirk	125	300	750
Le Havre	250	500	1,000
Rotterdam	250	300	350
Rotterdam (Botlek)	80	80	80

Source: Arthur D. Little, Inc.

Fig. II-2

Voyage Cost per Ton of Cargo
(Foreign Flag Tankers)



Source: Soros Associates, Inc.

Only 12 years ago, Japanese and European ports were still limited to 35,000-45,000 ton vessels. At that time the ports of the U.S. East and Gulf Coasts were the world leaders in bulk carriers then in service. Today the United States is virtually surrounded by nations with ports that can accept super-sized vessels. In those foreign ports where adequate natural harbor and channel depths are not available, transfer terminals have been constructed, often several miles offshore to attain the necessary deep water. In many countries dealing in the iron ore, coal, and crude oil trades, the guiding philosophy of such developments is that the port which expands the fastest will get the bulk cargo business of the future.

How should the U.S. respond to this trend? Is it really necessary for the world's largest industrial trading nation and consumer of energy to have the ability to receive supersized tankers and bulk carriers? What would be the major consequences for the U.S. if no deep-water facilities were provided to handle these ships?

Tons Up, Dollars Down

Since World War II a major segment of the U.S. industrial base has become increasingly dependent upon the oceanborne importation of raw materials. Almost 90 per cent of this tonnage presently consists of bulk cargoes, the majority passing through Atlantic and Gulf Coast ports.

The Texas Gulf Coast contains the greates concentration of oil refining and petrochemical processing industries is the world. The second largest concentration of refineries in the U.S. -- more than 90 per cent of the East Coast's capacity -- is located at the Delaware River estuary.

A recent study for the Corps of Engineers by Robert A. Nathan Associates predicts that U.S. seaborne imports of crude petroleum will increase from about 50 million tons in 1969 to nearly 300 million tons in 1980 and perhaps 1 billion tons annually by 2000. This oil will be delivered mostly to East and Gulf Coast ports from the Middle East and Africa. "Potential economic savings from the use of super-carriers" according to the Nathan report, "are of a scale that will effectively compel the use of such tankers for the ocean transport of crude petroleum imports, particularly from Far East, Middle East and African sources." Consequently, if deep-water port facilities are not available in the U.S., the oil companies can be expected to transship the oil from superport facilities in the Maritime Provinces of Canada of the Caribbean islands.

With the tremendous concentration of industrial activity along the East and Gulf Coasts massive volumes of oil will have to be moved there whether or not deepwater terminal facilities exist. Forced to depend on smaller tankers, the region will suffer significantly higher costs. By 1980, if these ports are still inaccessible to supertankers the industries they serve may become locked in the use of a needlessly inefficient transportation system. Inevitably, these industries will suffer serious competitive handicaps, with far-reaching economic consequences not only at the regional and national levels but also for individual consumers.

The U.S. consumes a great portion of the world's output of raw materials. Heavy industry locates where raw materials are least expensive. Therefore, it is essential to bring the transportation savings of supersized vessels to the bulk-producing-and-using industries of the East and Gulf Coasts. Denied these economies, the competitive disadvantages could be significant enough in the long run to drive the affected industries into seeking more favorable locations outside the U.S. The oil industry, for example, could decide to construct new refineries in Canada or other Western Hemisphere locations where superports are available. U.S. refinery operators claim they can phase out an operating plant over a five-year period without excessive losses. Thus, the functions of some of our existing petroleum ports could eventually be reduced to simply storing and distributing finished products.

Any significant change of this kind in the pattern of industrial activity in the U.S. could clearly have an adverse effect on the employment of many thousands of workers who contribute billions of dollars to the regional and national economies. In addition , relocation of industry outside the U.S. and the "multiplier" effects of the concomitant loss of U.S. markets, would undoubtedly cause massive outflows of U.S. capital -- exactly how much, we cannot calculate, but it appears safe to estimate that many billions of dollars would ultimately be involved.

These capital movements would be reflected in an adverse effect on this nation's U.S. balance of payments. Moreover, the increased importation of finished goods produced overseas by the relocated industries, in place of the importation of the cheaper bulk-shipped raw materials from which the goods are made, would further tilt the balance against the U.S.

In Deep

In their Maritime Administration study, Soros Associates considered 32 potential U.S. deepwater terminal sites and chose one outside Delaware Bay, 8.5 miles east of Cape Henlopen, Delaware. They concluded that this location would be economically competitive with other sites under consideration and would offer advantages in terms of environmental protection and minimal ship traffic congestion.

Soros' proposed Delaware superport project, known as N.A.D.O.T. (North Atlantic Deepwater Oil Terminal), would consist of three construction stages. Although the total cost was computed at more than $1.3 billion, Soros figured that annual savings in oil transport costs could exceed $750 million, resulting in an extremely favorable economic investment. The initial stage terminal would consist of an island of about 100 acres, protected from ocean waves by a dog-legged breakwater about 11,500 feet long. The terminal would contain two berths for tankers up to 350,000 tons and would service refineries in the New York-New Jersey area and along the Delaware River. It also would have a pipeline or six shallow-draft berths for 30,000-60,000 ton feeder vessels. At this initial stage the terminal would cost $499 million and would handle 100 million tons annually.

The next construction stage would double the terminal area, the ship facilities, and the oil-handling capacity, at a cost of $288 million. The final stage, priced at $531 million, would enlarge the island to 500 acres and lengthen the breakwater by 7,500 feet. In addition to 300 million tons of oil, the terminal would be able to handle dry-bulk commodities, such as iron ore and coal. It would consist of six deep-draft berths for supertankers, two deep-draft berths for dry-bulk carriers, and 13 shallow-draft berths for feeder operations (or alternatively a pipeline network).

The N.A.D.O.T. schedule calls for construction of the initial stage to start in 1974 and be completed in 1977. The next stage would begin in 1976 and finish in 1978. The final stage would start in 1978 and be completed in 1981.

The Maritime Administration feels that any delay in developing such deep-draft terminals will permit Canada and possibly the Bahamas to secure the necessary support from U.S. industry and markets to justify constructing a deepwater redistribution terminal. Such a project would probably be based on long-term contracts, and once established it would substantially preclude the development of a competitive U.S.-based facility. The Maritime Administration has warned: "That such a vital transportation terminal be owned and controlled by foreign interests and not subject to U.S. jurisdiction would be distinctly undesirable, particularly from a national security standpoint, and would have a deleterious impact upon our world trade posture."

So far we have considered the U.S. only as a transportation user, without regard to American ship construction and operation -- at one time a major element in the world maritime picture. In fact, in the Merchant Marine Act of 1970, Congress indicated the need for an American-flag, bulk-vessel fleet to protect our commercial and defense interests by ensuring that the U.S. has enough vessels to efficiently carry a significant percentage of our total bulk-commodity foreign commerce. A major part of President Nixon's new maritime program is the availability of federal subsidies to assist U.S. ship-owners in constructing and operating a modern fleet of competitive bulk vessels under U.S. colors. A major hindrance in the construction of supertankers in this country has been the lack of superport facilities.

Berth of a Supership

What, in practical detail, are the obstacles that prevent supersized vessels from calling at U.S. ports?

The most significant physical constraints preventing large, fully-laden tankers and bulk carriers from entering and berthing at U.S. North Atlantic ports are the depths and widths of entrance channels and harbors. Other major restrictions identified by the Maritime Administration are:

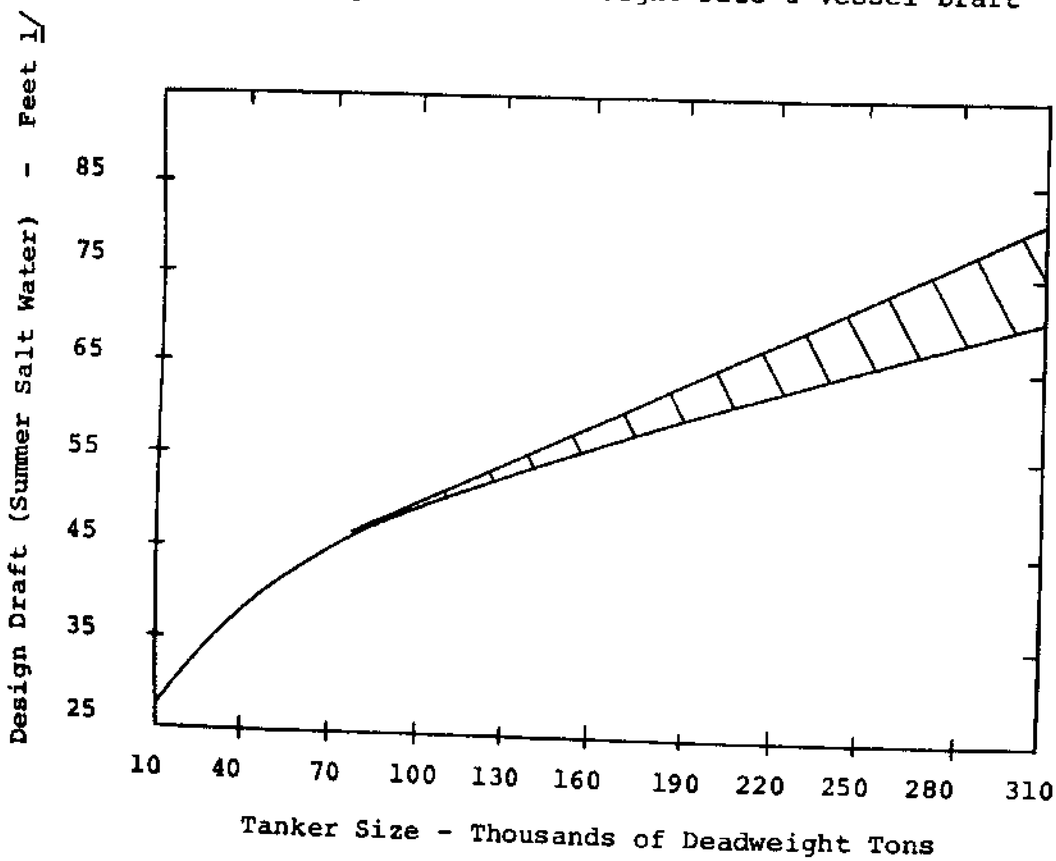
I. Grave risks of collisions or grounding in congested inner harbors.
II. Strong public concern about environmental damage resulting from oil spills.
III. Inadequacy of existing transfer and storage facilities for handling large bulk cargo carriers.
IV. Shortage and increasing cost of waterfront land for expanding terminal capacity.

U.S. port channels are grossly undersized for vessels with drafts greater than 45 feet (generally displacements of 80,000 dwt or over as shown in Figure II-3). The majority of U.S. ports, particularly those on the Atlantic and Gulf Coasts, are deep enough in their main ship channels and alongside their berthing facilities to accept vessels of only 35-to-40-foot drafts, or about 30,000-55,000 dwt. Relatively few can berth fully laden bulk vessels of 80,000 dwt. So the ships of the massive fleet expected to be in service by 1974 -- some 779 tankers and bulk carriers over 100,000 tons, requiring depths of at least 55 feet -- will be unable to arrive or depart fully loaded at any existing terminal along the entire southern and eastern sweep of the U.S. coast.

On the West Coast, the Port of Seattle can now fully load 250,000-ton bulk carriers with grain at its new 73-foot terminal, and the Port of Los Angeles can discharge tankers of up to 120,000 tons. The Port of Long Beach is deepening its main ship channel to 62 feet at mean low water; it will be the only U.S. port capable of unloading a 200,000-ton tanker at berth. Thus these three West Coast ports are the only ones in the U.S. that can handle vessels exceeding 100,000 dwt.

Fig. II-3

Relationship Between Deadweight Size & Vessel Draft



Note: 1) For safety purposes required channel depths must generally be 5 to 10 feet greater than the maximum draft of vessels using the channel.

2) Beyond 100,000 DWT data available indicates a range of possible drafts depending upon the design characteristics of the vessels involved.

Source: Corps of Engineers

In the last decade the volume of waterborne commerce moving through U.S. ports and the number of vessels used to transport it have increased. The growing density of traffic in these ports poses the constant risk of collisions and groundings, which for oil tankers and other chemical carriers bearing flammable, explosive, or toxic materials can result in loss of life and property and in pollution of valuable adjacent land and water areas. According to the U.S. Coast Guard there have been over 500 tanker collisions worldwide in the last 10 years; 80 per cent of the accidents occurred as the ships were entering or leaving ports. The Coast Guard also calculates that oil spills from tanker collisions average at least a million tons annually and cost about $40 million.

Superbreak

In the continued absence of federal regulations governing marine traffic control systems, the prospects for even greater human tragedies and pollution disasters become increasingly ominous. It is evident that continued dependence upon voluntary compliance with "rules of the road" and recommended traffic separation schemes will not be adequate to prevent future collisions and groundings. Some form of control and regulation of marine traffic patterns in U.S. ports and harbors is needed. Legislation has been passed that gives the Coast Guard broad authority in controlling the flow of marine traffic and requires radiotelephone communication between vessels in the navigable waters of the U.S.

One of the most important factors in connection with collisions and groundings is the "crash-stop" ability, which has decreased drastically as tanker size has increased. The energy absorbed in stopping a ship is directly proportional to displacement. In today's supervessels engine power has increased less than proportionally; it is chosen for steady, moderate, economical speed. A T-2 tanker of 16,000 tons can come to a stanstill from full speed within half a mile in five minutes, while 2 1/2 miles and 21 minutes go by before a 200,000 ton tanker dead-stops. It would be hazardous indeed to sail large tankers in port channels designed for the movement of World War II vessels.

In recent years, public awareness of water pollution has increased substantially, although initially it was focused on inland lakes and rivers. The 1967 grounding of the Torrey Canyon off southwest England and the resultant spill of about 18 million gallons of oil brought increased attention to pollution of the world's oceans and shores.

Many Americans are haunted by the thought of a large supertanker breaking in two off the U.S. coast. Most of them seem not to be worried by the ever-increasing volume of U.S. petroleum imports per se, but they view with alarm the fact that much of this petroleum could in the future be handled by supertankers. A 200,000-ton tanker is sometimes seen as more of a pollution threat than ten 200,000-ton tankers. Supertankers would probably be less subject to collision, mainly because they would be fewer in number, and less apt to go aground, since many would be loaded and unloaded at deep offshore terminals. Nevertheless, the potential for a catastrophic spill exists in any supertanker mishap.

Nowhere is this more evident than in proposals that deep-draft bulk carriers enter North Atlantic port channels. All major North Atlantic ports are surrounded by large concentrations of population. Because their harbors are quite limited in area oil spills are concentrated. Any pollution-causing accidents in such ports will have a great public impact.

Dredges and Drills

In dredging East and Gulf Coast ports for channel-deepening some major constraints would be encountered. To provide the 75 feet or more of water for ships of 250,000 tons and upward, dredging would have to go 30-40 feet below the present bottom of many ports. It is becoming apparent that the dredging of major ports to such depths is neither economically nor physically feasible. The 35-to-45-foot channels of many major ports may be deepened no more than about 10 feet primarily because of underlying rock, harbor and river tunnels, and a welter of environmental and ecological problems. Not only would a 10-foot increase cost about $500 million per port, but the channels would not be deep enough to accommodate the large bulk vessels of today and tomorrow. A Maritime Administration report has stated that an attempt to overcome these numerous obstacles to a major channel-deepening program would be like peeling an onion -- "each layer removed reveals another layer beneath it, resulting in many tears in between."

Environmental and ecological problems, for example, would be an inevitable consequence of the dredging process. Deepening the Port of Philadelphia's 40-foot channel to 50 feet would require the removal of such a volume of silt and rock that a critical problem would arise in finding accessible disposal areas within the Delaware River/Bay region. If the spoils were deposited alongside the channel, the normal currents of the river and the bay might be interrupted.

Ecologists are concerned that dumping spoils in confined oceanic areas may already be creating "dead seas" in those regions. The vast stretches of tidal marsh in the bay would appear to be ideal disposal areas; however they are essential breeding and feeding ground for fish and wildlife; once such areas are filled -- as many have been along the East Coast -- they are lost forever as sanctuaries, and the resultant damage to fish and wildlife is frequently extensive and irreversible. If the spoils are scattered over a much greater oceanic area, certain sea life in the affected region, such as oysters and other shellfish, could be seriously harmed.

Shellfish in Delaware and Chesapeake Bays, particularly oysters, might be affected by the existence of a deeper channel. The oyster drill, a type of marine snail that comes in from the sea to feed on valuable shellfish, is currently prevented from penetrating too far into the bay by the downstream flow of fresh water. A deeper channel would allow more extensive intrusion of salt water into Delaware and Chesapeake Bays and probably result in considerable drill damage to up-bay oyster beds. Channel deepening also could possibly alter shoaling patterns in the rivers and estuaries.

In fact, the increased salinity along with the deposit of the dredging spoils in the estuaries could dramatically change the entire ecology, seriously damaging the commercial seafood industry and the very substantial recreational activities of millions of East Coast residents. The dredging itself very likely would stir up and recirculate pollutants that have settled to the bottom.

The deeper channels would bring about an increase in the salt content of municipal and industrial water supplies. Perhaps more important would be the potential threat to the entire region's aquifers -- the underground fresh-water-bearing strata that pass under many of the river beds and bays of the East Coast. The potential danger if these channels are deepened substantially is by no means indonsequential.

What has experience in other countries revealed? In a report on "Foreign Deep Water Port Developments" to the Corps of Engineers, Arthur D. Little, Inc. found that "Historically, with the exception of the United Kingdom, concern over environmental management was not too apparent in the countries studied." However, the report continued, "increased awareness of the urban-industrial decay in major ports has brought to light the need for improved planning and increased communications between concerned organizations and individuals."

Opposed Regardless

While detailed studies of the above problem areas can be helpful in determining their magnitude, the fact is that they do constitute significant obstacles to adopting a major channel-deepening program. Consequently, superports in the U.S. will probably take the form of offshore terminals.

Although this would circumvent some of the obstacles, offshore terminals would raise a different set of problems. Construction would be more difficult, hency more costly. Operations, as well as construction, would be hampered by weather and wave action. An offshore terminal would require a system of feeder vessels or pipelines to transport cargo to and from shore. Establishing such a terminal would not require channel dredging, but this is not to say that all possible risk to the environment would be eliminated.

The construction activities associated with offshore terminals would affect the regions' ecologies, probably temporarily, depending upon the types of facilities being built. While the construction of floating platforms with submerged connections to shore-based facilities would have the least effect, construction of piers, causeways, and islands that have fixed connections or bases on the bottom would have greater and longer lasting influences on the ecology of the area.

Local navigation tracks for traffic, commercial fishing, and recreation would be altered. Effects of littoral drift and wave patterns would be influenced by the size, shape, and offshore distance of the facilities. While pollutants could be kept away from the shoreline, thus affording greater dilution and flushing, the problems of containment of oil spills could be greater. Fish populations would probably concentrate around the structures and therefore be more vulnerable to pollutants. The exposure of ships and ports to the weather and seas would be greater, thus increasing the probability of accidents, although an offshore facility located within a bay would be less prone to mishap than one in the open sea.

Offshore terminals could be made into multiple-use facilities including marinas, fishing fleet or aquiculture bases, recreation areas, or even locations for nuclear power plants. If so, the effects of possible pollutants are likely to become more complex.

At present, the most significant constraint (other than cost) to offshore port development is the public fear of oil spills and degradation of the quality of life. Oil spills represent a tangible, visible, direct hazard associated with port development that persons can readily understand and decry. Conservationist, recreational, and some political interests are deeply concerned with safeguarding coastal beaches, wetlands, and marine life. Tourism and recreation are primary industries in many states, and extensive investment in beach resort areas has made every coastal state extremely sensitive to environmental damage from oil spills.

Preserving and improving the quality of life has become an important part of the general environmental movement. In the case of port development, many individuals and organizations are concerned by the realization that a large offshore oil terminal will have secondary influences including the building of refineries. As Congressman Charles W. Sandman, Jr., of New Jersey stated at a public hearing held by the Corps of Engineers:

"Establishing an oil terminal in the lower Delaware Bay, in my opinion, whether there is spillage or there is not, is still objectionable and strenuously opposed by the half million people....I represent ....

"They are concerned with what is going to be brought in with this particular facility. It is only going to be a foot in the door. First an oil transmission line, then later a great big marine terminal for oil tankers, and then sometime after that there will be .... some oil refineries there. And I am confident that this part of the country does not want any oil refineries in that particular area....

"I do not think that this is the best possible use of the land involved."

Although the issues relating to quality of life are not as easily defined as those corresponding to oil spills, they are just as important, as shown by the coastal-zone law passed by the State of Delaware in June 1971. This unprecedented conservation legislation specifically bars from a defined coastal zone along Delaware's bay and ocean fronts not only heavy industry, such as refinery, petrochemical, steel, and paper plants, but also offshore bulk transfer terminals. Following a strong emotional controversy, Delaware elected to preserve these areas for tourist and recreational uses and compatible industries. As Governor Russell W. Peterson of Delaware put it, "As far as I'm concerned, even if Shell Oil can build a plant 100 per cent free of pollution, I'm still opposed."

Role Reversal

Andrew Gibson, former Assistant Secretary for Maritime Affairs within the U.S. Department of Commerce, has described this legislation as an example of "emotional hysteria." The immediate impact of the Delaware legislation was to thwart construction of a major new refinery complex and two proposed offshore deep-draft transfer facilities in Lower Delaware Bay, one for exporting coal and another for importing crude oil. (The offshore facility proposed by Soros Associates would be located outside of Delaware Bay beyond the three mile state territorial boundary.) In the light of what occurred in Delaware, other coastal states have passed or are considering similar legislation.

The role of the federal government in superport development is tied closely to problems of energy supply, land-use policies in coastal states, and protection against massive oil spills. History has shown the United States government exhibiting a definite lack of leadership in port development. This is not surprising in view of the fact that more than 24 federal agencies have missions connected with port planning. In addition, some agencies have functions quite the reverse of what one might expect. For example, the Secretary of the Army, through the Corps of Engineers, is responsible for seeing that port facilities are adequate for commercial traffic. It is the duty of the Secretary of Commerce, on the other hand, to allocate available ports and port facilities to meet the needs of our nation and our allies in time of war.

The outcome of this governmental morass is that the nation as a whole has suffered from waste and inefficiency in the construction and operation of port facilities. As a preview of what might soon be expected, a Maritime Administration-sponsored study estimates that by 1975 the U.S. will have a container facility capacity 250 per cent above the expected need (on the West Coast the capacity will exceed demand by 570 per cent).

A similar danger exists in the building of superport terminals to handle oil tankers and bulk carriers. From Texas, where one plan calls for an offshore tanker facility in the shape of the "Lone Star," to the northern part of Maine, some private parties would be happy to see a proliferation of superport facilities. However, government-sponsored studies have shown that the East and Gulf Coasts need only a small number of superport terminals for maximum benefit to the nation. Conservation interests, on the other hand may work against construction of any superports along the Gulf-Atlantic perimeter. Clearly, major emphasis must now be placed on devising acceptable plans that will balance environmental safeguards with economic needs and private goals with the commonweal. An eight-agency federal investigation, headed by the President's Council on Environmental Quality, is in fact underway seeking to outline the role of the private and public interest in superport development and to work out a plan of early action.

A New Order

The trade-offs between the two basic types of designs, the floating mooring buoy and the fixed artificial island, may be decided on the basis of ecological impact. The fixed island allows barriers to be placed around a berthed vessel to contain spills. At a single point mooring buoy, the ship would swing with the current and the wind making containment barriers impractical.

Favoring the mooring buoy, however, is research indicating that after oil is spilled it releases most of its toxic properties within 24 to 72 hours by evaporation and dissolution. If the oil does not reach the biologically productive shore areas for 72 hours major ecological damage is averted. One way to provide a three-day safety factor is simply to place a terminal very far offshore. Naturally, the prevailing winds are an important consideration here. The construction cost of a single-mooring buoy system (a single berth and storage facilities on shore) would be a fraction of the cost of a multi-berth fixed island terminal. Although there are significant unknowns in the economics of superport construction, there would be a point where a multi-mooring-buoy system would become more expensive than an island terminal of equal capacity. On the other hand, the cost of the fixed island system increases much more rapidly with water depth. If, therefore, environmental considerations force the siting of superport facilities very far offshore, the probability that a mooring-buoy system will be used will increase with distance and depth.

No matter which engineering design is used, significant resources must be allocated in the attempt to make the facility ecologically safe. In the $1.3 billion offshore island proposed by Soros Associates pollution control systems would represent about 10 per cent of the cost and would include containment booms placed around each berth, spillways on the island to control storage tank spillages, and a facility for treating oily waste (including ballast water). Advanced traffic control and collision avoidance systems would also be used to protect the ships and the environment.

Ray Brimble, president of the Texas Superport Study Corporation, has estimated that an offshore terminal would provide 300,000 to 500,000 new jobs during the first decade of operation. Although this estimate may be grossly exaggerated, the impact on the community involved would be sizeable in terms of population growth, industrial development, highway construction, traffic congestion, and pollution. The Gulf Coast with its highly industrialized coastal areas may be generally better able to absorb these impacts than the Atlantic Coast with its scenic beaches and tourism.

The overwhelming national interest argues for developing ways of constructing deepwater transfer facilities that are consistent with the integrity of the environment. Given the capabilities of present technology, there appears to be no reason why adequate superport facilities cannot be provided in such a way as to protect adjacent land and water areas from the dangers of pollution. All of this would require a new order of harmonious cooperative planning by federal, state and local government agencies as well as port authorities and private industrial interests. It is the only way to resolve the basic conflicts between economic and environmental needs and values.

CHAPTER III

THE EMERGING BATTLE BETWEEN CONTAINERSHIPS AND JUMBO JETS

Many persons may feel that competition does not really exist between containerships and modern wide-bodied aircraft. They might point to recent data collected by the Bureau of the Census for waterborne and airborne foreign commerce of the continental United States. This information shows that, even after bulk commodities are excluded, the airlines handled less than one-half of one percent of the tonnage in 1970. The 1,277 million pounds moved by air would not seem to pose a serious threat to the 288,932 million pounds moved by water. In addition, the speed and cost characteristics of all-cargo jumbo jets and containerships are so significantly different that each mode should be attracting a different type of cargo. The Bureau of Census data on value per pound of commodities moved would tend to verify that different types of cargoes are being carried by each mode. Commodities shipped by vessel in 1970 averaged 11 cents per pound for exports and 18 cents per pound for imports. For air, the figures were $7.48 per pound for exports and $5.87 per pound for imports.

DIVERSION OF CONTAINERSHIP CARGO TO AIRCRAFT

The author readily agrees that the majority of cargo normally carried by each mode, when labor strikes are not in process, is in little danger of being diverted to the other mode. However, there are many reasons why the author feels that fierce competition will exist in certain instances between containerships and jumbo jets. Consider the following three interrelated factors.

First, the rate of growth of air cargo will continue to greatly exceed the corresponding rate of growth for waterborne commerce. Where air cargo may grow in excess of 25 per cent per year on certain trade routes, waterborne tonnage may only increase by almost an order of magnitude less. Naturally, much of the new air cargo will be diverted from containerships. Although the average waterborne shipment is valued at less than 25 cents per pound while the average airborne is valued at more than $5.00 per pound, the large amount of containership cargo that lies in the "gray" area between these average values is vulnerable for diversion.

Second, the capacity of air cargo space is continually increasing not so much by the entry of all-cargo jets, but with the introduction of combination passenger/cargo wide-bodied aircraft, such as the Boeing 747, the DC-10, and (eventually) the L-1011. Although most of the publicity goes to the double-decked passenger quarters and piano lounges, each Boeing 747 has more than 6,000 cubic feet of space below the passenger compartments. Modern container systems make efficient use of the belly cargo space, a situation not possible with narrow-bodied conventional passenger jets. As passenger travel grows (and present plane overcapacity disappears), the number of jumbo jets will increase, bringing a corresponding growth in belly cargo capacity--whether or not there is a demand for additional cargo space.

Third, and possibly most important, cargo is not always priced to meet fully-allocated costs on combination aircraft. An airline may feel that, since its combination jumbo jets are really meant for passengers, any revenue it receives for freight which exceeds its incremental cargo-handling costs is a contribution to overhead and profit. This philosophy helped the industry to generate $335 million in revenue for domestic belly cargo in 1969. This pricing system is made possible with the approval of the Civil Aeronautics Board.

Frank M. Lewis, Chief, Cost Standards Section, Civil Aeronautics Board, recently described the Board's views on the pricing of belly cargo at the October 1971 meeting of the Transportation Research Forum. The two basic costing methodologies recommended by various airlines are by-product costing and joint product costing. By-product costing, also called revenue offset, simply assumes that belly cargo operating expenses are equal to belly cargo revenues. Actually, this method is not costing at all, but a device to eliminate a floor on cargo rates.

With joint product costing, belly cargo operations are assigned all variable costs directly related to the cargo service. In addition, a generally accepted and reasonable method is used to allocate a portion of all fixed costs to the belly cargo operation. In the Domestic Passenger Fare Investigation by the CAB's Bureau of Economics, domestic belly cargo operations were analyzed by a variety of joint product costing methods. In each instance, these belly cargo operations produced a loss ranging from $43.7 million to $265.8 million depending on the joint product costing criteria chosen.

The Civil Aeronautics Board issued tentative findings of various parts of the Domestic Passenger Fare Investigation in April 1971.[1] Although the majority opinion favored, in theory, the use of a joint product costing basis for belly cargo, the majority felt that, in practice, the by-product costing method offered the fairest solution in this particular case.

The majority stated:[2]

> ...ideally, each service on the combination aircraft should bear its fully allocated share of jointly incurred costs. However, where the demand for one of the

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1. Orders 71-4-59 and 71-4-60, Docket 21866-7, April 9, 1971.

2. Chairman Browne, Vice Chairman Gillilland and Member Timm concurring.

> jointly produced services is not sufficient to permit that service to recover full costs from the rates charged, then clearly the users of all the services benefit from the establishment of rates at the level which will produce the greatest total revenues, even though this may mean that some services bear a higher share of the joint costs than others....In our opinion and in the absence of any showing that cargo revenues do not more than cover all the added costs properly attributed to the cargo services, the fairest solution for purposes of the present case is to assume that cargo costs are equivalent to the revenues derived therefrom.

As long as the CAB maintains this attitude, the airlines should be able to divert high-value cargo from containerships with their combination jumbo jets. Although all-cargo jumbo jets will be the major challenge to containerships in the long run, it will be the combination aircraft that causes containership operators the most harm for the next several years. The airlines have all the tools necessary for this venture: CAB approval to price at less than fully allocated costs, overcapacity, and efficient freight container system for their combination wide-bodied aircraft.

EFFECT ON CONTAINERSHIP OPERATORS

Three factors in the maritime field will make containership operators particularly sensitive to air freight competition. First, the change from break-bulk general cargo operations to sophisticated container operations altered the industry from being labor-intensive to becoming capital-intensive. Once the huge initial investments are made in containerships, containers, and specialized freight terminals, the incremental costs involved with handling an additional container are relatively small. Therefore, a profitable containership line can greatly increase its profits with a relatively small increase in cargo volume. Conversely, if even a very small percentage of cargo is diverted to air freight, the percentage loss in profit should be large enough to concern the containership operators.

Second, the major containership trade routes are presently experiencing overtonnaging. Consequently, containership lines are operating at low profits or at losses in many cases. For several companies a diversion of a small amount of cargo to air freight may mean the difference between a marginal profit and an embarrassing loss.

Third, any air cargo diverted from containerships will be high value commodities. Of the foreign trade moving through the New York Port District in 1969, air cargo accounted for less than 1 per cent of the total tonnage, but more than 22 per cent of the dollar value. Since transportation rates are generally based on commodity value as well as cost of service, it is reasonable to assume that the commodities with the highest values also give the containership operators the highest profit. This situation will exacerbate the seriousness of the first two factors. Consequently, if the air freight industry can "skim the cream" from the containership operators, the maritime field could suffer disastrous losses. The analogy has been drawn between the truckers overtaking the railroad industry after World War II and the air cargo people presently challenging the containership operators. Mr. T. S. Roberts, port director in South Wales, recently predicted that deep-sea containerization would not last more than one of two decades, but would be overtaken by air freight. In order to analyze more closely the competition between jumbo jets and containerships, let us look at two emerging battlegrounds: the continental United States to Hawaii and the U.S. North Atlantic.

THE MAINLAND TO HAWAII

The mainland to Hawaii marine container trade used to be the sole domain of the Matson Navigation Company whose fleet includes the world's two largest U.S.-flag containerships. In the past few years both Seatrain and United States Lines have placed containerships on this trade route, increasing the amount of competition as well as the degree of overcapacity.

In order to look at the possibility of the diversion of containership cargo to air freight, let us roughly predict the amount of cargo capacity available in combination jumbo jets in 1975. Only the westbound traffic will be considered here because this is the high-volume direction. Approximately 70 per cent of containership cargo between the mainland and Hawaii moves westward and perhaps almost 80 per cent of the air freight travels in this direction.

The Department of Planning and Economic Development of the State of Hawaii has forecast that 2.35 million passengers will travel from the mainland to Hawaii in 1975.[3] Let us assume that by 1975 all the passenger planes on this route will be wide-bodied aircraft; assume that half will be Boeing 747's and the other half will be either DC-10's or L-1011's. If the trend to lounge areas and seating luxury continues, the average seating capacity for a plane on this route could be 280. If the planes fly with a 50 per cent passenger load factor, then 16,786 plane trips will be needed in 1975 to carry passengers westbound from the continental United States to Hawaii.

The record cargo load carried in a combination jumbo jet is probably 79,810 lbs of delicatessen meats. Continental Airlines carried this nearly 40-ton load in a Boeing 747 from the mainland to Hawaii during the recent West Coast dock strike. For our problem here, let us assume that the average cargo-carrying capacity of each of the wide-bodied passenger aircraft moving

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3. The Economy of Hawaii, 1969, Department of Planning and Economic Development, State of Hawaii, 1969.

westbound in 1975 is 14 short tons for normal cargo densities. Consequently, the total air freight capacity of passenger aircraft on this route in 1975 will be 235,004 short tons. According to shipping executives, the containership cargo moving westbound from the mainland to Hawaii should total about 1.5 million short tons in 1975. Table III-1 shows calculated air freight carryings of combination jumbo jets as a percentage of the containership market in 1975; a range of load factors has been assumed for the aircraft and a range of values has been assumed for the containership cargo market.

From the exhibit we can see that, if the passenger planes use 50 per cent of their belly cargo space, the containership operators will lose 7.8 per cent of their westbound market. Moreover, the same load factor would account for a much greater percentage of marine cargo in the eastbound direction. If the capacity of all-cargo jets were included in this analysis, the position of the containership operators would be worse. Although this exercise has been performed in only a cursory manner, it is evident that the airlines will have the opportunity to affect the containership operators significantly in the not too distant future. Note that, if the airlines carried 10 per cent of a possible 1.5-million-ton containership market or 150,000 tons in 1975, this would represent a 329 per cent increase in six years from the 1969 figure of 35,000 tons. However, the percentage increase in the six years prior to 1969 was 438 per cent, a remarkable rate of growth.

Table III-1

1975 Passenger Plane Air Freight Carryings as a Percentage of Containership Demand Westbound between the Mainland and Hawaii*

		Estimated Containership Demand (millions of short tons)				
		1.00	1.25	1.50	1.75	2.00
Estimated Air Freight	25%	5.9	4.7	3.9	3.3	2.9
Load Factor	50%	11.9	9.4	7.8	6.7	5.9
	75%	17.6	14.1	11.8	10.1	8.8
	100%	23.5	18.8	15.7	13.4	11.8

*For this exhibit to be accurate, one must assume that in 1975 all-cargo jets will carry an amount of tonnage equal to the existing air freight tonnage. In that way the belly cargo space of the wide-bodied passenger jets can be used for cargo diverted from containerships.

The air freight tonnage on this route has increased greatly in the past year due to the West Coast dock strike and selective lowering of air cargo rates. Continental Airlines filed a rate application commonly called the "15-cent-per-pound rate." General commodity shipments moving from Los Angeles to Honolulu in 10 or more Boeing 747 LD-3 containers could get the 15-cent-per-pound rate if they exceeded the minimum of 933 pounds per container. These containers would move on a space-available basis. Sears, probably the largest commercial shipper on this route, stated that they would divert 7 million pounds of cargo per year from containerships to combination aircraft if this rate were approved. Although a CAB examiner recommended rejection of the new rate proposal, the Board did not act on his recommendation within the allotted time limit. Consequently, the rate went into effect. The CAB later ordered the rate to be canceled, but it is interesting to note that there was little or no opposition by containership operators to these low rates.

THE NORTH ATLANTIC

While passenger jumbo jets on the mainland to Hawaii have managed to divert traffic from containerships, the last few years have seen containership operators actually steal cargo from the airlines on the North Atlantic. (Obviously, this time period occurred before the East Coast dock strike.) This cargo diversion calls for an explanation since containership and aircraft operators on the North Atlantic face generally the same cost structure as on the mainland to Hawaii route. In addition, overcapacity exists for both containership and aircraft operators on the North Atlantic just as it does between the mainland and Hawaii.

The author feels that containership rates on the North Atlantic are the key factor in explaining this apparent phenomenon. Extreme containership overtonnaging on the North Atlantic resulted in a severe rate war occurring over the last few years. Prices were generally described as "chaotic." Although the containership operators belong to steamship conferences which set rates and, theoretically, do not allow any form of rate cutting, these formal tariffs are largely ignored in times of severe competition. In contrast, federal agencies strictly enforce containership rate on the domestic route between the mainland and Hawaii. Consequently, since a containership operator cannot drive out an intramodal competitor by cutting rates on a domestic route, all the containership operators servicing Hawaii have raised their rates by 12.5 per cent to increase their profits on their individual shares of the market. These containership rate increases help diversion of traffic to the airlines.

On the North Atlantic where containership rates have dropped however, the volume of air cargo carried in 1970 decreased by 2.8 per cent from the preceding year, as shown by the International Air Transport Association data in Table III-2. This decrease is in marked contrast to the previous three years where the total air freight carried increased by 14.8, 31.0, and 38.5

Table III-2

North Atlantic Cargo Tonnage
(in metric tons)*

	1966	1967	1968	1969	1970
Passenger Aircraft	98,083	101,185	125,886	160,467	163,623
% Change from Preceding year	-	3.2%	24.4%	27.5%	2.0%
All-Cargo Aircraft	102,132	128,619	175,067	256,278	241,545
% Change from Preceding Year	-	25.9%	36.1%	46.4%	-5.7%
Total	200,215	229,804	300,953	416,745	405,168
% Change from Preceding Year	-	14.8%	31.0%	38.5%	-2.8%

*1 short ton (2000 lbs) = 0.9072 metric tons.

per cent. Although a downturn in the U.S. and world economies helped to cause the air freight decrease in 1970, the diversion of air cargo to containerships undoubtedly played a role.

While air freight tonnage was diminishing in 1970, the number of passengers on the North Atlantic increased by 20.1 per cent. This increase in passengers, along with the introduction of more Boeing 747's, explains why the cargo tonnage in combination aircraft increased by 2.0 per cent while the all-cargo jets carried 5.7 per cent less than in the previous year.

James R. McCaul, a consultant with Booz-Allen, formerly Associate Professor of Economics at Webb Institute of Naval Architecture, has predicted that air cargo will badly erode containership traffic on the North Atlantic. The accuracy of his prediction will depend primarily on two factors: the rates used by each mode and the origin-to-destination travel time for each transportation system. It is not obvious how rates will change on the North Atlantic in the next five years. Although there will be some relation between rates and costs, the specific relationship may be somewhat obscure in the short term.

The containership operators are attempting to establish a revenue-pooling system. Under this situation the market share of each operator is predetermined. Theoretically, this arrangement should end the rate cutting and produce stable containership rates again. However, some persons feel that a lack of cooperation or trust between the operators will cause this revenue-pooling system to break down. In any event, the containership operators are presently trying to make up some profits lost during the recent rate war; four ocean freight conferences operating eastbound from United States North Atlantic ports to Northwest Europe have announced emergency surcharges of 15 per cent on rates and charges.

The future of air cargo rates is also under question at the moment. Since all members of IATA must agree before a rate is established, the process of making new tariffs can be quite difficult. Consequently, it is not easy to predict rates further than the existing IATA agreements.

Besides looking at the rates of the competing modes, a potential shipper will want to know the transit time of his shipment from origin to destination. Therefore, although the plane may cross the Atlantic in several hours rather than the several days needed for the containership, the shipper should be interested in the total transit which also includes pick-up, delivery and waiting times in terminals. Note that, as the delays increase in the land portion of the trip, the advantage of air freight decreases. If the door-to-door time using air freight is only 1 day compared to 6 days for a containership, then the shipper can move his goods 6 times faster using the airlines. If delays on land add 4 more days to the transit time, the shipper is only moving his cargo twice as fast--5 days rather than 10--by utilizing air cargo. As air cargo tonnage increases, many air cargo terminals and airport roadways will be in danger of becoming bottlenecks and causing delays.

The containership operators will be faced with similar problems, although not as serious. When vessels carrying 1500 containers come into port, modern equipment and control techniques are needed to get the containers to the proper destination without excessive delays. Roadway access also causes bottlenecks in this procedure. Land-based delays frequently occur for shippers using containerships; however, in general, after several years of using containerships the marine operators probably have fewer terminal problems to face in the immediate future than the airline operators with wide-bodied aircraft recently placed in service.

CONCLUSIONS

Although it is impossible at this time to make definite predictions about the outcome of the battle between the airlines and the containership operators, some general forecasts can be offered with some degree of certainty. Diversion of cargo from containerships to wide-bodied aircraft should continue on domestic routes. The general high growth of air cargo combined with the excess capacity on jumbo jets and the below fully-allocated cost pricing should insure this diversion. When rates stabilize on international routes, it is safe to assume that some diversion will occur for somewhat the same reasons.

The efficiency of airline terminal operations and the occurrence of dock strikes will undoubtedly play an important role in the future. The degree of diversion will also depend in large part on actions by the containership operators. As they realize the danger posed by air freight, they should take certain precautions. Containership operators should become more selective in their rate increases. It makes little sense to raise the price on a high-value commodity if it will be lost to the airlines. In fact, since high-value commodities on containerships are normally priced well in excess of their fully-allocated costs, containership operators may wish to reduce certain rates to regain cargo lost to the airlines.

On domestic routes the containership operators should also begin protesting the CAB's determination to allow airlines to price air cargo at less than its fully-allocated costs. The containership operators could argue that the airlines are unjustly overpricing passengers on their wide-bodied aircraft in order to steal cargo from the containerships at unreasonably low prices.

The CAB's attitude toward incremental pricing on combination jumbo jets will naturally play a major role in diversion of cargo from containerships. In addition, as long as the CAB allows combination aircraft operators to price cargo at less than its fully-allocated cost, there is little incentive for an airline to operate an all-cargo jumbo jet. Having no benefit from passenger revenues, an all-cargo jumbo jet would naturally run at a loss if its cargo did not cover all of its costs.

On the international scene, Lufthansa is now operating an all-cargo Boeing 747 on the North Atlantic. Lufthansa's success or failure will greatly determine the future for further orders of all-cargo jumbo jets. Although definite aspects of the future are very difficult to predict, it should be safe to forecast that the emerging battle between the containerships and the wide-bodied aircraft will produce the most exciting transportation encounter of the next decade.

CHAPTER IV

THE MARINE INSURANCE INDUSTRY[1]

Background

This chapter has two purposes: (1) to present data on the marine insurance industry as a whole, and (2) to examine particular aspects which have a special effect on the U.S. merchant marine.

Very few vessel operators can afford to sustain any conceivable loss that might occur to their property; consequently, with the exception of a few major oil companies, marine insurance is a necessary part of the cost structure of the merchant marine. The problem of liability (protection and indemnity), the desire to avoid the cost and problems of handling claims internally, and the requirement of the shipper of goods to insure himself against the loss of or damage to goods in transit, all constitute portions of the marine insurance market.

The assured wants to know that the premium he pays for his insurance is based on rational practices, and that competition creates an effective ceiling on the rate that he pays. Consequently, this chapter will analyze this situation within the examination of the present market structure and practices of the marine insurance market.

The ability of the insurance industry to respond quickly to technical changes in the merchant marine is very important, since a long period of adjustment will hinder the innovator. Since the U.S. merchant marine depends in large part on becoming more capital-intensive in order to survive, it is critically affected by any hindrance on the part of the marine industry.

Marine Insurance Survey

In order to examine the marine industry, we used data obtained in a survey made by Alan Kirman. He sent questionnaires to the thirty stock companies and five mutual companies with the largest net ocean marine premiums in 1969. The objective of the survey was twofold:

1) to interpret the global $400 million net written premium in ocean marine in 1969; what portion of this underwriting is really "ocean" marine in the sense that it relates to U.S. seagoing commerce, and what portion falls to river trade, small pleasure craft, or other non-high sea categories;

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[1]This chapter is based on the study, A Report on the Marine Insurance Industry, by Alan P. Kirman, U.S. Department of Commerce, 1970.

2) to segregate this true "ocean" portion of marine writing according to its chief components: cargo, hull, and Protection and Indemnity (P and I).

As a result of the survey and follow-up work by Kirman, it was discovered that most of the reported ocean marine premiums are written on risks unrelated to merchant shipping. In the case of hull insurance, the American Hull Insurance Syndicate (A.H.I.S.) had net premiums of $40 million in 1969. Non-A.H.I.S. writings consisted of $10 million. In the case of protection and indemnity (P&I) insurance, net premiums were $30 million. Cargo insurance premiums were comprised of $93 million in U.S. foreign trade cargo and $23 million in U.S. intercoastal and foreign cross-voyage cargo. The total of all the above writings is $196 million, less than one-half of the $407 million net ocean marine premium in 1969 as reported in the Insurance Advocate. The remaining premium consisted of a variety of other risks including yachts, air cargo, inland waterway business, warehouse risks, oil drilling rigs and pipelines, ferries and fishing vessels, and tugs and barges. Although traditionally categorized as "ocean" marine business, most of these risks do not involve the merchant fleet.

Table IV-1 shows the profit and loss data which could be generated from the responses to the survey. Note that to the loss ratio shown in the table, one must add 25% for underwriting overhead. Consequently, a loss ratio of 75% or more signifies:

Table IV-1

Class of Business	Loss ratio = $\frac{\text{claims paid or pending}}{\text{net premium}} \times 100$
Hulls*	67.7%
Cargo:	
Export	86.5%
Import	58.7%
Other (inter-coastal, cross voyage	43.0%
P & I	89.0%

*This figure should be treated with reserve as it represents a much more favorable result than the average over 10 years. This reflects the large swings in hull underwriting experience.

an unprofitable operation. Hull, import cargo, and "other" cargo are the only categories showing a profit. "Other" cargo, meaning intercoastal and cross voyage underwriting, is the most profitable and accounts for 20% of total ocean cargo premiums.

One large P & I company in the survey separated its loss experience by flag of registry; the loss ratio for U.S. flag ships was 87%, higher than the 69% for foreign flag vessels. Another company had a hull loss ratio of 110% in 1969. Subsequently, it left the A.H.I.S. and is now writing its own hull business.

In conclusion, the data developed from the survey enables one to segment the ocean marine market into various categories of business, some more profitable than others. Due to the lack of any active trade association in ocean marine underwriting, the reluctance of companies to release any figures for competitive reasons, and the lack of sophistication in record keeping, the gathering of such market statistics is a complex process. The participation in this survey (76% of writings) and the general evidence produced is without real precedent, and it would be highly desirable if such a survey could be conducted on an annual basis. The government should be able to take an active role, if not the major role, in collecting such statistics which would be of great value both to the U.S. merchant marine and to the insurance industry.

The World Market

The London market has traditionally dominated the marine insurance in the world and continues to do so. While a marine insurance market exists in the U.S. and markets have sprung up in Germany, Japan, Switzerland and Scandanavia in recent years, the volume of business (converted to millions of dollars) transacted in London (broken down in the figures below into Lloyds and "outside" London market) exceeds all other markets combined.

	1966	1967	1968
Lloyds	401.2	482.4	583.2
"Outside" London Market	316.4	379.2	458.4
Total London Market	717.6	861.6	1041.6

The growth of U.S. and U.K. markets is shown in Figures IV-1 and IV-2. In most years the London market growth rate has been higher, though more erratic. However, Figures IV-3 and IV-4 show that both from a percentage and absolute point of view, the dependence of the U.S. market on London, through reinsurance, has declined. Consequently, while the U.S. has been growing more slowly than London in absolute direct premium value, it has become more independent than in the past.

Table IV-2 shows that the U.S., Lloyds, and the remaining London market have all seen a series of unprofitable years. However, it should be remembered that earnings from investment of premiums are not included, and this makes a substantial difference.

It is estimated that the net U.S. outflow of insurance business to the London market, after losses and expenses were paid, was $14.5 million in 1968 and $25 million in 1969. These earnings were on reinsurance, hull, cargo, and the special forms of insurance that the U.S. market has been unwilling to underwrite on a large scale such as war risk and builder's risk.

Fig. IV-1

Ocean Marine Market

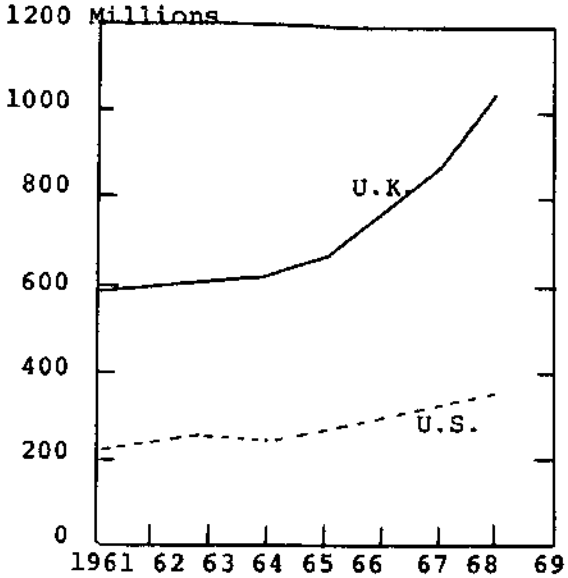
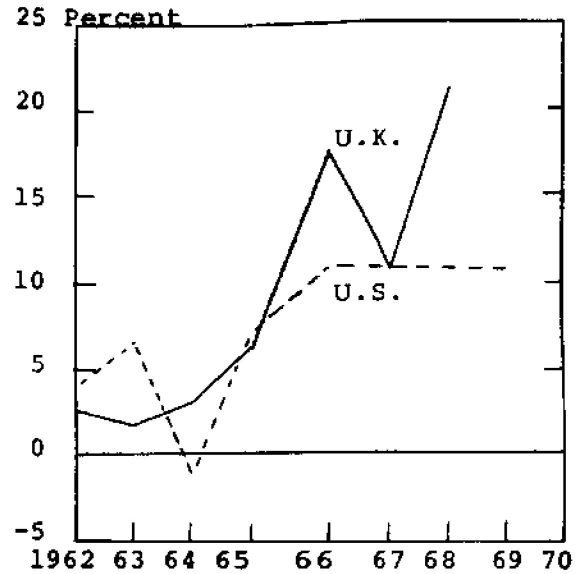


Fig. IV-2

Growth in Net Premiums



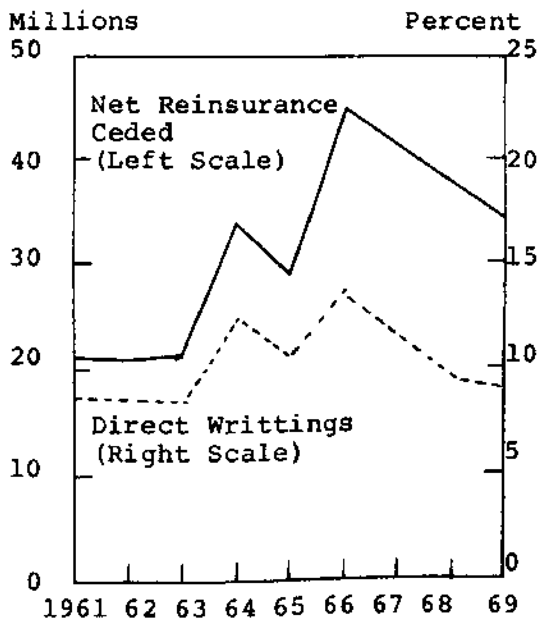


Fig. IV-3

U.S. Reinsurance

Source: Insurance Advocate

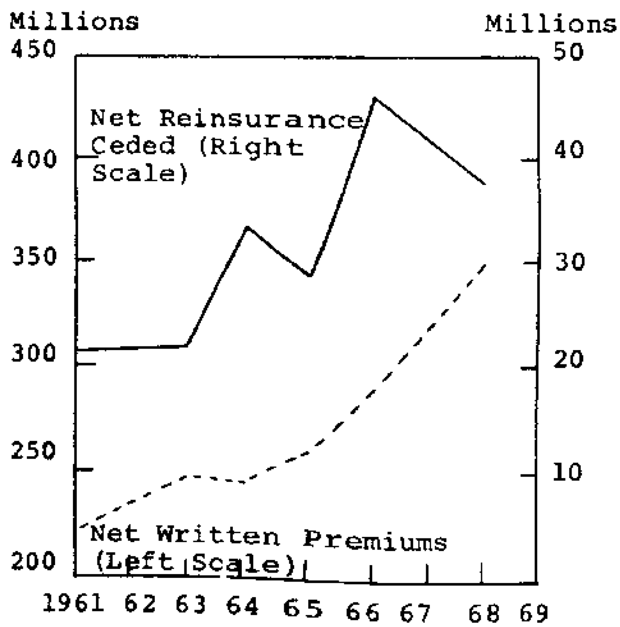


Fig. IV-4

U.S. Ocean Marine Market

Table IV-2

COMBINED LOSS AND EXPENSE RATIO

Year/Market	U.S.	Lloyd's	Outside London Market
1961	98.1	90.3	90.5
1962	92.6	90.9	100.0
1963	97.4	96.3	100.0
1964	106.5	104.8	105.0
1965	112.8	113.7	106.0
1966	109.4	.....	.....
1967	102.4	.....	.....
1968	99.7	.....	.....

Although the U.S. market has maintained a substantial share and the net outflow of business has declined in recent years, the U.S. merchant marine will continue to depend on the London insurance market in the future. Consequently, the U.S. Government should be well informed as to developments of the London market, and in a position to influence or at least anticipate, any decision which would have a direct effect on the U.S. fleet.

The American Market

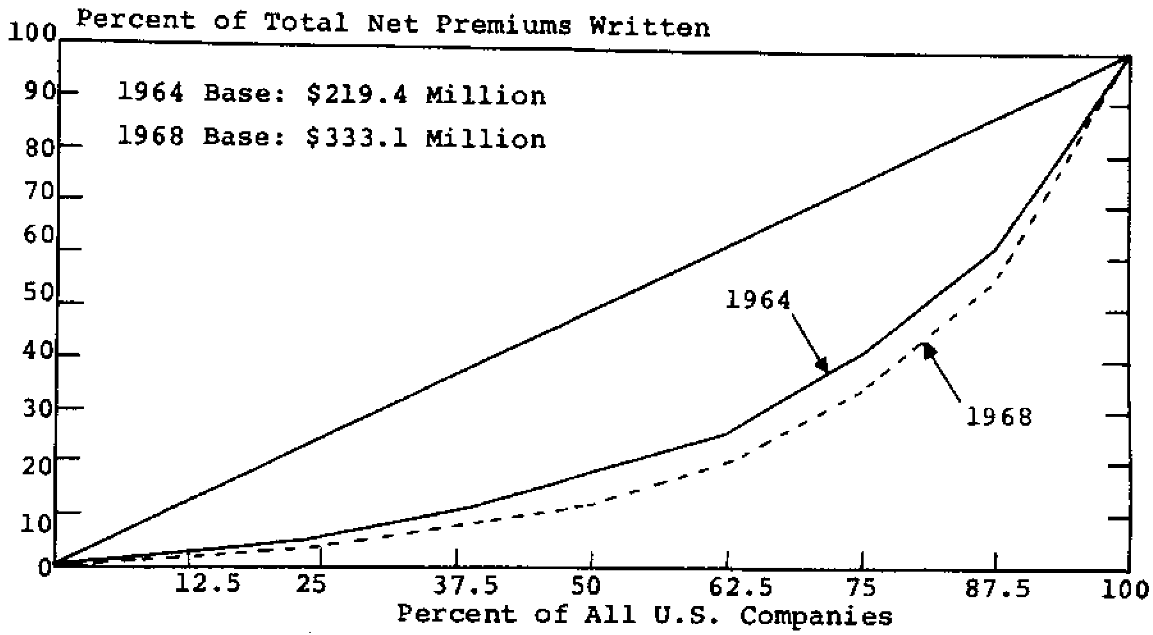
Information on the organization and size distribution of marine insurance companies provides some guide to the degree of monopoly present in the industry. We are in reality considering a market composed of small segments of very large companies, since ocean market premiums accounted for only 1.5% of the total property and liability insurance market in 1968.

Lorenze curves are presented in Figure IV-5 to show some measure of concentration and the amount of change in the period from 1964 to 1968. Each curve is constructed by ranking companies in terms of percentage of total business and then plotting their share of business against their percentage of the total number of firms. The further the curved line from the original, the greater the degree of concentration. Although the Lorenze curves have been subject to criticism as estimates of the degree of monopoly, they will serve our purposes as a crude measuring device.

Figure IV-5 shows that not only does significant concentration exist in this industry, but also that the concentration is increasing. Since the industry has a natural tendency to concentrate, the government should play an active role in watching out for the possibility of exploitation. Therefore, it is

Fig. IV-5

U.S. Concentration



Source: Best's Aggregates & Averages

recommended that a representative from the Maritime Administration continue to attend, as was past practice, the various meetings of the A.H.I.S.

Hull Insurance

The classification "hull insurance," as generally employed, encompasses considerably more than the normal marine policy for hull and machinery. Also included under this heading are builder's risk and war risk insurance, for example. The figures quoted when segregating premiums into the three major categories therefore reflect this more comprehensive category.

London dominates the marine hull and machinery insurance market although the American market has provided a countervailing power in recent years. In order to analyze the hull and machinery insurance carried by American ship owners, a sample of the 254 vessels comprising the subsidized fleet was used. We recommend that government data of premiums paid by each vessel be computerized on a continuing basis because this information would undoubtedly be valuable in analyzing trends and the impact of rate changes.

Table IV-3 outlines the hull insurance requirements prescribed by the Maritime Administration for all vessels in which it has an interest. Although it might seem that the requirement which places 75% of the insurance in the American market would bias any statistical exercise, we feel that additional factors exist which greatly offset this potential bias. In the first place, most owners carry more insurance than the amount required by the government. Consequently, the amount required to be placed in U.S. markets is closer to 50% than the stipulated 75%. Secondly, if the owner can show that it would be clearly advantageous for him to place more insurance in a foreign market, an exemption is usually granted.

Table IV-3

MARITIME ADMINISTRATION REQUIREMENTS FOR HULL INSURANCE

Type of Vessel	Approved Insured Value	Sources of Valuation	Requirements
Subsidized Operators' Vessels	Maximum of: 1) Commercial Market Value 2) 110% of mortgage balance 3) Net book value	Off. of Ship Construction Div. of Accounts Div. of External Audits & Financial Analysis	75% in American Market
Bareboat Charter	Commercial Market Value	Off. of Ship Construction	
Use Agreement (Exchange Program)	Maximum of: 1) Value of vessel at trade-in 2) Commerical Market Value	Ship Valuation Committee Off. of Ship Construction	

At present, however, hull insurance on American flag vessels is generally placed in one of the following four markets:

1) The American Hull Insurance Syndicate
2) The "outside" American market
3) Lloyds
4) The "outside" London market

No distinction between Lloyds and the "outside" London market was possible in the sample of subsidized vessels. Consequently, Table IV-4 combines both these categcries in the "London" market.

In 1964 the A.H.I.S. quoted above the London rates in every case. However, in 1969 the U.S. rates were lower in 40% of the policies. Apparently this change in rates accounts for the decrease in the London market share from 31.7% to 28.0% as shown in Table IV-4.

Table IV-4

HULL INSURANCE PLACEMENT FOR 254 SUBSIDIZED VESSELS
(in per cent)

Year	A.H.I.S.	"Outside" American Market	Total American	London
1965-66	55.0	13.3	68.3	31.7
1966-67	56.4	11.7	68.1	31.9
1967-68	54.6	12.6	67.2	32.8
1968-69	56.5	12.9	69.4	30.6
1969-70	57.5	14.5	72.0	28.0
Total 5-year period	56.0	13.0	69.0	31.0

The American Hull Insurance Syndicate

Formed in 1920, the syndicate is comprised of 51 member companies who underwrite risks jointly at premiums established by the underwriting committees and agreed to by the rates committee. Since the syndicate acts in concert and does not permit its members to bid independently in business considered by the syndicate as a whole, it would normally be considered to be in violation of antitrust legislation. However, it was argued that the only practical way to generate an effective competitor to the London market was to establish a joint venture. Consequently, Section 29 of the Merchant Marine Act, 1920 (46 U.S.C. 885) states that nothing in the "anti-trust laws" shall be construed as declaring illegal any association of marine insurance companies formed:

> "To transact a marine insurance and reinsurance business in the United States and in foreign countries and to reinsure or otherwise apportion among its membership the risk undertaken by such association or any of the component members."

The A.H.I.S. has collected data on losses for a substantial sample of vessels of varying ages and types. It spreads total losses over the fleet and large partial losses over the type of ship where the size of the sample is sufficiently large. Although this method does not break down losses by cause, it is a considerably more sophisticated approach than most, and does represent a segmentation of premiums. The statistics of the A.H.I.S. point out that some old vessels have extremely poor loss records. However, these ships are generally not the war-built vessels in liner operation. The failure of the London market to make this distinction has resulted in relatively high rates in London for war-built liners.

There is little evidence that the A.H.I.S. has used its dominance of the U.S. market to the detriment of the U.S. merchant marine. Indeed, the syndicate has moved to a more rational approach to underwriting. Nevertheless, since a monopoly practice exists, the government should have access to the rates and rate setting practices of such a body.

Conclusion

Hull insurance is probably less of a problem in the U.S. than many other aspects of marine insurance. Moreover, it seems in this country, at least, to be moving toward a more rational basis. The American fleet is still vulnerable to decisions in London, however, and there, paradoxically, rate setting is more arbitrary than in other branches of the marine insurance business. Consequently, the government should be closely in touch with developments and should encourage innovations which might decrease dependence on foreign markets.

Cargo Underwriting

Cargo underwriting is perhaps the area of marine insurance farthest removed in present practices from those outlined earlier. Rates are quoted on the basis of individual accounts, and reflect the experience of a particular shipper, but not of a specific carrier. In general, a shipper purchases an open cargo policy under which his shipments are insured at rates specified in the policy. These rates take into account the trade routes, type of merchandise, volume of shipments, principal carriers, and the previous loss experience of the assured. Were these numerous factors used to build up a premium in a "scientific" manner, there would be little room for complaint. However, it is readily acknowledged that at the present, ocean cargo insurance rates are "judgment rates".

Under this system a shipper may face a rate which is not rational, and know that he will only be able to influence that rate ex post. Therefore, his incentive to move to more modern modes of shipment such as containers, will be decreased by the knowledge that several years of good experience will be necessary before his rates are reduced, even though there might be substantial evidence that containers have helped other shippers. Hence, the lack of information readily available to shippers and underwriters results in a decrease in the willingness of shippers to use new capital equipment of carriers, and reduces the latter's incentive to use such equipment.

The insured bill of lading, issued by the carrier or his underwriter, presents an alternative approach to normal cargo underwriting. Under this method, which is currently being employed on a number of non-conference routes, the shipper is charged freight and insurance together. It is argued that he will obtain more favorable rates, as possible subrogation by the shipper's underwriter against the carrier is now ruled out. For the insured bill of lading method to gain wider acceptance, the cooperation of carriers, underwriters, and shippers is required. The government has the opportunity to act as a catalyst in this instance to help evaluate the merits of this system.

Cargo Insurance on U.S. Ocean-borne Foreign Trade

In an effort to obtain some information on where cargo insurance is placed, three large banks were asked to keep records on their terms of sales by export and import of their letters of credit over a brief period. They were asked to establish specifically what portion of exports were sold CIF (insured in the U.S.) as opposed to FOB, FAS, and C&F (insured by purchaser abroad). The results from all three banks were within a few percentage points of each other with the following weighted averages:

	Per Cent Insured in U.S.	Per Cent Insured Abroad
Exports	30%	70%
Imports	91%	9%

By applying these percentages to the dollar value of ocean-borne exports and imports, it is shown that approximately 66% of total ocean trade (by value) is insured here.

In terms of total cargo premium written, the percentage is somewhat lower, since the premium per $100 value on U.S. exports (predominantly manufactured goods) is higher than the premium on imports (raw materials or "bulk" items). Using census data on commodities and world trading areas, and average premiums quoted by a large New York broker, these total premium figures were developed:

	$ Value of Ocean Trade (1969)	Total Cargo Premium Generated
Export	$20.8 billion	$96.5 million
Import	21.6 billion	78.6 million

By simple calculation the total cargo premium written in the U.S. is approximately 57%, a number much higher than many persons thought.

It is particularly significant that the placement of insurance varies substantially with the direction of trade, and this should be borne in mind when considering the solution to any particular cargo problem. Thus a problem primarily concerning U.S. imports could be handled directly by negotiation with the U.S. market, whereas such negotiation would be of little value in treating an export question. This means that in the present situation, of course, any general cargo insurance question relating to the U.S. merchant marine can only be handled by consultation with U.S. and foreign markets, particularly London.

Container Insurance: "Class" Underwriting vs. Account Underwriting

To the extent that the emphasis on accounts promotes both loss-awareness and fairness, the avoidance of putting everyone in the same class is justified. However, the introduction of containers has challenged the rigid account philosophy of most underwriters and the following points merit particular consideration.

Containerization is technologically a new mode of transport; hence, it should be viewed quite independently of break-bulk shipping. Just as an underwriter considers the experience with air freight to be distinct from that with ocean freight, experience with containers should be segregated from that of break-bulk. This should first be done for comparative purposes and then simply as different means of carriage, assuming that the comparison indicates substantially different risks.

Given this technological difference and the supposed "safer" carriage, a shipper who switches to containers (or is a new account) should not have to accumulate three to five years good experience to lower his break-bulk rate. It would seem fair to him and desirable for the underwriter from a marketing (sales) point of view to have a container premium quoted ex ante.

The whole container/break-bulk controversy has brought to light the inability of ocean marine underwriters to document statistically a new mode of transportation with new records of loss causes, loss ratios, etc. There is no incompatibility between the necessity of accounts, explained above, and the desirability to recognize new "classes of carriage" when they appear.

A great concern of underwriters has been the container losses due to hijacking. The following container hijackings were reported for the port of New York alone:

Year	1967	1968	1969	1970 (1st quarter)
Container thefts	25	41	50	17

Source: Insurance Advocate, July 1970.

Shippers are concerned with containers in the hope of lowering their insurance premiums. However, shippers on the whole are far more interested in insurance from the point of view of loss prevention rather than premium payment. A few large shippers such as Westinghouse, G.E., and Dupont have obtained premium reductions on 10-25% of cargo stowed in containers. This decrease shows, in part, the bargaining power of larger firms, particularly if they keep insurance records by mode of transport.

It is important to realize the significance of the 10-25% reduction. Substantial evidence shows that containers resulted in drastic reductions in losses in many cases. However, if losses are halved, this does not mean premiums should be halved. A simple example will illustrate this point. Consider an average cargo rate of 30¢ per $100 of cargo value. Assume this premium was calculated as follows:

1/3 = 10¢ for fortuitous, uncontrollable losses (sinking, stranding, etc.)

1/3 = 10¢ for costs

1/3 = 10¢ for preventable losses

A movement in containers rather than break-bulk obviously does not affect the first cost. Assuming that underwriting costs are also unaffected by a switch to containers, that leaves the 10¢ allocated to losses that are controllable. This is the premium segment which improved experience can reduce. If the total premium is lowered by 20% or 6¢, due to an improved loss record this effectively reflects a 60% reduction in preventable claims:

$$20\% \text{ of } 30¢ = 6¢$$

$$\frac{6¢ \text{ overall reduction}}{10¢ \text{ preventable portion}} = 60\% \text{ cut in preventable claims}$$

Although the controversy concerning container cargo insurance is several years old, no meaningful comparitive loss ratios have been developed by underwriters. Several large carriers, however, have released information. Sea-Land shows the following "with average" (heavy weather, general, average, loading and unloading loss) loss rate for 1962-1967:

$$\text{Rate} = \frac{\text{Total Losses } \$2,051,000}{\text{Total Values } \$10,710,000,000}$$

$$= 1.92¢ \text{ per } \$100 \text{ of value of cargo}$$

Sea-Land definitely feels that this loss rate is far superior to anything they could expect carrying break-bulk cargo.

Matson Navigation Company, which handles both container and break-bulk, developed a different ratio to compare these two modes:

Comparative Cargo Loss Experiences

Ratio of Break-Bulk Cargo Losses to Container Losses
(Based on Claims Paid and Incurred to Gross Revenues)

MATSON NAVIGATION COMPANY

Year	Ratio
1964	1.94
1965	2.77
1966	3.17
1967	2.83
1968	3.44

Even though it is evident that containers can decrease losses versus break-bulk, nearly all underwriters express the following two points:

1) Ocean marine cargo insurance is handled by accounts--always has been, always will be;

2) He wishes he knew what the container experience really was, but loss ratio information is "not available".

The first point, and the tradition embodied in it, explains in large part the unavailability of statistics on containers. Data-gathering for containers implies class rating to which underwriters object. What is needed, however, is not class rating, but comparative statistics for rational rate setting ex ante and loss prevention by mode of transport for individual accounts. This is not class rating, but underwriting that is equitable and rational. Several companies have recognized this fact and have begun to segregate container experience.

The Overage Vessel Problem

It has been standard practice to consider cargo carried in old vessels as a greater risk than that carried in vessels of more recent vintage. Recently London proposed the introduction of a surcharge on cargo carried in vessels built more than 25 years ago. This was vigorously opposed by the U.S. merchant marine as the majority of U.S. merchant vessels are of this vintage. As a result of representatives' visit to London, agreement was reached to increase the age limit to 30 years, but there is no guarantee as to how long this will be kept in effect.

The United States has argued that the U.S. fleet operates under more stringent requirements than many other fleets, and its experience, as a result, has been better. However, there was no recognition of this claim on the part of the underwriters. Here again the problem of failing to segregate data appeared.

To establish whether or not the U.S. fleet was being unfairly charged with these losses, several major steamship lines were requested to break down their cargo P & I losses by vessel, and these were ranked. A check was then made to see if there was any correlation between the rank by age and rank by loss experience. An alternative approach was to see if the percentage of losses generated by old vessels was greater than their percentage of the total tonnage of a fleet. The data for this survey is not yet complete, but a preliminary examination of three fleets showed absolutely no correlation between cargo losses and age. When the sample is complete, this might conceivably change, but at the moment, the evidence is strong that there is no relationship between age and losses.

Conclusion

We have been unable to find substantial evidence to signify that any conscious effort has been made by any segment of the marine insurance industry to discriminate against the U.S. merchant marine in whole or in part. Without exception the problems in the marine insurance business have arisen as a result of the failure of the industry to adapt some of its long-standing practices to meet the changing needs of shippers and owners. It would be foolish to assert that the industry has not considered these problems at all, nor tried to do anything about them, but their efforts have been limited and sporadic. It is perhaps paradoxical that an industry which has existed for so long on a basis of almost incredible trust in its dealings with its clients, and which has developed an enviable reputation for its integrity and dependability, should now find itself being charged with discrimination by various groups. Yet the means to resolve this problem would seem to be available, and rest on the acquisition of information and the ability to adapt underwriting methods to make use of it.

The government can play a major part in achieving these goals, but it will require a considerable change in the role that the Maritime Administration has previously played in marine insurance. In the past the government has limited itself to enforcing certain requirements of various programs, the preparation of insurance to meet the needs of a national emergency, and to some administration of insurance on behalf of MSTS. Occasionally particular problems have arisen and these have been dealt with in a somewhat ad hoc fashion at various levels within the Maritime Administration.

In assuming a more active role, the government should immediately start in the area of cargo insurance. The importance of this area has been emphasized by the overage vessel problem and the container controversy. Both these areas are of primary concern to the U.S. merchant marine. The government should be equipped to collect statistics on the various aspects of cargo insurance to assist in the implementation of new developments such as the insured bill of lading, and to undertake a factual analysis of any significant problems in these areas.

In other areas of marine insurance, the government should play an equally active role, in collecting data, disseminating information and acting as a promoter of new ideas.

There is little doubt that both the American marine insurance industry and the American merchant marine would benefit from a cooperative and constructive relationship between the government and the insurance industry.

CHAPTER V

CLASSIFICATION OF SHIPS

Purpose of Classification

People do not always understand the reasons for marine classification societies because there is really nothing similar to them in other industries. From the start of maritime commerce, it has been in the interest of the shipowner or the shipper of goods, then later the marine underwriter to assure the soundness and seaworthiness of ships. Since the forces to which the ship is subjected by the sea are not wholly understood, the only criterion by which a ship can be appraised reliably is by comparison with similar ships known to have been successful in service.

We are constantly learning more about the nature and magnitude of the forces of the sea. This new knowledge is being gained through research, both analytically and by instrumentation of ships in service. In addition, continual review has made the rules of the classification societies more precise in comparing one ship with another and in comparing individual components on the basis of recognized engineering principles.

By applying the experience gained in ships and theory of structures, standards for the construction of ships and their machinery have evolved which are acceptable to all parties interested in ships. These standards are referred to as the rules of the classification societies. It should be noted that the standards have changed greatly and continually over the years as experienced was gained with new types of ships, new materials, and different services.

Each time a ship is built to the requirements set down by the rules of a classification society, under the survey of the society's surveyors, the hull material and other components are tested to specifications given in the rules. When all tests and trials prove satisfactory, the society grants "classification" to the ship by formal action of its committee in accepting the recommendation and reports of the surveyors. This fact is then published in the society's register book, so that anyone may see that the ship in question conforms to recognized standards of sound construction.

The classification of the ship helps all parties associated with maritime shipping. It helps the owner, in the event of a casualty, to establish that he has used "due diligence" required of him; it informs the shipper that he is not taking a disproportionate risk by sending his goods aboard that specific vessel; and it helps the underwriter decide the nature of the risk involved when he is asked to insure the ship, especially if it is a new type or an unusual vessel.

Although the relation of each classification society to its government varies, they are generally independent, a fact which makes their services particularly valuable. In addition, the societies are non-profit in nature and are supported by fees charged to the owners or to the builders of a new ship for their services. The major societies have offices throughout the world and representatives are available at almost any port. Consequently, many governments have authorized classification societies to carry out on their behalf the technical survey and certification required by the various international conventions with respect to ships under their registry. This delegation of duties shows the recognition given to the competence and integrity of the societies.

In addition to being involved in the construction of ships, the rules also provide for periodic surveys of vessels in service to ascertain that they are being maintained "in class". Not only does this procedure tend to insure proper maintainance of the ships, but also it furnishes valuable information on the adequacy of the rule requirements and points out areas in which revision of the rules should be considered. In such circumstances the staff prepares studies to support a change shown to be needed, and then submits them to the cognizant committee of the society for its approval. In this way, the process of evolution of the rules is accomplished.

History of Classification

The classification of wooden ships concerned itself with periodic maintainance surveys rather than compliance with rules for new construction since the quality and probable life of these small sailing ships depended more on the kind of wood, the type of fastenings, and the standard of workmanship than on the scantlings. In 1835 Lloyd's Register issued the first wood rules based on a tonnage numeral. Since most British sailing ships were similar and relatively short (about 100 ft.), these rules worked out satisfactorily.

When shipbuilders begin to construct ships of iron, each designer had to determine the iron equivalent of the wooden scantlings. Consequently, iron ships, designed and built without the benefit of classification or other rules, varied considerably structurally. While most ships had transverse framing, some had longitudinal or diagonal frames. In addition, a few ships had no framing at all, which was practical only because these vessels were small, with rounded midship sections and heavy shell plating.

In 1832, Lloyd's Register classed the first iron ship. In 1855 it published the first rules for building iron ships. These rules were of a simple form and patterned after those for wood. Tabulated scantlings were in 1/16", by tonnage, for ships of 6, 9, and 12 year grades. Ships meeting the requirements of these rules were assign the character of A. Satisfactory periodic surveys were necessary to retain this character rating.

Because of the lack of experience with iron ships, the new rules were based to some extent on experience with wooden ships. Lloyd's stated that these rules would be revised when adequate information on hull corrosion and on other factors became available. This approach has been characteristic of the development of classification society rules. In this way classification societies claim a responsible balance between the acceptance of innovations, based on technological progress, and a need to insure the safety and reliability of ships' structures through the aid of service experience.

When Lloyd's Register rules were amended in 1863, the designation of class by years was abolished and symbols were substituted to designate probable durability and to indicate length of time between special surveys. In 1870 Lloyd's Register issued new rules for iron ships with the scantlings based on numerals determined by dimensions. New classification symbols were introduced, the familar 100A1, 90A1, and 80A1, were preceded by a Maltese Cross (✠) where ships were built under the supervision of the surveyors. Two years later, the first iron rules of the American Ship Master's Association were published. This organization was renamed the American Bureau of Shipping in 1898.

It was remarked that "these rules are based upon the belief that properly constructed iron vessels of good materials, of sufficient strength, by the use of cement inside, and with necessary attention to the outside coating, accidents excepted, will last, in good condition, for a period of 20 years." The scantlings of keel plates and the diameter of rudder stocks were based on depth of hold, the shell plating on the sum of the half-breadth and depth, and the keelsons and stringers of the various decks on ship's length. The longitudinal scantlings were augmented when the length-to-depth ratio exceeded 12.

Lloyd's Register 1885 Rules for Iron and Steel Vessels allowed a general reduction of 20% for steel ships; i.e., 1/16" for iron scantlings became 1/20" for steel. The advent of the British Corporation Register of Shipping in 1890, when steel ship building was well advanced, signaled the birth of a new spirit in classification work. Starting with a clean slate, unhampered by practices in administrative methods dating back to the wooden ship era, the whole classification structure was thoroughly investigated and simplified. The principle was established that, provided a ship met the required strength standard for her maximum draft, she was fit to be classed and to be retained in class as long as her hull and machinery were maintained in good condition. Only one class was specified in association with a service or draft limitation where necessary. The first issue of Rules for Steel Ships, published in 1893, displayed a more specific approach to ship structural problems than had been evident in the past. The table scantlings were graded in 1/40" instead of 1/20" and the rules were applicable to ships whose length-to-depth ratio did not exceed 14. A formula was given for the diameter of rudder stocks. Detailed structural plans were required to be submitted. The past practice of leaving plan approval to the surveyors in the field was discontinued; instead plan approval was centralized in the head office.

The American Bureau of Shipping gave steel ships first priority in the published rules of 1900. The old tonnage numeral was dropped as a basis for certain scantlings and scantling numerals similar to Lloyds appeared for the first time in the ABS Rules. In 1909 the Lloyd's Register rules were completely revised and very much improved in all respects. Lloyd's Register went one step further than the British Corporation by specifying gradations of 1/200". While table scantlings were still determined by dimension numerals, the latter were very much simplified. Rules were laid down for two basic types, full-scantling ships and ships with complete super structures. Interpolation was used to determine scantlings for ships with intermediate drafts.

Seven years later, the British Corporation Rules were revised completely, making extensive use of simple formulas to arrive at the scantlings of many component parts. Following the precedent set by Lloyd's Register 1909 Rules, scantlings were tabulated in increments of 1/200". The design maximum draft entered directly as a factor in assessing scantlings, and the specifying of minimum deck areas was a novel feature. Although the rules were not as simple to apply as former rules, they were much more flexible. These rules had the decided advantage of enabling designers to gauge readily the effect of variations in draft, frame spacing, etc. After some modifications to suit United States Practice, these rules were adopted by the American Bureau of Shipping in 1916 and also by the Registro Italiano Navale and the Japanese Marine Corporatior

Classification society rules are promulgated only after consideration and approval by technical committees, thoroughly representative of shipbuilding and allied maritime industries. This procedure insures practicability and suitability for up to date standards. Classification societies have continued to grow in influence and importance because of their usefulness to the shipping fraternity. While there are numerous classificatio societies in existence today, the following may be considered leading societies:

American Bureau of Shipping

Bureau Veritas

Det Norske Veritas

Germanischer Lloyd

Lloyds Register of Shipping

Nippon Kaiji Kyokai

Registro Italiano

Russian Registrar of Shipping

The societies have held conferences from time to time in order to discuss problems of common interest, especially the application of the Loan Line Convention, which the societies largely administor as assigning authorities authorized by various governments. A number of working parties have been constituted for the purpose of establishing closer agreement in respect to certain requirements.

Classification societies are concerned with many more aspects of ships structures than we have space to describe here. The reader is referred to the American Bureau of Shipping Rules for Building and Classing Steel Vessels, for more detailed information.

Load Line Assignment

Because load line assignment has been a key element in ship design analyzed by classification societies for more than 100 years, we feel it worthwhile to describe some of the relevant background. Legal requirements for freeboard first came into being because of the concern about vessels being loaded too deeply for the safety of the vessel and the crew. From time immemorial prudent men embarking on voyages at sea always provided some freeboard, based on their experience. However, just how much this should be was not clear, nor were there, at first, any statutory rules to follow. While economic pressures dictated that the ship should be loaded as full as possible, only concern of the owner and the master for the safety of both vessel and crew limited the drafts to which vessels were loaded. After a series of losses which many felt could be attributed to overloading and as a result of the public pressures that followed, the marking of the vessel to show the deepest loading permitted was made mandatory.

History in the U.S.

The early rules of the American Rules of the American Bureau of Shipping contained recommendations for maximum loadings for various types of ocean-going ships which varied from 1 1/2" to 3 3/4" per foot of depth of hold from 8' to 30' respectively.

Before World War I, there were comparatively few American flag ships in foreign trade and in the absence of compulsory load lines in the U.S. these ships were assigned freeboards to comply with the regulations of the particular country to which they traded. In 1917 the United States Shipping Board required that ocean-going vessels built to its account be assigned load lines by the American Bureau of Shipping in accordance with 1906 British Board of Trade Regulations. At approximately the same time a committee on bulkheads and freeboards was appointed by the U.S. Department of Commerce to study the load line problem. In 1919, its report included a recommendation for reduced freeboards for tankers and proposed a system of zoning and seasonal allowances which substantially was adopted at the 1930 International Load Line Convention.

In 1928 the Department of Commerce appointed another load line committee in anticipation of the 1930 International Conference. This committee made an extensive investigation of American loading practice based on records of actual voyages. While its recommendations for ordinary cargo vessels agreed closely with British practice, reduced freeboards for tankers were recommended on the basis of the successful experience obtained on American tankers which, in the absence of any U.S. regulations, had operated at appreciably reduced freeboards compared with the British rules. In addition, special concessions were recommended also for special type vessels, such as ore carriers, colliers, and for ships carrying lumber.

In March 1929, a law was passed requiring compulsory load line markings on ocean-going ships over 250 gross tons engaged in foreign voyages, to become effective September 2, 1930, with the American Bureau of Shipping being specified as an assigning authority. In May 1930 the International Load Line Convention was convened in London and after lengthy deliberations unanimous agreement was reached; the final protocol was signed on July 5, 1930. The United States ratified the Convention on February 27, 1931 and the Convention became effective January 1, 1933.

Evolution of Present Load Line Requirements

The 1930 Load Line Convention applied to cargo ships up to 750' long and to tankers up to 600' long. Freeboards for longer ships, which began to build in the late 1940's were arrived at by projecting the tables in the convention. Unfortunately, the resulting freeboards were considered unnecessarily large and questions were raised which led to the consideration of a new load line convention. One effect of this projection was to make it more economical to keep the depth of a tanker to a minimum, usually that which has been established by the classification requirements, since otherwise the large freeboard and corresponding draft made it impossible to fill a tanker with cargo of the usual density. As a result of this condition, pressure was exerted on the classification societies to permit ratios of length-to-depth greater than 14.

In 1966 a load line conference was held under the auspices of IMCO. The basic document for this conference was a new draft prepared by the U.S. Government and circulated in 1964. Other governments made many comments and suggestions for changes to this draft, including some rather drastic departures from previous practice. As finally agreed, the 1966 Load Line Convention contains no strength standard, since the various assigning authorities were not in agreement as to a proper standard. It had become generally recognized that longitudinal strength was almost independent of draft, whereas, in the 1930 convention, draft had been a direct factor in determining strength. The 1966 Load Line Convention placed even more emphasis upon the conditions of assignment, going as far as to assess penalties of freeboard for ships with wood hatch covers. The evaluation of super structures was greatly simplified and made more rational. For smaller ships with length of less than 300', the freeboards were changed very little from the 1930 tables, since it was generally agreed that these were necessary for adequate stability. It was universally felt, however, that freeboards for larger ships could be safely reduced. Consequently, the final freeboard table for large ships, particularly for the tanker and similar types, showed greatly reduced freeboards at the upper limit of length. In order to obtain this decreased freeboard, however, a requirement was added that the vessel must meet certain standards of subdivision and stability in damaged condition. It is generally felt that the subdivision requirement will result in safer ships despite the reduced freeboards.

In the future ship design will be influenced in the direction of meeting subdivision standards, providing steel covers on hatches, and otherwise giving more attention to security of openings. Although the application of new regulations of existing ships will present problems of interpretation and acceptance of equivalence, the requirements of the 1966 Load Line Convention should offer no problems to the designer of a new ship. A little - noted provision of the 1966 convention allows certain unmanned barges to obtain greatly reduced freeboards; this may further stimulate the use of tug and barge operation in place of self-propelled ships in some services.

The very large tankers introduced after 1965 are designed without reference to depth of harbors, since they are intended to load and unload offshore. Because depth is no longer a limitation, freeboard becomes of secondary importance. Thus, it is possible to utilize a small length-to-depth ratio, leading to a high moment of inertia of the midship section, and to obtain the necessary section modulus with deck and bottom plating of moderate thickness. This reverses the earlier trend found in tankers of the 600-700 ft. length group under the 1930 Convention.

Length-To-Depth Ratios

As mentioned earlier, the ratio of length-to-depth (L/D) of the relatively small ships of iron and steel of a century ago was quite small and therefore, required no upper limit. However, as lengths increased, the application of mandatory freeboards resulted in wasted space, unless the depth was kept as low as permissible. For ocean-going ships the length-to-depth ratio had traditionally been held to a maximum of around 14. Later this ratio was extended to 15 or more in anticipation of the smaller freeboards of the 1966 Load Line Convention.

Smaller ships in limited, short, coastwise services such as interisland and the Gulf of Mexico have been allowed greater ratios of length-to-depth with 16 being the general ratio in the United States. Some of the barges in this trade are so large, and the experience of the smaller barges has been so successful, that certain of them have been approved for more extensive services even with higher ratios. This is particularly true of the coastwise trade on the Pacific Coast on the U.S., where one class of railroad car barges having longitudinal strength much above the minimum has operated to Alaska with an L/D ratio of 20.

The L/D ratio is a rough measure of the stiffness of the vessel. Consequently, for a given set of scantlings, a deeper hull will provide greater longitudinal strength. It is known from experience that the extremely shallow hulls of river barges will not survive large ocean waves. However, concern for the need for stiffness has been examined critically in the light of the long, successful operation of Great Lakes bulk carriers having L/D ratios of 18 and over, up to an extreme of 21. These ships exhibit visible deflections, but suffer no apparent damage. While the difference has always been justified on the basis of shorter waves on the great lakes, this too is being carefully studied.

The Short Life Ship

While early classification rules based scantling requirements on explicitly stated ship's life expectancy, this practice has long been superceded, although there has been a tacit assumption of a 20 year life. Some owners have speculated on the possibility of constructing ships to relaxed standards for a shorter life. The contention was that most classification rules included a margin of material to allow for wastage over the expected life. Consequently, if a ship were intended for a shorter period, the scantlings might properly be reduced in proportion. Although there was much discussion of this "short life ship", it was soon recognized, taking a realistic view, that there would be great pressure to continue to operate such ships in a time of high freight rates. Therefore, in effect the reduced requirements would become the rule. In view of the continual striving which already exists to save weight wherever possible, it was generally agreed that the owner's interests would not be served by further reducing the minimum set by classification rules by introducing the short life ship.

New Design Concepts

Past experience will not be sufficient to cope with the new advances being made in ship design. Consider for example, the following new advances: nuclear energy as a power source, with its attendant hazards; liquids at extremely low temperatures as bulk cargo; completely novel structures for use in drilling for oil and gas in deep water; and submersible vehicles capable of descending to the greatest depths of the ocean. The lack of experience is not likely to deter the pioneers in these new fields; however, they will seek some standards and be glad to refer to whatever previous experience bears any relation to their problems.

Naturally, the classification societies cannot grant classification in the usual manner when new concepts are presented. Instead of evolving requirements for satisfactory service wholly on previous experience with similar ships, the societies must participate in the development of the new concepts. When the industry is prepared to adopt standards for these new concepts, the mechanism of the technical committees of the societies is brought into place to formulate them. Note that 11 of the 14 LNG (liquefied natural gas) vessels built so far have been constructed to ABS classification rules. Also, since ABS published Rules for Building and Classing Offshore Mobile Drilling Units in 1968, 26 such units have been built complying with these standards.

The classification societies also use a combination of developing new concepts and applying experience when new developments take a conventional type of ship design far beyond the size with which present experience has been accumulated. Typical examples are those of the ocean-going tankers, Great Lakes bulk areas, and Sea-Land's giant new containerships.

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PART 9

A REVIEW OF MERCHANT MARINE SUBSIDIES WITH AN ANALYSIS OF PLANNING SUBSIDIZED LINER REPLACEMENT

by

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INTRODUCTION

This report studies merchant marine subsidies from the viewpoint of both the government and the private steamship company. Chapter I deals with objectives and methods of government action related to aiding its national merchant marine. This section describes direct and indirect subsidies of various countries, their economic effects, and their general effectiveness in meeting their desired goals.

Chapter II analyzes the problem of planning ship replacement in the subsidized liner fleet. Particular emphasis is placed on the effects of unitization both on the corporate planning process and on the government regulations. Recommendations are made to improve the decision-making process in subsidized ship replacement by making changes in managerial procedures and in government regulation. It is hoped that studying the roles of both government and private parties in the merchant marine subsidy program will give the reader a better overall understanding of this topic.

CHAPTER I

SUBSIDIES AND GOVERNMENT AID TO SHIPPING

Background

Since early in the history of the world's commercial shipping, the economic, political and military importance of the merchant marine was recognized and supported by direct or indirect government involvement. The Italian city states such as Venice, as well as Spanish, Portuguese, English and French monarchies, sponsored commercial shipping by indirect subsidies in the 15th to 18th century. The German Hansa States, as well as the Dutch and various Baltic countries, enacted laws for direct subsidy support of merchant shipping in the 16th to 18th century. In many of these states government influence on commercial shipping effected its capability which in turn influenced the states political viability, public affluence, and military sufficiency. The importance of maintaining a healthy, profitable merchant marine to a nation was recognized in addition by the assumption of the risks involved in commercial shipping using insurance or other risk liability by the public and/or the state.

Various imperial or colonial nations used the merchant marine as an indirect arm of the military for conquest and resupply and many merchant ships were armed in time of peace or war to assure defensive capability and potential coverage for landings on hostile shores.

During the period of the 15th to 20th century practically every world seafaring nation used its merchant marine as an adjunct to its naval forces. Throughout history, privately owned ships have often been confiscated or conscripted in support of military actions, and were then used as a direct component of the nation's military.

In the history of the United States from Colonial days, the War of Independence, the Civil War, World War I to World War II, to the Korean and the Vietnamese Wars, the U.S. Merchant Marine or private commercial shipping has been called upon to render service in the public or national interest, in times of peace and war.

In addition, it has been found throughout history that a sufficient merchant marine under effective control of a nation or state adds considerable power and influence to its economic participation and competitive position in trade or commerce. The volume of exchange and cost of goods as well as the control of markets, prices, and trade, as such, is largely a function of the size viability and effectiveness of the commercial shipping under the effective control of a nation.

As a result of the above and other considerations, governments have attempted to encourage and support development of effective merchant marines throughout history. The most recent and currently active law applying to all Federal involvement and support of the U.S. Merchant Marine is embodied in the "Merchant Marine Act of 1970 and 1936", as amended through Congress. These Acts and amendments are furthermore supported by the "Shipping Act of 1916" and other related Acts. All these acts are based in essence on the declaration of policy of Title I: Section 101, in which stated:

> "It is necessary for the national defense and development of its foreign and domestic commerce that the United States shall have a merchant marine (a) sufficient to carry its domestic waterborne commerce and a substantial portion of the waterborne export and import foreign commerce of the United States and to provide shipping service on all routes essential for maintaining the flow of such domestic and waterborne commerce at all times, (b) capable of serving as a naval and military auxiliary in time of war or national emergency, (c) owned and operated under the United States flag by citizens of the United States insofar as may be practicable, and (d) composed of the best equipped, safest, and most suitable types of vessels, constructed in the United States and manned with a trained and efficient citizen personnel. It is hereby declared to be the policy of the United States to foster the development and encourage the maintenance of such a merchant marine."

Similar laws have been enacted by many seafaring nations.

It is the purpose of this section to review the method, effectiveness and potential of the various direct and indirect subsidy programs in effect. Particular attention will be devoted to the effect of direct and indirect Government aid on the development of the maritime industry and its ability to efficiently serve its function of providing economic transportation.

Recent years have brought a distinctly new trend in transportation. Integrated transportation demands that shipping be more responsive to the requirements of inland or coastal feeders. As a result of these developments and the changing patterns in the world trade, the distribution and requirements of trade routes is vastly different today and will continue to change. Unless the merchant marine is equipped with the means for effective response to the demands of change, its participation in international trade is bound to continue to be very limited and to be without economic, political and military influence.

Payment of any subsidy or aid designed to be effective in maintaining initiative, free enterprise, and growth, must be based, at least in part, on productivity or work performed as contrasted to cost differentials under the present system. The recipient is then motivated to greater production at reduced costs in his self interest of higher profits and increased returns on his capital investments.

Performance or the capability to produce, is an obvious measure of public interest. Our whole economic philosophy is based on the premise that enterprise is motivated by a potential for increased earnings. Earnings again depend on productivity or the combination of production and costs. Productivity again can be related to profit or a measure of return on capital necessarily employed and invested. In the past, the public benefit was expressed in terms of relative production performed, such as per cent of total weight or measurement tons of cargo carried by national flag ships in foreign commerce. These measures do not really represent proper criteria or achievement as there is little relationship between values in tons of one commodity or another. In addition their measures certainly do not permit a comparison of transportation capability. The potential transportation capacity is an obvious measure of public interest but applies more to a reserve fleet, as it does not necessarily attain a proper balance in terms of emergency requirements, employment, balance of payment, and economic effect on foreign trade freight rates.

In theory, subsidy payments should be based on each operator's profit. However, this method would create horrendous problems in bookkeeping, auditing and control. Another method is to base payment of subsidy on revenue dollars generated by the operation. This method is based on the premise that the freight tariff is structured to take into account all of the many vicissitudes of the particular trade for which it is written, including cargo mix, distance, voyage, and vessel costs, direction of flow biases, and so on. It responds to the pressures of supply and demand and ultimately reflects them even though it may lead or lag them. As a common denominator it dismisses many of the inequities contained in other performance standards because it is based upon a rate structure which already reflects traffic differences.

Such a system, if a single rate of payment can be used, permits maximum business flexibility. It also provides for private choice as to allocation of resources, area of operation, type of equipment and service, frequency and scope of sailings, and kinds of cargo sought.

If we assume freight rates reflect average costs, modified of course by supply and demand, then the revenue dollar will contain a built-in factor for escalation due to rising prices. On this assumption, the subsidy factor can be a constant.

Payment on this basis gives full consideration to business chance. It provides an incentive for a recipient to produce, and/or to lower unit costs because he is paid only for performance. He is not guaranteed a specific amount if there is a temporary period of short cargo availability. He must either reduce his operating capability (lay-up ships) or fight harder for full utilization if he is to make ends meet. This is a normal risk of private enterprise where booms and recessions must be coped with as they come.

It is relatively simple in administration, is subject to rapid audit for both control and calculation purposes, and permits a good degree of accuracy with equal treatment for all. Unfortunately, no system is perfect, and this one has its faults. In the cases where there is no positive correlation between revenue and profit, the basic objective of the system is not achieved. In addition, the allocation of subsidy payments would have to allow for certain unusual circumstances in order to be equitable. For example, if a disaster, such as a drought, severely reduced the revenue on a particular trade route, the subsidized line on that trade route might have financial difficulty. The revenue-based subsidy would exacerbate the firm's problems just when the line needed help the most. In conclusion, a revenue-based system would certainly need safeguards to assure that neither undue losses or undue gains were made by the operators.

A. General Rationale for Subsidization of International Shipping

It is generally assumed that a major nation largely involved in trade needs an ocean shipping capability to meet emergency requirements and provide ocean transport capability for a meaningful portion of its foreign trade. Within these broad objectives, the public interest requires that they be achieved as expeditiously and economically as possible. Furthermore, the premise should be assumed that the powers of the free trade system, including its inherent risks and rewards, innovations and propensity for growth, are the best vehicles for the implementation of these broad objectives. As a result, any system designed to aid an industry such as Shipping and Shipbuilding must be structured to employ the best attributes providing measures which effectuate incentive, growth, innovation, judgment, and effectiveness.

The cost parity or cost differential make-up system employed in some subsidy laws attempts much of this. Basically, we may summarize the purposes of an industrial aid or subsidy system as a method by which governments attempt to achieve certain goals without interference into the basic premises of free shipping:

1) Maximize probability of achieving basic aid objective.

2) Maximize national benefit received for public money spent.
3) Increase productivity and reduce resulting cost of ocean transportation.
4) Assure retardation of inflationary trends and resulting effects on other industries.
5) Maintain freedom of management and business decision and choice.
6) Minimize government regulation, protection and involvement.
7) Assure true collective bargaining.
8) Assure competitive, free rate-setting.
9) Simplify aid administration.
10) Maximize incentives.
11) Improve balance of payments.
12) Improve competitive position of national flag shipping.
13) Provide advantages to national foreign trade.

Generally, aid of subsidy to industries is offered to "infant" industries, to assure national security and/or national economic health and growth. The "infant" industry argument obviously does not apply to one of the oldest industries in the world. Yet while other industries can be "protected" by tariffs in lieu of subsidies, the merchant marine and shipbuilding industry must be supported by direct and indirect aid. Relevant legislation usually relies on the arguments of assuring improved standard of living, balance of payment and national security, by means of "effective" participation in international trade, which supposedly permits influencing ocean freight rates, which in turn affect the cost of imports and competitiveness of exports. While higher wage rates are cited in some countries as the reason for noncompetitiveness, the argument ignores the real determinant, which is the labor cost per unit of output. High labor productivity in an industrial country permits a predominance of manufactured goods to compete favorably in international trade in areas with lower wage rates and lower labor productivity.

Foreign shipping is an export industry, as are airlines operating on foreign routes. Both buy their labor and capital resources usually from the same market, yet while the shipping industry often requires subsidy, airline operators have until recently been able to subsist without subsidy in most cases by the efficiency of their operations. Some of the reasons are obvious. While the airlines adapt to the system of high labor productivity by adopting capital intensive operations which take full advantage of the lower costs of capital, the greater availability of capital, and more advanced technology, steamship operators and shipbuilders do not generally use all the capital resources available to them, follow instead of lead in the adoption of new technology, and do not provide incentives conducive to higher productivity.

A recent estimate of the relative proportions of expenses for modern liner ships and jet aircraft operating in various countries indicate that liners consume often twice as much (before subsidy) for crew wages, compared with jet aircraft. On the other hand, aircraft operating expenses include 16% for fuel compared to 7% for fuel of the ship. Over 28% of the airline operators' costs are for maintenance, for which the ship operator spends a mere 4%.

A simple subsidy system may discourage high risk and imaginative operations, and not include sufficient incentives. If we consider the distribution of costs incurred by U.S. and foreign operators for a typical modern 20-knot break bulk cargo liner (shown below) we note that the proportion of labor costs after subsidy are appreciably lower than those of the foreign competitor. Similarly, fuel costs are lower, which indicates a desirability to offer higher speed U.S. ships which by itself will increase productivity, as capital costs increase much more slowly than fuel costs.

COMPARATIVE OPERATING COSTS*

	Without Subsidy	With U.S. Subsidy	Norway	Japan
Wages	26.8%	14.6%	21.7%	19.5%
Fuel	12.5%	22.8%	23.5%	26.3%
Overhead	9.7%	17.5%	13.6%	17.4%
Capital Costs	40.1%	35.1%	17.8%	24.2%
Other Costs	10.9%	10.1%	23.4%	12.6%
TOTAL	100.0%	100.0%	100.0%	100.0%

*Source: "Selected Commodity Unit Costs for Oceanborne Shipments", U.S. Department of Commerce

Considering non-subsidized operations, even higher speeds are justified. In fact, it can be easily shown that an increase in speed of 2-3 knots above that of non-U.S. competition of the trade route will often lead to an appreciable closure of the competitive cost gap. An unsubsidized 25-knot fast turnaround ship has a total fuel-plus-crew cost per ton mile equal to that of an unsubsidized 20-knot ship of the same deadweight capacity. However, the fuel-plus-crew costs of a 25-knot subsidized vessel per ton mile is 50% higher than the costs for a 20-knot subsidized vessel.

All the above considerations indicate that the U.S. cost parity subsidy system falls short in meeting its objectives. The effectiveness of government subsidy and aid to the shipping industry has also been questioned from the point of view of public interest. It is obviously important for a government to maximize the national benefit received from tax money spent in direct or indirect subsidy. It should also attempt to use such aid to increase productivity gains to retard inflationary trends and assist by such expenditures to maintain a proper balance of payments. On the other hand, all of the above factors should be accomplished with a minimum of government involvement regulation and protectionism, to assure maintenance of a free, competitive shipping industry. Similarly, even under economic protection, the industry should maintain proper bargaining positions toward various sectors of the economy involved and be encumbered as little as possible by government regulation or program administration. All of the above, often conflicting desires, really assume a maximum of industry management decision making in business choices and the introduction of business incentives and risks to which all free enterprise is subject.

Although merchant shipping aid programs are usually designed to accomplish the above aims, the actual results are often quite different. More often than not government aid to shipping creates shipping enterprises unwilling to take risks due to the lack of incentives.

Decisions on method and approach of government aid to shipping are difficult because among other things the true effectiveness of a shipping industry is hard to measure. Various measures of transportation utility obtained per unit of government involvement are sometimes used. Effectiveness, on the other hand, involves more than economic performance to fully justify the intent of government aid to shipping. In addition to the capability of influencing rates and reducing foreign currency expenditure such aid is usually supposed to support the public interest and, therefore, various qualitative measures of effectiveness. These included among others:

1) The capability of responding to government transportation requirements in a cost-effective manner.
2) The capability of handling a substantial portion of the foreign trade of the country and thereby affect balance of payment by transportation revenues.
3) The effect of shipping capability on import and export freight rates. This particularly refers to differential rates for import and export cargo.
4) The capability of maintaining quality of shipping and employment opportunities for a reasonable and sufficient number of citizens.
5) To provide a market for national shipbuilding, ship component manufacturing industries to maintain a sufficient economic base for this industry.
6) To provide ocean transportation of a form properly integrated with feeder-like domestic services benefitting national commerce and industry.

The above considerations provide additional qualitative measures of effectiveness which are hard to determine, yet play a major role in satisfying public interest needs of the nation.

B. Direct Subsidies and Incentives Provided

Many governments believe that a national flag merchant marine is basic to their national economic (and defense) interests and as a result attempt to encourage its development and maintenance by a variety of incentives. Typical measures of direct and/or indirect government aid to shipping and shipbuilding are presented in Table I-1.

In addition, they often provide assistance in:

a) Training of merchant seamen.
b) Medical care of merchant seamen.
c) Pensions and repatriation of merchant seamen.
d) Domestic port charges and other expenses.
e) Laws pertaining to national citizen crews.
f) Preferential and often subsidized use of products.

These and other measures often assure meaningful benefits to national flag shipping in competition on a route, particularly if and when engaged in foreign trade of the country. Direct subsidies to shipping and shipbuilding have for many years been subject to international criticism because of the often resulting overt favoritism and similar effects of international trade. Yet, it is noted that this type of involvement is definitely on the increase. Similarly, it is noted that government participation in ownership of the national fleet is on the increase, both in the number of countries involved (Table I-2) and the percentage of ownership.

Although there are many involved reasons for government participation in ownership, it appears that countries with lagging foreign trade are more inclined to involve such government participation.

Direct subsidies fall essentially into operating and construction subsidy for government and/or privately owned vessels. The degree, regulation, method and extent of direct subsidy varies widely as shown in Table I-3. In some countries it is furthermore limited to an upper sum. While some countries pay operating subsidies to assure cost parity, the majority of operating subsidies are paid for "special" services, extraordinary provisions, losses incurred (irrespective of cost differentials) or to assure "essential" services. Construction subsidies, on the other hand, are largely paid on a basis which assures cost parity and/or "reasonable" profitability of the national shipbuilding industry.

Table I-1

Types of Direct or Indirect Government Aid To Shipping and Shipbuilding

1) Operating Subsidies
2) Construction Subsidies
3) Government Construction or Ship Acquisition Loans at Low Interest
4) Government Operating Loans at Low Interest
5) Interest Subsidies
6) Credit Guarantees (with or without collateral)
7) Accelerated Depreciation
8) Tax-Defered Sinking or Reserve Funds
9) Duty-Free Imports of Materials and/or Supplies for Ship Construction
10) Duty-Free Imports of Materials and/or Supplies for Ship Operation
11) Tax Benefits to Operating Personnel
12) Cargo Preference (rate and/or carriage)
13) Cabotage Restrictions
14) Restrictive Use Laws Specifying Operations of National Flag Ships in Domestic and/or Foreign Trade
15) Exclusive Use of Domestic and/or Government Owned Shipping in Carriage of Government Owned or controlled Cargoes

Table I-2

*Merchant Fleet National Trade Participation and Government Ownership (1967)

No.	Country	Merchant Fleet GRT (000)	Foreign Trade million dollars	% Change since 1957	Government Participation in Ownership of Fleet	% of Foreign Trade Carried in National Flag
1.	Liberia	23,881	262	181.0	Yes	18
2.	England	20,005	32,142	50.2	Yes	37
3.	U. S. A.	19,179	57,758	62.7	Yes	6
4.	Norway	18,666	4,482	113.9	No	43
5.	Japan	16,101	22,152	210.2	No	46
6.	Greece	7,275	1,681	125.9	No	31
7.	Italy	5,943	18,397	195.5	Yes	25
8.	Germany	5,870	39,114	142.7	No	30
9.	France	5,284	23,745	110.4	Yes	48
10.	Panama	4,691	300	97.4	No	Ø
11.	Netherlands	4,531	15,622	116.9	No	16
12.	Sweden	4,404	9,231	102.2	No	30
13.	Denmark	2,842	5,688	124.6	No	17
14.	Spain	2,023	4,846	262.2	Yes	32
15.	India	1,894	4,327	19.5	Yes	13
16.	Brazil	1,178	3,237	12.4	Yes	8
17.	Argentina	1,051	2,572	12.6	Yes	15
18.	Finland	112	3,297	89.6	No	54
19.	Belgium	847	14,199	113.8	No	7
20.	China (Rep.)	760	1,172	225.6	Yes	40
21.	Hong Kong	735	3,313	131.8	No	59

*U.S. Maritime Administration, Department of Commerce

Table I-2 continued

No.	Country	Merchant Fleet GRT (000)	Foreign Trade million dollars	% Change since 1957	Government Participation in Ownership of Fleet	% of Foreign Trade Carried in National Flag
22.	Israel	709	1,309	127.3	Yes	45
23.	Philippines	707	1,973	76.5	Yes	17
24.	Australia	637	7,415	78.8	Yes	16
25.	Portugal	605	1,718	117.5	No	40
26.	Turkey	575	1,214	63.6	Yes	30
27.	Indonesia	498	1,252	-29.4	Yes	18
28.	Lebanon	490	770	162.8	No	12
29.	Pakistan	467	1,717	115.2	Yes	N.A.
30.	Cyprus	420	247	38.0	No	N.A.
31.	Korea	360	1,248	169.0	Yes	25
32.	Canada	356	21,994	89.7	Yes	1
33.	South Africa	350	4,892	63.7	Yes	11
34.	Mexico	326	2,918	54.5	Yes	N.A.
35.	Venezuela	293	4,020	-5.0	Yes	44
36.	Chile	262	1,638	82.8	Yes	13

Table I-3

DIRECT SUBSIDY TO SHIPPING INDUSTRIES

Country	Operating Subsidy	Construction Subsidy
1 Liberia	None	None
2 England	None in foreign trade. Aid given to domestic essential service to sparcely settled areas.	Investment grant of 20 to 25 per cent of any investment expenditure. 12 mo. lag between investing and grant. Foreign purchases eligible. Depreciation figured on price minus grant.
3 United States	Provision for operating cost parity with foreign vessels on same trade route provided for subsidized operators on essential trade routes. Essential trade route definition relaxed under 1970 law. ODS includes differential cost of crew, maintenance, ship management, survey and supplies.	Provided for difference in cost between U.S. and lowest cost foreign built vessel of same design. Construction subsidy given directly to shipbuilder and is, under Act/1970 applicable to all foreign going ships, including bulk carriers. Current negotiations for inclusion of ships trading domestically. CDS limited to 45% in 1971 and gradually reduced to limit of 35% by 1974.
4 Norway	None in foreign trade. Aid given to domestic shipping serving sparcely populated outlying districts.	None
5 Japan	a) Subsidies in cross trades of between 3% and 4.75% of freight reserve. b) Subsidy to domestic island/mainland service. This was $386,000 in 1965.	a) None for normal circumstances. b) 3/4 cost of new nuclear ship paid by government.
6 Greece	None	None

Table I-3 continued

	Country	Operating Subsidy	Construction Subsidy
7	Italy	a) 37.9 million distributed annually to 4 companies principally owned by the Italian government. b) 5.6 million distributed to 4 other companies to maintain island/mainland service.	a) Difference between Italian costs and foreign costs (about 15%) paid directly to shipyard. This is for all ships built in Italy even exported vessels. b) Subsidies granted for repair, conversion, etc.
8	Germany	None	Ship construction subsidy of up to 10% of cash. Must be repaid if ship is sold.
9	France	a) Mail carriage subsidy to state controlled lines. b) Operating subsidy to compensate for differences between French and other countries.	a) Lump sum payment to builder of 10% of construction costs, b) or 12% of cost of vessel to owner. c) 10% of value of vessel granted for modernization.
10	Panama	None	None
11	Netherlands	None	None
12	Sweden	None	None
13	Denmark	None	None
14	Spain	a) High seas: subsidy to two companies for "special" services in interest of state. b) Coastal: reimbursement for losses.	9% payment to shipowner if whole ship Spanish, 6% if engine imported. Said to be compensation for high duties.
15	India	None	Difference between price and cost of ship paid to yard. This yard is government owned.

Country	Operating Subsidy	Construction Subsidy
16 Brazil	None to private shipping. Operating losses of Lloyd Brasilerro (gov't. owned) covered by government.	Decree 60679167 established CMM fund which pays the difference between Brazilian and average Western European cost of new construction and repair.
17 Argentina	None for overseas trade. Government budget has provision to cover deficits of national line (ELMA). River fleet gets 25% operating subsidy.	Construction subsidy authorized for cost differential between domestic and Western European costs. Includes modernization 7 conversion. No subsidies granted in recent years as no foreign-going ships built.
18 Finland	None	None
19 Belgium	None	Subsidy of 8% of contract price in 8 equal annual payments.
20 China (Rep.)	None	Granted in special cases. 1/3 of difference between price from Japan and price from Taiwan.
21 Hong Kong	None	None
22 Israel	Direct payment for operation of passenger lines.	None
23 Philippines	None	None
24 Australia	Subsidy to cover deficit of coastal services. Subsidy of up to (55,000 165,000) to KKK (Japan flag) per voyage for 7 sailings per year to So. America and Carribean.	Subsidy up to 33% of cost for building in qualified Australian yards for coastal or inland waterway service (equalization with costs). Shipbuilding Board orders ship and sells.
25 Portugal	None	None

Table I-3 continued

Country	Operating Subsidy	Construction Subsidy
26 Turkey	None	None
27 Indonesia	None	None
28 Lebanon	None	None
29 Pakistan	None	Up to 40% of building cost of ships built at Karachi Yard (KSEW).
30 Cyprus	None	None
31 Korea	a) Losses incurred by ships operating in international trade and earning foreign exchange will be made up. b) Ship receiving this aid may be ordered to operate on given routes.	For ships over 20 gross tons a subsidy of up to 40% is granted. Usual practice is 30%.
32 Canada	a) None to foreign trade shipping. b) Coastal and inland service to communities unservable on commercial basis given; 10.7 million to 32 coastal lines in fiscal year 1966/67.	a) Funds for subsidy provided through parliamentary appropriation of 25% of cost of ship until 1969, then reduced 2% each year until 17% in 1972. Subsidy payable to either owner or builder. Ships must retain Canadian registry for 5 years Actual subsidies paid: 62/63 22,500,000 63/64 40,000,000 64/65 32,000,000 65/66 40,512,684
33 South Africa	None	35% of contract price for ove 6000 tons. 25% of contract price for 5000-6000 tons.
34 Mexico	None	None
35 Venezuela	Deficits of national line (CAUN) are made up. Company has not failed to show profit since 1955.	None

Table I-3 continued

Country	Operating Subsidy	Construction Subsidy
36 Chile	a) Deficits of national line (EME) met by treasury. b) None to private lines.	None

Indirect Subsidies and Incentives Provided

The number of methods whereby governments assist their shipping and shipbuilding industries indirectly is varied indeed. It extends from tax benefits to cargo preference laws of different forms and even assumes the form of linking pricing of foreign trade to national flag carriage. The major methods of indirectly subsidizing the industry in various important maritime countries are presented in Table I-4.

It will be noted that large emphasis is usually given to financing aspects and protection from foreign competition. Tax benefits are generally in the form of depreciation allowances through escalation, write-offs, and direct tax reduction by allowing non-taxable reserve funds, elimination of income tax on earnings and reduction of duty on material imports used by the maritime industry.

Nearly two-thirds of all maritime nations impose cabotage laws, while many have additional or separate requirements for domestic trade. Cargo preferences in foreign trade are usually imposed on a selective basis either involving government cargoes or specific trades. Furthermore, such discriminatory practices are generally tied to percentages of available cargoes or types of cargoes which must be carried by national flag ships. The most popular of all indirect methods of government aid are probably special or accelerated depreciation and special taxation schemes adopted by practically all maritime nations. Countries whose governments own part or all of the national flag shipping usually treat it differently from privately owned national flag shipping, by provision of special write-off and/or loss (tax) considerations.

Table I-4

Indirect Subsidies to Shipping and Shipbuilding Industries

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
1 Liberia	None	None	None	
2 England	a) Refund of indirect taxes for exported ships greater than 80 gross tons. Refund is 2% of ship price. b) Depreciation at any rate chosen by business.	a) million loaned to Cunard @ 4½% for Queen Elizabeth. b) Guaranteed loans for ships constructed for export.	None	91 million loaned & up to 41 million granted to shipbuilders reorganizing and "improving" resources.
3 United States	Ship owners may put profits before taxes into tax-free reserve funds. Amount deposited negotiable. Accelerated depreciation	Government insured mortgage loans for U.S. built ships of up to 75% (with subsidy) or 87-1/2% (without subsidy) of ship owner's portion of indebtedness. Construction loan provided by the government for subsidy portion of ship cost plus guarantee for 75% of the remainder. Construction loans for non-subsidized ships guaranteed up to 87-1/2%.	A minimum of 50% of gov't. financed cargoes incl. foreign aid must be carried on U.S. ships at U.S. rates under PL-480. All gov't. owned and/or military cargo must be carried on U.S. flag ships if & when such ships are available. Domestic and cabotage trade reserved exclusively to U.S. flag ships.	
4 Norway	No special shipping treatment (except below). Any business can deposit 20% of its annual income in tax deferred funds to be spent in 4 yrs. on depreciable property. Goods del'd. to shipbuilding or repair yards not subject to turnover tax (13% of selling price). Complex & "unfavorable" depreciation rules. Refund of import duties paid on commodities incorporated into goods exported.	a) Permanent provision for granting of loans of up to 30% of value of ship. b) Temporary provision for 80% loans.	None	

Table I-4 (Continued)

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
5 Japan	a) Favorable depreciation giving advantage to "cross" shipping. S = N + (N x R) R = (B+C)/A N = 13.4% of book value S = depreciation B = export revenue C = cross trade revenue In foreign currencies A = total revenue b) Basic depreciation 13.4% of book value for 16 yrs., 10% may be taken on top of this for first year (for domestic trade).	a) 253 million in 13-15 year 6.5% loans to Japanese shipping Co. Up to 70% of value of cargo liners & 80% of oil & bulk ships (J. Development Bank). b) Interest subsidy 2.5% on above loans; 2.76% on city bank loans. c) Moritorium interest payments JDB is possible.		
6 Greece	a) No income tax on earnings of Greek flag ships. b) "Net tonnage tax" due instead. Ship Age / Tax per net ton (U.S.$) 0-10 — 0 10-20 — .20 20-25 — .30 over 25 — .40 c) No income tax on foreign flag ships owned by companies operating in Greece	a) Gov't. will loan money to banks at 3.5% if it is subsequently loaned to Greek shipowners placing orders in Greek yards. b) Gov't. guarantee of 30% of value of ship. Priority given to Liberty replacements. c) These loans are for 80% of construction cost payable in 10 years, 5.8% interest.	Cabotage	Depreciation inapplicable because of lack of income tax.
7 Italy	a) Materials for use in ship construction & repair are imported duty free. b) Depreciation period 12-1/2 years.	a) Loans for construction, repair, or conversion for 50% of cost of work are available at about 8.5%. Gov't. may contribute 3.5% towards interest. b) Funds (10 million in '68) given to shipyards for modernization.	a) Ships of countries discriminating against Italian flag can be used only with permission. b) Cabotage.	a) Gov't. owns the bulk of the stock of Italian shipping companies

Table I-4 (Continued)

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
8 Germany	a) Transactions of marine business exemption from turnover tax. b) Book profit on sale of vessel can be transferred to a reserve fund to be used to replace vessel. c) For vessels built between '65 and '70 an additional depreciation, up to 30%/yr., may be taken. d) Depreciation period: 14 yrs. dry cargo, 12 years tankers.	a) Ship construction loan for up to 30% of const. cost, 20 yrs. 2-1/2%. b) Export ships to non Common Market countries can be financed with up to 80% borrowed funds @ 2-1/2% repayable in 16 semiannual payments.	a) Foreign ship can be used in domestic trade only if German ships unavailable. b) Use of ships of countries excluding German ships is licensed.	
9 France	a) French owners relieved of 4.8% tax on marine insurance. b) Materials for ship construction & repair admitted duty free. c) 8 year depreciation scheme.	a) 80% of ship cost can be financed with gov't. loan at 5.5% payable over 8-15 years. b) Shipbuilders have access to 20 year loans at 5% to modernize.	a) 2/3 of imported crude oil in French ships. b) Cabotage c) Trade to present and ex-colonies sometimes restricted to French and the colonies ships.	Shipping lines reimbursed for personnel accident costs.
10 Panama	No income tax payable on either earnings of ship or crew.	None	Cabotage	
11 Netherlands	a) None b) Depreciation periods: passenger & cargo 20-26 yrs.; tanker 18-20 yrs.; war-built ships 16-18 yrs.	a) Loans to replace war losses b) Loans to shipbldrs. to allow financing export ships at reduced rate. Subsidy up to 25% of current interest rate.	None	

Table I-4 (Continued)

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
12 Sweden	a) Taxable earnings from sale of vessels can be transferred to reserve fund & are not taxable if used to replace vessel b) 30% of price of vessel can be written off before delivery c) Depreciation: 30% writeoff per year or complete writeoff in 5 years.	a) Mortgages available for up to 70% of ship's value. b) Government guarantees loans for export ships.	None?	
13 Denmark	30% writeoff possible before delivery, no more than 15% per year.	Credit at 6% for 8-10 years available to domestic and foreign owners.	None	
14 Spain	a) Subsidies tax exempt. b) 50% rebate of real estate and stamp taxes for 1st 10 years of Spanish registration. Tax repayment of 12% given to shipbuilders.	Loans for up to 80% of value of vessel repayable in 8 yrs. @ 5.75-6%; preference given to those breaking up old ships.	a) Cabotage b) Imports of petroleum & tobacco restricted to Spanish ships.	
15 India	Profits up to 40% of cost of new ships & 20% of old may be deposited in reserve fund. After 8 years they may be used for any purpose.	Loans are made to national shipping company at 4.5%. This is much lower than usual rate.	Cabotage; however, for lack of tanker capacity coastal petroleum traffic only uses 17% Indian tonnage	
16 Brazil	a) Lloyd Brasileiro tax exempt law. b) 4622/65 exempts shipbuilding materials from import and consumption tax. Similar exemption for services & supplies for shipbuilding.	Up to 80% of ship cost at 8% over 20 years. Brazilian owners up to 95% over 15 years	a) Cabotage b) All government financial cargoes on national flag ships.	

Table I-4 (Continued)

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
17 Argentina	ELMA (nationally owned line) exempt from all taxes.	a) Up to 80% to all shipowners for construction or conversion in local yards @ 5% (gov't. pays differences between interest charges by industrial bank if any). Terms: 15 yrs. new; 10 yrs. conv.; 5 yrs. repairs. b) Shipyard loans @ 5% for 10 years. c) Modernization financed by 4% import and 2% export tax.	By decree #6087 3/9/40 imports for gov't. agencies and institutions preferentially carried on national flag vessels. CIF & CEF exports must exclusively be carried.	Decree 5571/67 exempts gov't. agencies from consular fee on imports when carried on national flag vessels.
18 Finland	a) 30%/year book value depreciation. Extra depreciation not exceeding 60% ('66-'68) & 40% ('69-'73) of taxable income of firm. b) Depreciation begins on signing of contract for Finnish built vessels.	None (?)	Cabotage	
19 Belgium	a) Shipping repairs exempt from 6% transport tax. b) All contracts concerned with ships exempt from 6% tax. c) Fittings & furniture for ships exempt from tax. d) Imports used within 1 year for ships are duty free. e) Depreciation: 1st year 20%; 2nd 15%, each add'l. 10% (8 years).	1948 act gives credit for ship owners building ships in Belgium or elsewhere at 5% for up to 10 years and 70% of value of ship.	None	
20 China (Rep.)	a) No duty on items imported for shipbuilding b) Income taxes do not apply for 5 yrs. for national flag ships. c) Deprec. 12% on tankers & 15% on cargo ships. St. line.	Loans for 80% of cost given at 6%.	None officially. Mutually agreed that 50% of trade with Japan to go in nat'l. bottoms. Preference generally given nat'l. companies.	

Table I-4 (Continued)

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
21 Hong Kong	None	None	None	
22 Israel	a) Enterprise exempt from income tax for 5 years after it first shows profit. b) 5 year deferment of corporate registration fees and property taxes.	a) Loans for construction of ships at Israel Shipyards Ltd. b) Gov't. will guarantee 80% of purchase price providing another guarantor for 13-1/2% can be found. Gov't. gets first mortgage.	All meats imported must go on Israeli flag ships.	Zim 80% owned by government.
23 Philippines	a) Double the freight of goods carried on Philippine ships can be deducted from income tax of exporters. b) 10 year exemption of income derived from shipping provided all profits are reinvested.	11 year loans for 100% of value of vessel at 3% interest 3 year grace period	a) Import licenses granted only when cargo is carried on Philippine flag ship except when capacity unavailable--frequently the case. b) Preferential treatment given reparations vessels carrying reparations goods. c) Cabotage	Government owns Philippine National Lines.
24 Australia	a) 20 year depreciation b) No special tax benefits. c) Ocasionally machinery unavailable may be imported duty free.	None	a) Ships meeting wage & manning scales may operate in coastal trade with license. b) If licensed ship unavailable, unlicensed ship may be used.	Government owns national line.
25 Portugal	25% reduction in maritime trades tax for use of ships of countries having signed trade & navigation agreements with Portugal.	Loans for up to 75% of vessel at 3% payable over 20 years; 1st payment due in 5 years. Loans issued by merchant marine renewal fund & guaranteed by government.	a) Cabotage b) Cargoes to military or scientific bases must go in Portuguese ships.	

Table I-4 (Continued)

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
26 Turkey	None	$4 million used for loans to build steel ships under 6000 tons. 6 year payment period and 6% interest.	None	
27 Indonesia	None	None	a) Indonesian freight board has unlimited power to discriminate in favor of national flag. As of 1969 it has not exercised this power. b) Transshipments are required to be in national flag bottoms unless they are unavailable. c) 40% of all cargo between Indonesia & Europe to be on nat'l. flag ships.	
28 Lebanon	a) No income tax on shipping enterprises. b) Shipbuilding materials imported duty free. c) New shipbuilding industries are tax exempt for 5 years.	None	Shippers required to pledge not to ship on Israeli vessels or on ships blacklisted because of calls at Israeli ports.	
29 Pakistan	Fuel oil & lubricants for coastal shipping exempt from customs duty & sales tax.	Foreign loans & credit are arranged by government.	a) Cabotage b) Portion of shipping conference cargo is reserved for Pakistani ships.	a) Most of marine endeavor gov't. cont. but run on comm'l. lines. b) Official & semi-official agencies (exc. AID) must purchase insurance from organization administered by Pakistan Insurance Corporation

Table I-4 (Continued)

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
30 Cyprus	No corporate taxes or personal taxes on dividends on proceeds from shipping for period 1963-1973	None	None	
31 Korea	Shipbuilding materials imported duty free and without payment of internal taxes.	a) Ship owners can get loan for 55% of value of ship at 7.5% repayable in 5 years. b) Shipyards can get loans repayable in 3-5 years at 10-12% interest.	a) Cabotage. b) Gov't. frequently buys FOB & ships on Korean vessels. c) Waiver system: waiver allowed only when no Korean ship available. d) Trade agreements with U.S., W. Germany & Japan. Cargo transported under these agreements goes on national line at slightly lower tariff.	a) Loans extended for: Importation of ships. Improvement of ship facilities. Repair of ships. Chartering of ships to take up Korean registration in 5 years. b) Preferential treatment in above for those modernizing. c) Subsidy given businessmen shipping on national flag ships.
32 Canada	a) Tax on proceeds from book profits on sales of vessels are remitted if proceeds used to build new approved vessels. b) Ships permitted to claim an amount of depreciation not more than 15% on a diminishing basis.	None	a) Much of coastal trade in eastern region & Greak Lakes reserved for Canadian vessels. b) Other areas for Canadian & English ships.	

Table I-4 (Continued)

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
33 South Africa	a) Initial depreciation of 40% 10% each succeeding year for 6 years. b) 20% customs duty on ship built abroad & registered in South Africa. There is a rebate if the purpose of the ship is approved. c) Rebates of taxes on imported components of ships.	Guaranteed loans and interest subsidy of 2% to approved buyers.	All goods to U.K. must go on ships belonging to members of South African Shipping Conference.	
34 Mexico	None	Government has guaranteed loans for one shipping company.	a) Cabotage b) Import licenses approved conditionally on the use of Mexican vessels (only when Mexican carrier requests).	a) 25% subsidy of freight to shippers of products to U.S., Guatemala or British Honduras on Mexican controlled transportation. b) 2% reduction in tax on bee honey if shipped on Mexican vessels. c) 50% subsidy of freight for final products (25% for intermediate goals) for exports on Mexican ships. d) Foreign exchange is rationed. Sea transport on Mexican vessels is not included in quota.

Table I-4 (Continued)

Country	Tax Benefits	Loans & Interest on Loans	Cargo Preference & Cabotage	Comments
5 Venezuela	None	None	a) Gov't. gives preference to CAVN (national line). b) Various types of pooling arrangements insure CAVN share of cargo. c) Cabotage	
16 Chile	a) 20% of profits placed in tax exempt reserve fund. Can be withdrawn to purchase new tonnage. b) Equipment of domestic shipping enterprises can be revalued annually. c) Exemption of up to 50% of income tax allowed if proceeds used to renew fleet. This has been 20% in practice.	None	a) Half of cargo going between Chile & countries served by Chilean lines to go on Chilean ships. Foreign shipping lines can carry this cargo if they have a cargo pool with a Chilean line. b) Foreign vessels allowed in coastal trade only when domestic ships unavailable.	a) EME is a government owned company engaged largely in coastal trade. b) Chilean line can convert foreign currency at a 20% advantage over market rate.

c. Comparative Analysis of Subsidization

Although countries state a variety of different aims in justifying their interference with the competitive processes in world shipping and shipbuilding, these aims are usually very general, often irrational, and seldom thought through. Few of the subsidization programs have ever met the stated objectives, while a large number have tended to achieve the opposite. Many of these programs have far exceeded the estimated cost to the public. Most of the programs share the characteristics, though, of becoming a benefit to the maritime industry by right which often results in perpetuation of ineffective laws.

The major aims stated in some combination in justifying or rationalizing subsidy programs can be listed as follows:

1. Establish and maintain national prestige.

2. Merchant fleet capable of transporting essential trade to assure independence in time of emergency.

3. Permit growth of merchant marine to critical self-supporting size capable of competitive operations without government assistance.

4. Maintain merchant marine of sufficient size for defense reasons.

5. As a means of control of segments of foreign trade capable of fostering such foreign trade in the interest of the policy and economy of the country.

6. Balance of payment aspects, saving or earning of foreign currency.

7. Employment for countries' seamen.

8. As a countermeasure to discriminatory practices real or expected by conferences, trade groups or other nations.

9. Compensation of shipping industry for effects of artificial exchange rates and resulting commercial disadvantages.

10. Commercial protection of shipping industry.

11. Improve size and quality of shipping industry as an economic national asset.

12. Assure frequency and quality of service on "essential" trade routes.

13. Encourage service to developing regions of the country.

14. Provide a market to national shipbuilding industry deemed essential for economic or security reasons.

The method selected to achieve the key policy aims may furthermore be divided into various forms of subsidy and discrimination. Various aims can be attempted by a mixture of subsidy and discrimination or a choice between alternatives of subsidy or discrimination. Experience has shown that complex subsidy systems are generally only attractive for relatively developed countries with effective civil service. Otherwise, administrative convenience often dictates the adoption of a state owned fleet covering a large proportion of the ocean transportation requirements. Many countries unable to afford subsidies resort to flag discrimination even if such a system is less suitable or irrelevant to the aim pursued. It is generally found that flag discrimination is not necessarily cheaper than subsidies but the cost of such a policy is carried through pricing and not taxation. Individual forms of government aid or subsidy either lower cost or increase receipts. Under some circumstances they may accomplish both. Typical cost lowering subsidies are direct subsidies noted before as well as such forms as provision of capital at subsidized rates of interest and accelerated depreciation provisions. Some forms of operating subsidies may combine a lowering of cost and an increase of receipts. This depends largely on the method of payment and computation. If, as in the U.S. example, operating subsidy is paid as an excess of operating cost over lowest competitor cost, then the shipping firms are left to make profits or losses according to their effectiveness on the trade route. In this case subsidy is basically a cost reducing method. On the other hand, providing, for example, bounties for tramp operators, which is closely related to the special negotiated rates achievable by American operators under the terms of PL-480, the operating subsidy is essentially a revenue increasing method.

Receipts may also be increased by various preference methods which assure securing of an increased percentage of cargo for national ships or by simply increasing the permissible freight rates on cargo carried. This very often goes hand in hand with imposing additional requirements on foreign ships in competition with national flag carriers. The choice of subsidy and/or discriminatory method is often affected by the availability (current or projected) of insufficient or excess capacity. The choice between lowering costs and increasing receipts should be affected by the aim of the policy and the situation in which the shipping and shipbuilding industry of a particular country operates. Therefore, a uniform nationwide policy very seldom meets the basic aims of the policy. Capacity and conditions vary widely among trade routes and services that various segments of the shipping and shipbuilding industry provide. As a result, while some owners or operators may achieve the aims of the policy and benefit by its terms, others may not do so. In fact, a rigid subsidy/discrimination policy may achieve the opposite of its desired aim. This is particularly important at a time of rapid economic and technology changes in the shipping and shipbuilding industry where a maximum of flexibility in policy is required to maintain particular national aims.

The various aims and methods are often subject to a multitude of interpretations, the majority of which are ill-defined and difficult to translate into economic measures. As a result, it is found that the real success of methods of subsidy and discrimination can usually not be determined in explicit form.

On the other hand, it has also been recognized that most aims and methods are closely related and interlocked. For example, the aim of promoting and protecting shipping capacity for times of emergency is of little value without the support of a healthy shipbuilding and repair industry to service it. If, as a result, ship owners are forced to build at home, laws may be enacted which restrict national registry and/or payments of various types of direct and indirect operating subsidies or tax benefits. The same applies to various discriminatory measures such as cargo preferences.

While liner operators usually consider their cost/revenue aspects from the point of view of service on a trade route, operating and construction subsidies as well as various types of loan and/or interest subsidies are interchangeable without modification to the basic aim. Non-liner (general cargo - bulk) operators, on the other hand, have to consider their operations on the basis of unit time or voyage and therefore will usually only agree to such service if the unit time or voyage receipts exceed the extra costs incurred in performing the service for the time or on the voyage. For this reason construction and operating subsidies are not interchangeable for the non-liner operator and serve diverse aims. Construction cost or loan interest subsidy will therefore not as greatly affect the activity of non-liner ships in the charter or tramp market. Considering Table I-5, one may define as major trading nations those whose foreign trade assumes a high percentage of their GNP. It is interesting to note that with few exceptions the larger the dependence of a nation on foreign trade (measured as a function of GNP), the fewer discriminatory and other measures which interfere with the competitive processes in world shipping are imposed. Similarly, we note that a majority of countries which impose a minimum of such measures have a positive balance of payments, participate widely in cross trades, and sustain a rapidly growing shipping industry.

Table I-5

SIZE OF MERCHANT FLEET AND VALUE OF FOREIGN TRADE
(Fleets of Countries where Maritime Industry State Owned Are Not Included

No.	Country	No.	Merchant Fleet 1970		GNP 1968 (Billions per Year)	Value of Foreign Trade 1967			
						Export		Import	
			GRT(000)	DWT(000)		Millions	% of GNP	Millions	% of GNP
1	Liberia	1707	30,256	52,119	0.2	147	73.5	115	47.5
2	England	1785	22,237	33,133	90.5	14,351	15.9	17,791	19.7
3	U.S.A.	1937	17,964	24,560	835.0	30,942	3.7	26,816	3,21
4	Norway	1205	18,495	30,000	7.0	1,736	25.0	2,746	39.0
5	Japan	1989	21,968	34,633	97.0	10,478	10.7	11,647	12.1
8	Germany	923	6,711	9,904	119.6	21,748	18.3	17,366	14.5
9	France	471	5,740	8,322	100.0	11,346	11.3	12,399	12.4
10	Panama	610	5,474	8,657	0.7	86	11.2	214	30.5
11	Netherlands	445	4,562	6,529	21.0	7,286	34.5	8,336	39.5
12	Sweden	393	4,716	7,150	23.0	4,528	19.6	4,703	20.4
13	Denmark	306	3,006	4,736	12.0	2,536	21.2	3,152	26.0
14	Spain	389	2,555	3,778	24.6	1,384	5.5	3,462	14.1
15	India	240	2,256	3,424	47.4	1,823	3.9	2,904	6.1
16	Brazil	228	1,403	1,996	20.3	1,616	8.0	1,621	8.0
17	Argentina	143	1,053	1,430	11.4	1,453	12.7	1,119	9.8
18	Finland	204	1,204	1,817	8.7	1,577	19.0	1,720	20.1
19	Belgium	75	977	1,469	18.1	7,047	38.8	7,152	39.0
20	China (Rep.)	144	1,007	1,432	3.1	569	18.3	603	19.4
21	Hong Kong	123	1,274	1,952	N.A.	1,505	-	1,808	-
22	Israel	89	777	1,103	3.4	548	16.1	761	22.4

Table I-5
(continued)

No.	Country	No.	Merchant Fleet 1970		GNP 1968 (Billions per Year)	Value of Foreign Trade 1967			
						Export		Import	
			GRT(000)	DWT(000)		Millions	% of GNP	Millions	% of GNP
23	Philippines	164	876	1262	5.5	801	14.6	1,172	21.3
24	Australia	100	777	1087	23.0	3,485	15.2	3,930	17.1
25	Portugal	92	684	863	4.1	696	17.0	1,022	24.8
26	Turkey	86	542	718	10.5	523	4.9	691	6.6
27	Indonesia	149	495	597	10.5	679	6.4	573	5.4
28	Lebanon	62	218	329	1.1	120	10.9	650	59.0
29	Pakistan	65	507	687	10.6	599	5.6	1,118	10.5
30	Cyprus	155	998	1432	0.4	81	20.0	166	42.0
31	Korea	95	729	1164	3.2	309	9.7	939	29.2
32	Canada	66	289	342	53.5	11,024	20.5	10,970	20.5
33	South Africa	52	374	454	12.3	1,949	17.2	2,943	24.0
34	Mexico	40	338	520	24.0	1,172	4.8	1,746	7.3
35	Venezuela	37	323	473	1.7	2,850	168.8	1,170	69.0
36	Chile	49	284	386	5.2	881	16.7	757	8.5

d. Effect and Effectiveness of Subsidization

Considering the various aims of subsidy and discrimination it may be useful to investigate the effect and effectiveness of such measures in meeting the announced aims which they are designed to accomplish. It is interesting to note that most nations promulgating laws which interfere with the free competitive process of shipping and shipbuilding find it necessary to announce a statement of policy such as recently used in the new U.S. Merchant Marine Act of 1970:

"It is necessary for the national defense and development of its foreign and domestic commerce that the United States shall have a merchant marine (a) sufficient to carry its domestic waterborne commerce and a substantial portion of the water-borne export and import foreign commerce of the United States and to provide shipping service essential for maintaining the flow of such domestic and foreign water-borne commerce at all times, (b) capable of serving as a naval and military auxiliary in time of war or national emergency, (c) owned and operated under the United States flag by citizens of the United States insofar as may be practicable, (d) composed of the best-equipped, safest, and most suitable types of vessels, constructed in the United States and manned with a trained and efficient citizen personnel, and (e) supplemented by efficient facilities for shipbuilding and ship repair. It is hereby declared to be the policy of the United States to foster the development and encourage the maintenance of such a merchant marine."

It is generally assumed that policy methods to achieve certain policy aims can be listed as follows:

a) To achieve lowered costs with national shipping capable of supplying needed capacity and primarily occupied in liner trades (or for such segments of the shipping industry) construction, operating and indirect subsidies such as tax free (or deferred) reserve funds. Similarly, direct loss reimbursement or tax reduction. If excess capacity is available then the direct subsidies can be calculated on the basis of the difference between receipts and costs or based on level of utilization of capacity and/or achieved freight rates.

b) To achieve increased receipts with national shipping capable of supplying no more than needed capacity and primarily occupied in non-liner trade (or for such segments of the shipping industry) cargo preferences, treatment by rate, premium freight rates, differential operating subsidy, (based on difference of receipts and costs) and various special concessions. If excess non-liner capacity is available or to be encouraged, cabotage restrictions, cargo preferences (by rate and/or flag), discrimination in cargo allocation and/or carriage, premium freight rates, and operating subsidy to compensate for unused capacity are often used.

Obviously many of the above policies are not available to some countries. Discrimination in cargoes, cargo preference, or premium rates can really be usefully employed only if a nation directly controls a large volume of foreign trade. Cabotage restrictions are only applicable to a country with a long ocean coast and meaningful coastal ocean trade.

The desire to improve balance of payments often leads to encouragement of national shipping even if it results in highly uneconomic use of national resources. In fact, it can be shown that for many countries use of the same resources in other segments of the economy would lead to better balance of payment effects. The reason is that the basic premise of saving foreign exchange by the use of national shipping in foreign trade is largely fictitious. Assuming fuel, certain repair, port and similar charges are paid in foreign exchange, as much as 50% of the freight earnings will have to be used for such expenditures. If ships are also imported and amortization is in foreign exchange as well the percentage may easily reach 65%. Similar findings can be made regarding national shipbuilding if major material and equipment components are imported in this comparatively low added value industry. These effects may look even less attractive if the national flag ships are forced to join conferences and participate in a generally high freight rate tariff, and when foreign ships continue to carry an appreciable proportion of the nation's foreign trade.

To achieve a real saving in foreign exchange it is essential to create new capacity and then introduce preferential treatments to fully use this capacity and increase receipts. Other methods may consist of cost reducing subsidies to national non-liner operators until they can undercut competition which will (under conditions of world excess capacity) lead to falling rates. This may, in turn, require an increase in subsidies but reduce foreign exchange payments for trade carried by foreign vessels.

It is important to note that in non-liner shipping slight variations in demand to supply usually lead to large changes in freight rates.

Countries adopting complete discrimination whereby major components of controllable exports and imports are carried by national flag shipping usually find that their resulting costs and/or freight rates rise appreciably as a result of additional ballast or low utilization voyages required. Discrimination by shipping conferences and other private associations is found at least as damaging as national discriminating practices and are one of the major reasons for the often otherwise irrational build up of shipping by developing countries. Such build up furthermore is generally supported by flag preference and direct government support which is then termed discriminating by the conferences. Thus the cycle is closed and continues its spiraling effects.

Instead of construction subsidy some countries institute policies which require scrapping of tonnage in return for favorable new building terms. Such methods usually assure required capital for new construction but require the replacement tonnage to be much more effective.

Certain problems related to the effectiveness of government measures are involved in the area of foreign exchange. If the currency is overvalued and operators are subsidized to make up such obvious disadvantage, then no special advantage is provided national shipping nor is it necessarily made more competitive. If such subsidy results in overcompensation a direct competitive advantage is introduced. Such measures are expensive and really untenable over long periods. An undervalued currency is obviously of direct advantage to a national shipping industry although it cannot be called a subsidy to that industry as the forces governing such policy usually arise from other considerations, or even external forces. Shipping is often affected by policies established for the protection of other industries such as tariffs, or negative preferences designed to assist domestic manufacture or agriculture. Under some circumstances subsidies are paid to national shipping to counter induced disadvantages of domestic protection.

In conclusion it can be stated, that while the cost of direct subsidies can be ascertained, neither the cost of indirect subsidies nor the economic effect of all subsidies can really be determined. Attempts have been made to calculate the increase of shipping costs resulting from subsidies and the effect on the viability of the shipping and shipbuilding industry.

Construction subsidies usually only help shipbuilders and may even penalize the operator by inducing him to buy a ship different from one he may have bought in a free market. This penalty may in turn require an increase in operating and other types of subsidies.

Extensive subsidies provided nonselectively often lead to an increase in competition as tonnage in excess of need is supplied and freight revenues fall. The most severe problem introduced by subsidies is often the elimination or reduction of incentives particularly if operators are assured increased subsidization when freight revenues fall.

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APPENDIX

SUMMARY OF THE U.S. MERCHANT MARINE ACT OF 1970*

• Authorizes construction in U.S. shipyards, over a ten year period beginning in Fiscal 1971, of 300 merchant ships for operation in U.S. foreign trade.

• Extends construction assistance to bulk cargo carriers.

• Continues present procedures for annual authorization and appropriation of funds for maritime purposes.

• Broadens the definition of qualified applicants for participation in the program to include shipyards.

• Encourages applications which reduce U.S. shipbuilding prices.

• Extends preference to applicants who promote ships of high transport capability and productivity.

• Requires the Secretary of Commerce to compute estimated foreign costs of construction annually for comparative purposes.

• Establishes Federal Government construction support ceiling goals of 45% maximum for fiscal year 1971, 43% for 1972, 41% for 1973, 39% for 1974, 37% for 1975, and 35% for fiscal 1976 and thereafter.

• Provides for direct payment to the shipbuilder.

• Authorizes the Secretary of Commerce to obtain competitive bids for each ship to be built, to contract with the low bidder if the bid is below the goal limit and to negotiate with bidders to reduce prices if bids are above the prescribed goal or, until June 30, 1973, to accept a price negotiated between a purchaser and a shipyard if the price is equal to or below the goal limit.

• Reaffirms the 1936 Act requirement that all materials in the ships in the program be of U.S. origin, but permits the Secretary of Commerce to waive this requirement if delivery date is threatened.

• Liberalizes definition of obsolete vessels and extends the Secretary of Commerce's authority to determine the appropriate age for retirement of vessels.

*Shipbuilders Council of America

• Provides that operating subsidies "*shall equal*" the difference between U.S. and specified foreign operating costs, principally wages and benefits in collective bargaining agreements.

• Creates a seven-member Commission on American Shipbuilding appointed by the President to review the status of the American shipbuilding industry -- its problems and its progress toward increasing productivity and reducing production costs.

• Establishes a new position of Assistant Secretary of Commerce for Maritime Affairs who will also serve as Maritime Administrator.

• Provides centralized control over administration of preference cargoes by authorizing the Secretary of Commerce to issue regulations which would govern all agencies having any jurisdiction.

• Authorizes the Secretary of Commerce to promulgate regulations under existing "*foreign trade*" or "*foreign commerce*" definitions, applicable to bulk carriage, to include movements between foreign ports.

• Grants to the St. Lawrence Seaway Corporation forgiveness of unpaid ($22.4 million to date) and future interest to avoid increases in seaway tolls.

• Offers any shipping company in foreign, Great Lakes and non-contiguous domestic trades (such as that with Alaska, Hawaii and Puerto Rico) and in the fisheries, authority previously granted only to operators on "*essential foreign trade routes*" to defer taxes on income paid into a capital construction fund for the purpose of replacing, reconstruction or adding new vessels.

• Phases out foreign flag operations of the U.S. shipowners participating in the program by:

Limiting continued foreign flag holdings during a 20-year period to bulk cargo vessels rather than all vessels;

Determining that the 20-year period for divertiture of foreign holdings for program participation would begin April 15, 1970;

Determining that mere broker or agent activities in dual-flag operation (not involving ownership) cannot continue beyond April 15, 1972 for program participants;

Requiring that shipowners who wish to qualify under the 20-year gradual divestiture plan must file with the Secretary of Commerce a complete statement of foreign-flag activities and affiliations within 90 days of enactment of the legislation;

Requiring the Secretary of Commerce to report to the Congress annually on foreign-flag operations by U.S. shipowners and recommend any necessary legislation.

• Removes certain restrictions on the development of Great Lakes commerce.

• Increases the allowable amount of outstanding Federal Ship Mortgage insurance on ships to $3 billion from $1 billion.

• Extends the Secretary of Commerce's authority to grant war risk insurance to September 7, 1975.

• Adds as an objective to be accomplished by the Secretary of Commerce in his administration of the Act, "*the creation and maintenance of shipbuilding and repair facilities in the United States with adequate numbers of skilled personnel to provide an adequate mobilization base.*"

CHAPTER II

PLANNING SUBSIDIZED LINER REPLACEMENT - THE EFFECTS OF UNITIZATION

BACKGROUND

The subsidized liner industry of the U.S. Merchant Marine is at a crucial juncture in its history. At the very moment that a great percentage of its ships is ready to be replaced, the industry confronts technological innovations which stand to alter the way business is done in the steamship industry. The choice is not simply among ships, but among styles of competition. Unitization of cargo in the form of containerships or barge-carrying vessels demands a different approach to the decisions about ship replacement and forces companies to consider strategy before equipment.

In the past the simple truth that arranging for ship replacement is just one part of long-range planning was obscured because the planning was virtually indistinguishable from operations. Until the advent of containerization, the general outline of ships had remained the same for many years, and the basic cargo-handling techniques had not significantly changed since the time of the Phoenicians. Because the environment was consistently stable, there was little need to look beyond day-to-day operations. Consequently, planning new vessel construction was generally a standard procedure requiring little more knowledge than that used in daily operations.

Unitization has greatly altered the requirements for adequately planning ship replacement. Concentration on the total transportation system rather than just the pier-to-pier portion has necessitated acquiring knowledge on the origins and destinations of cargo movements and on the operations of inland transportation systems. Starting a capital intensive container system requires knowledge of large-scale financing, possible benefits of container pooling and consortia, and possible advantages of mergers. With unitization, competitors now provide different services at different freight rates. Therefore, marketing operations assume a new importance. Changing from break-bulk cargo ships to ones carrying unitized cargo requires subsidized steamship companies to apply new attitudes, new knowledge, and new skills to the planning process for liner replacement. In addition, flexibility in operations becomes more important in this changing environment.

Although the economic and technological feasibility of containerization was proved in the domestic trades in the late fifties, subsidized lines have had difficulty planning for a change in their operations. Since Sea-Land began its successful full containership service in the U.S. foreign trade in 1966, more than 30 subsidized break-bulk cargo vessels and semi-containerships have been launched. Some of these subsidized companies became dissatisfied with the results of their past planning and converted their vessels to ships which made better economic sense while under construction. Others have regretted their past decisions only after receiving their new break-bulk cargo vessels or semi-containerships.

Blaming the change in environment for mistakes in ship designs is convenient, but only underscores the need for better perception of the environment on the part of those who are responsible for planning vessel replacement. Powerful management tools are available for aiding in the planning process. Sea-Land and Matson, the pioneers of large-scale containerization, introduced systems analysis as well as new technology to the maritime world.

Management Tools in Planning

"Systems analysis is as much an attitude--a philosophy--about exploring a many-dimensional problem as it is a collection of sophisticated techniques."[1] This attitude, which may have resulted from the threat of financial ruin in the domestic trades, was fostered in the unsubsidized lines with the introduction of new types of management. Sea-Land's concept of cargo movement as a door-to-door process required bringing in truckline specialists, including research engineers, maintenance directors, traffic experts, and others. Matson, who became more deeply involved in formal systems analysis, formed a research group of experts in operations research. The company chose not to hire experienced maritime personnel so that the conventional wisdom of the steamship industry could be tested by new ideas.

For many years the management tools have been available for comparing prospective investments of different size ships or vessels of different design. Basic economic methods, such as discounted cash flows, as well as more sophisticated methods, have been proved useful in analyzing these problems.[2] Government-sponsored studies have provided a methodology for comparing the costs of various systems for moving from an inland origin to an

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1. A. Scheffer Lang, "Innovation as a Coordination Requirement," Coordinated Transportation, The American University, Cornell Maritime Press, Inc., Cambridge, Maryland, 1969, p. 4.

2. For more information read "Principles of Engineering Economy in Ship Design," by Harry Benford, The Society of Naval Architects and Marine Engineers, 1963, "On the Rational Selection of Ship Size," by Harry Benford, The Society of Naval Architects and Marine Engineers, 1967, and "Systems Analysis in Marine Transport," by J. B. Woodward III, Harry Benford, and Horst Nowacki, The Society of Naval Architects and Marine Engineers, 1968.

inland destination across the ocean.[3]

For more than ten years Matson has effectively used computer simulation techniques in its vessel replacement planning.[4] These management tools have the advantages of: (1) capaoity to handle a great number of variables, (2) speed, (3) accuracy, and (4) adaptability to handle a great number of problems simultaneously. Their major disadvantages are: (1) cost, and (2) the lead time required to accumulate necessary input and to design the simulation. In 1960 the National Academy of Sciences felt that the amount of funds involved in vessel replacement programs warranted investigation of the advantages of simulation techniques by the subsidized lines.[5] In the past ten years the cost of ship replacement has greatly increased; consequently, the author feels that the advantages of computer simulation are even greater today than at the time of the National Academy of Sciences' study.[6]

Research is continuing on the development of better mathematical methods for analyzing ship replacement problems. Such a management tool is described in a S.N.A.M.E. publication by Dave S. Miller of the University of Michigan.[7] He has stored the data from several works on shipping economics and engineering in a computer program; when given the container flow rate, frequency of service, ship speed, and voyage length, the computer program calculates the construction and operating costs of the required containerships as well as many engineering parameters of the ship design.

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3. This methodology is contained in the following two studies by the National Academy of Sciences - National Research Council: Maritime Transportation of Unitized Cargo, Publication 745, 1959, and Inland and Maritime Transportation of Unitized Cargo, Publication 1135, 1963.

4. The following publications describe these techniques: The Journal of the Operations Research Society of America, Operations Research, Vol. 6, No. 5 (September-October 1958): "Operational Simulation of a Freighter Fleet," by Foster Weldon, Research Techniques in Maritime Transportation, National Academy of Sciences - National Research Council, Publication 720, 1959; and Trade-Fleet Study, Maritime Cargo Transportation Conference, National Academy of Sciences - National Research Council, 1960.

5. National Academy of Sciences - National Research Council, Trade-Fleet Study, op. cit., p. 2.

6. A more recent study of fleet simulations is the User Manual for the MARAD Fleet Operations Simulations, Arthur D. Little, Inc., Contract No. MA-2451, 1964.

7. "The Economics of the Containership Subsystem," Marine Technology, Vol. 7, No. 2 (April 1970), pp. 180-195.

Greater adoption by the subsidized lines of the types of management tools as described above will become more and more a necessity in the currently changing environment. Although many subsidized companies do make some use of these tools, few subsidized lines, if any, consistently approach the problem of vessel replacement and long-range planning with a systematic large-scale effort using these management tools.

Focus of This Chapter

The present need, then, is not simply for fancier technology or more powerful management tools to cope with the challenges of unitization. The technology and the tools are at hand now, and the transition to a new type of liner service is past the early stages. What is needed now is a systematic method of planning, a context within which effective analysis can be brought to bear.

This study will propose a strategy for planning subsidized vessel replacement. This strategy will provide a framework within which such management tools as computer simulation techniques can be used to solve the long-range planning problems of the company. Since current government regulations can hinder the plans of subsidized lines, changes in the subsidy program will be recommended. These suggestions will relate only to those regulations and procedures which affect the planning and operational flexibility of the subsidized lines.

PROPOSED STRATEGY FOR PLANNING SUBSIDIZED VESSEL REPLACEMENT

The decision on vessel replacement is an extremely complex part of long-range planning, influenced by many interdependent factors which can vary to form an infinite number of combinations. The major problem in industry planning has not been in recognizing the factors to be considered, such as cargo demand, vessel types, labor unions, government regulations, inland transportation and port facilities. Rather, gathering the data and analyzing it in a systematic manner have been the weak points in planning. In the first place, steamship companies have rarely assigned personnel solely to planning ship replacement. In the second place, innovations in the technology have been few, and planners pressed for time could safely make sweeping assumptions about the markets, competitors, port systems, etc., based on their current status. With unitization, such assumptions no longer serve planners.

Moreover, new forces are at work which must be accounted for in the planning process. For example, because containers facilitate the transfer of cargo from one transportation mode to another, inland networks of transportation may be used to extend an ocean carrier's area of influence. Accomplishing this requires incorporation of data on the ultimate origin and destination of cargo in conjunction with the inland rates and practices.

Economies of Scale

One of the greatest changes--which bears some detailed examination before any presentation of the planning processes is made in this paper--is the introduction of economies of scale by unitization. During the break-bulk cargo era, large firms had no significant cost advantages over small lines; today the advantages lie with larger firms. A closer look at these advantages will provide some important insights into the economic pressures operating within the liner industry--pressures which unsubsidized lines are able to take advantage of more easily than subsidized firms. Such factors would become evident in the discussion concerning steps in the planning strategy, but a unified presentation will underscore their importance and also serve to emphasize the complexities with which planners will have to deal.

Economies of scale appear in three areas of a container operation: (1) operation of port facilities, (2) the number of containers required in the system, and (3) the operation of a computerized container control system. Similar benefits exist in a large-scale barge or lighter operation, but not to such a great extent because of the lower volume of barges or lighters.

A simple example with very rough estimates will illustrate benefits of economies of scale. Assume a small company is serving four ports on one trade route on a weekly basis with three containerships. Also assume a large firm is using 27 containerships to serve 12 ports located in several major trade routes. All 12 ports are interconnected by some complex schedule of overlapping trade routes where each ship visits four ports on a 21-day round-trip voyage, as in the previous case. For simplicity in the example, assume that all ships carry 500 40-foot containers. In the case of the small company each port will receive one ship per week and will handle 500 containers (250 unloaded, 250 loaded). In the case of the large company each port will receive three ships per week and will handle 1,500 containers (750 unloaded, 750 loaded).[8]

Operation of Port Facilities

Since stevedoring has become a capital-intensive operation, the cost per container moved decreases greatly with volume. One consultant estimated that:

> The cost of handling a container drops from $100 to approximately $30 as the weekly volume increases from

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8. Since three ships can make four port calls per week in the case of the smaller company, 27 ships or nine times as many should be able to make 36 or nine times as many port calls in the case of the larger firm. Since the latter company only serves 12 ports, each port receives three vessels per week.

500 containers to 1500 containers. Although the capacity of a typical container berth is at least 1500 containers per week, many berths are currently used for only one ship per week. As a result, the cost to steamship lines is close to $100 per container.[9]

If each ship handles 2,000 containers (1,000 unloaded, 1,000 loaded) per 21-day round-trip voyage, and makes 17 voyages per year, then each vessel will handle 34,000 containers per year.[10] In order to be more conservative than the consultant's estimate, let us assume that the cost of handling a container is $60 for the larger company and $100 for the smaller company. Consequently, the larger firm will save $1.36 million per ship per year on handling costs.[11] If this comparison were between a large unsubsidized operator and a small subsidized operator, the savings would more than eliminate the advantage of an annual operating differential subsidy appropriation of $700,000 per ship.

The Number of Containers Required in the System

One method of estimating the number of containers required uses the following equation derived by the National Academy of Sciences for a multiship, multiport system:[12]

$$N = (n + i)C$$

where N is the maximum number of containers required; n is the number of ports served; i is the number of ships in the fleet; and C is the number of containers carried on each ship. Using this equation we find that the small firm needs 3,500 containers, while the large company requires 19,500.[13] Hence, with nine times as many ships the large company only needs 5.6 times as many containers. If we convert these figures to show the number of containers needed per ship, we find that the large com-

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9. "Emerging Changes in the Container Revolution," Highway Research Record, No. 281, Robert A. Hammond, McKinsey & Company, New York, 1969, p. 10.

10. One week is lost for maintenance each year.

11. Each ship handles 34,000 containers x $40 saved per container = $1.36 million. This analysis does not consider additional costs which the larger operator might have to pay for additional terminal space or equipment to handle the larger volume of containers.

12. This equation is presented in Maritime Transportation of Unitized Cargo, op. cit., p. 70.

13. For the small firm, $N = (4 + 3)500 = 3{,}500$.
For the large firm, $N = (12 + 27)500 = 19{,}500$.

pany requires 445 fewer containers per vessel.[14] Steamship companies must also buy bogies which contain the wheels and suspension systems, etc., to use when moving their containers inland. If we assume the number of bogies purchased is one-third the number of containers, the large firm can save 148 bogies per ship in its fleet. The costs of containers and bogies varies widely. For this example, assume that the cost of a 40-foot container is $3,500 and the cost of a bogie is $4,500. If we assume that three sets of containers and bogies are needed during the 25-year life of a ship, the total cost savings on an annual basis will equal $267,000 per ship.[15]

Operation of a Computerized Container Control System

Economies of scale will also exist in the computerized container control system. Once the system is in operation, additional containers can be added at low incremental cost. The cost savings here will be less than in the other two examples so that no attempt will be made to pinpoint this value.

Implications for Strategy

This crude illustration has shown that definite economies of scale do exist for large firms carrying unitized cargo. In theory, a small firm can gain these benefits by joining together with other firms in terminal facilities and container pools. In practice, however, companies sharing terminal facilities have sometimes complained of poor service and little control over their operations. No large-scale container pools have yet been formed, evidently because companies do not wish to have others controlling their equipment.

The Planning Process

Economies of scale and other factors relevant to long-range planning will all be analyzed in a format outlined in Exhibit II-1. Starting with the present and forecasted market demand, the company must look at how this cargo could best be carried if there were such current restrictions as lack of port facilities or inland transportation systems, labor rules, customs procedures, etc. In this way the firm can develop some idea of what the industry may be like in 5 years, 10 years, or 20 years from now as it continues to rationalize its operations. Next, a company must look at what is possible in the present environment and analyze its own strengths and weaknesses as well as those of its

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14. Each vessel of the small company requires 1,167 containers, while each vessel of the large company requires 722 containers. The difference is 445 containers.

15. The total equipment savings over 25 years equals $6,670,500 per ship. Divided by 25 gives $267,000 per ship per year.

EXHIBIT II-1

PROPOSED STRATEGY*

Define System

Cargo Market Analysis and Forecast

↓

Find Theoretically Ideal Solution

↓

What is Possible Today

↓

What is Being Done Today

What is Planned by Competitors

↓

Self-Analysis of Strengths and Weaknesses

Comparison with Competitors

↓

Long-Range Strategy and Vessel Design

↓

Obtaining CDS Funds

↓

Updating the Analysis

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*The arrows in the diagram do not mean that the process cannot be iterative.

competitors.

At this point, company executives will have to formulate the alternatives open to their firm and to test the risks and advantages of each. They must then decide what role the company can play most effectively in the future environment, what types of service it should offer 5 years, or 10 or 20 years from now. Previous steps in the process have included presumptions on the economic and physical characteristics of the company's fleet, but only after a company has developed a corporate strategy and long-range planning program are the details of implementation decided upon. The ships must be selected to meet the company's objectives.

Subsidized lines require CDS funds to build new vessels. In order to obtain construction differential funds for its proposed ships, modifications in vessel design may be necessary. No analysis is so accurate that it will serve long without revision. The final feature of the planning process will establish machinery for updating the analysis and altering strategy or ship designs, if necessary.

The proposed planning process will require trying many alternative solutions to various problems. In addition, sensitivity analysis must be performed to identify the more critical factors. Although not essential, computer simulation techniques would be very valuable throughout this procedure.

Market Demand

A key factor in the proposed strategy is the forecast of market demand. With the advent of unitization the problem becomes more complex and more critical. Since ships will be more specialized in the cargo they handle, it is more important to analyze specific segments of the market rather than the aggregate general cargo market. Because the market is being fragmented, the problem of categorizing the cargo and predicting the growth for each segment becomes more complicated. Unless the data is properly structured, management will be limited in the alternatives they can analyze.

The present and future demand for cargo must be analyzed not only on the trade routes served by a company, but also in areas which could be affected by diversion of cargo. For example, with the use of unit trains or waterborne feeder service, cargo now in adjoining areas not served by a company could be diverted to those ports presently served or predicted to be served. A subsidized firm may also want to consider the possibility of sailing on new trade routes. These considerations will determine the regions in which the company should analyze trade.

Once a subsidized line has defined the geographic boundaries of its chosen system, it must look at the total flow of goods within this area. The analysis must even include cargo which the company believes it has no intention of carrying because only by viewing the total system can the firm be confident of seeing all relevant factors. For example, a liner firm may not be interested in carrying shipload lots of grain eastbound in its trade, preferring to leave this bulk cargo for tramp operators. However, by considering the volume and types of ships moving eastbound the company can better predict the freight rate competition between liners and tramps on the westbound voyage.

Origin and destination data on cargo movements, rather than just port-to-port information, are desirable whenever possible. Such knowledge will aid in consolidation of freight.

The demand for cargo must be broken down into: (1) bulk cargo--wet and dry, (2) general cargo--containerizable and non-containerizable, and (3) roll-on roll-off cargo. Special commodities, such as coffee, which make up a significant segment of the cargo on certain trade routes, will also deserve special attention. Some of the cargo mentioned above may belong in more than one category. For example, vehicular traffic, although belonging to the roll-on roll-off category, might also be containerizable. This should be noted in the analysis. All cargo must be analyzed in relation to weight and volume per revenue ton. Cargo must be divided between commercial and government cargo since the profit on each may be quite different. This data will show the volume required by the cargo as well as its profitability.

Categorizing cargo types and forecasting demand is an extremely difficult and expensive task for a steamship line. However, once the information has been gathered, a company can use it in its operations and scheduling as well as its long-range planning. Hopefully, the problem of gathering data will be lessened by research financed by the government. The Department of Commerce has sponsored studies on projections of bulk cargoes.[16] In addition, the Department of Transportation has sponsored studies which included forecasts for demand of containerizable and other types of cargoes.[17] The government has also spent one million dollars on studies aimed at determining ship designs to meet the needs of the future.[18] These types of studies should

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16. Such studies are the Forecast of U.S. Oceanborne Foreign Trade in Dry Bulk Commodities by Booz-Allen Applied Research, Inc., Bethesda, Md., 1969, and Projections of Principle U.S. Dry Bulk Commodity Seaborne Imports and Exports for 1975 and 1995, Stanford Research Institute, Menlo Park, Calif., 1969.

17. Such studies are Oceanborne Shipping: Demand and Technology Forecast by Litton Systems, Inc., Culver City, Calif., 1968, and Transoceanic Cargo Study by Planning Research Corporation, Los Angeles, Calif., 1971.

18. Newport News Shipbuilding and Dry Dock Co. and Bath Iron Works Corp. were the two prime contractors for these studies.

be particularly valuable to companies for looking at certain types of cargo or particular trade routes which are not within the firm's present sphere of operations.

Analyzing the Ideal System

Once the company has made its cargo forecast, it should consider the most economical means of providing the origin-to-destination movement of all the cargo within this system without regard to such restrictions as current labor practices, government regulations, port facilities, lack of inland transportation or intermodal cooperation, technology, or other generally practiced methods of operation. In considering the origin-to-destination movement, a firm must analyze the costs of packaging and handling at the factory as well as at the port. The cost of inland transportation and freight consolidation must also be considered.

By disregarding current restrictions, a company can get an idea of the size and type of fleet along with the inland transportation networks needed to carry all the cargo in the system under ideal conditions. This may include vessel types and feeder systems not in use today.

In this stage of the analysis ships need only be defined by the following parameters: construction cost, operating cost, carrying capacity, speed, and cargo-handling rate. Note that, since the economic analysis places a value on time as well as transportation cost, air freight will be a competitive factor in these studies.

Naturally, a study of this sort cannot expect to be completely accurate. However, general trends can be predicted, and untried methods of transportation can be tested at least tentatively. This section of the analysis invites the company to look beyond presently practiced methods, thus providing the opportunity for innovation. Men who were not constrained by the status quo have been responsible for 33-knot containerships and barge-carrying vessels. By looking at more than just one segment of the cargo market, Matson developed combination container-bulk sugar ships and combination container-automobile-carrying vessels.

Determining What Is Possible Today

Once the company has considered what could happen under ideal conditions, it should return to reality. This step should distinguish between real obstacles and those created by a failure to rationalize the system. Upon examination the line may discover that certain vessel types or feeder systems are in fact practical even though unused today. A long-distance container train currently not in use because of lack of cooperation between railroad companies or certain countries might be arranged. Consolidation of cargo at inland points might be economical by building certain facilities. Certain capital-intensive operations not currently in use may only need new methods of financing to become possible. Here is the occasion to investigate methods to improve the status quo.

Of course, the company may also discover that many operations it had planned are currently infeasible. Maybe inland transportation of an underdeveloped country cannot support a proposed containership operation. Possibly canals are not wide enough to take certain lighters the company had in mind. Port congestion might make necessary turn-around times impossible. Customs regulations between countries might hinder the planned inland movement of cargo. Structural difficulties may prevent the construction of ships as large as planned. Companies using private or contract carriers in certain areas might make consolidation of particular cargoes impractical.

Artificial cost barriers may also bar the most economical movement of cargo. For example, longshoreman rates might favor lighters over ships. Seamen's wage rates may favor using a tug and barge combination rather than a self-propelled ship. Government restrictions giving cargo preference on certain goods to ships of its own flag might make certain backhaul assumptions in the ideal situation impractical.

All of these factors that prohibit the ideal solution will modify the size and type of fleet needed. This fleet structure must be recalculated to find the best way to move the cargo under present conditions. Note that the fleets of individual companies have not yet entered into the analysis. Except for cargo which is required to go in bottoms of certain national flags, the remaining goods simply travel in ships unspecified as to company or country. However, at this point the company can realize how current restrictions are hindering the ideal solution. The line can also calculate the economic effect of removing certain obstacles either technological or institutional.

The Present Environment

Now the company must look at how the cargo in the system is actually being carried today. The firm will probably discover that many of today's inefficient ships would be forced out of business if the ships proposed in the previous analyses were built. Inefficient liners currently operating may be totally dependent on the artificial rate structure of the conference system for their existence. The fleet providing the cargo movement today is a result of many factors in the environment. The factors below all affect the movement of cargo; therefore, they all play a part in determining the size, speed, and type of vessels which are currently used.

War-Built Fleet

Many ships currently in service were built during World War II. The purchase of these ships at artificially low prices has discouraged the construction of new vessels of different designs. However, as these vessels become economically obsolete in the next decade, they will be replaced. The new fleet which will probably be more in line with the outcome of the previous analyses examining the most economical movement of cargo.

Port Conditions

The various ports in the system may differ in terms of depth of water, terminal facilities, amount of port congestion, safety from storms, and distance from ocean. To reach some ports may require passing through locks to reach a particular harbor, incurring a time delay.

Labor Conditions

The labor conditions at various ports as well as aboard ship may vary by union or region. Ports anxious to obtain a share of the container business might be more liberal in their stevedoring terms. The cooperation of various seamen's unions will determine which company or which country can use certain advances in ship automation.

Government Regulations

Regulations by various government agencies relating to customs procedures, bills of lading, etc., affect cargo movement. In addition, regulations for carrying cargo between countries inland may influence the type of transportation chosen. Subsidized lines are affected by the need to obtain MARAD approval to change foreign areas served or frequency of sailings. Cargo preference offered by many governments to ships of their own flag is reflected in present fleet operations.

Inland Operations

The inland operations serving a port are important, whether they are inland waterways, truck or rail. The possibilities of inland container pools and container trains will affect the ability to consolidate large amounts of cargo needed for huge unitized-cargo ships.

Financial Considerations

Entering the unitized-cargo market will entail a considerable investment in ships, containers, terminal facilities, and loading and unloading equipment. In addition, start-up costs will be incurred in establishing a computerized container system, retraining salesmen, and setting up a research staff.

Construction Differential Subsidy Funds

Since U.S.-subsidized lines require CDS funds in their ship construction, the availability of such funds will affect the amount of new subsidized construction. Standardized vessel designs may appear as a result of government pressure in trying to find ways of lowering construction costs. A company may also decide that, rather than wait for new construction or CDS funds, it would be more advantageous to convert their present ships or buy ships from another company.

Conference Agreements

The use of conference and various pooling agreements may affect the design of vessels. If a line cannot charge lower prices to attract more cargo for a large economical ship, there is less incentive to take advantage of economies of scale in the size of vessels. Also if a company cannot compete on price, there is an incentive to build ships faster than would otherwise be economically optimal. In this way a firm can have an advantage by providing faster service at the same price.

The Competitive Environment

By now the company has investigated how the cargo moves within its system and has realized the obstacles to improving the system. At this point the company must analyze its strengths and weaknesses, including share of market, types of cargo now carried, number of vessels as well as type and age, other equipment, management, sales force, trade routes, subsidiaries, and finances. This appraisal must also be duplicated for its competitors including their vessels under construction and their plans for the future. Then the company can evaluate who is now providing these services needed for the future.

Another factor to be considered is the action-reaction effect of one firm to the change in the operations of its competitor. For example, consider a situation in which one company places a full containership in the liner market of a system which is composed entirely of break-bulk cargo operators. A number of "what if" simulations will show the effect on competitors' operations of various numbers of full containerships using various lower freight rates.

Note that a company must study the cost structure of its competitors as well as its own in order to understand the process of action and reaction in the environment. Under certain market conditions a subsidized line may feel that changing from break-bulk cargo ships to full containerships will produce only a marginal operation. However, an unsubsidized line looking at the same situation may view it differently. Since the unsubsidized line does not receive up to $700,000 per ship in ODS funds, it realizes that it cannot compete side by side against a subsidized operator in break-bulk cargo operations. By using a capital intensive container operation the unsubsidized operator can reduce the competitive advantage of ODS funds. For example, if an equal amount of cargo per year can be moved by the containership operation of an unsubsidized line with only one-third as many ships as its subsidized competitor using break-bulk cargo vessels, the competitive advantage of ODS funds has been reduced two-thirds.

A subsidized break-bulk cargo operator must also realize that the economies of scale with unitized-cargo operations can work to his disadvantage. For example, a larger established operator of containerships might be able to start service on a new trade by adding only one container terminal operation, one sales office, and by rescheduling a few ships. Not only does this allow a low start-up cost for the containership operator, but the added cargo obtained on this trade route may be handled at very little incremental cost in the high fixed-cost container operation. Simulations for various "what if" situations may show the subsidized break-bulk cargo line that, despite its reluctance to containerize, containerships will eventually come to its trade route and that its only choice will be to start a unitized-cargo operation or be driven out of the liner business.

At this point the subsidized line knows where it stands relative to its competitors. Equally important, it knows how the present methods of transportation can be improved in providing the origin-to-destination movement of cargo in its system. Because the company is aware of the optimum system and changes in the present system, it has an idea what the fleet in its system will look like five, ten, or twenty years from now.

Strategic Planning

With this information, each subsidized line must decide what role it wishes to play in the future. A company may have to decide whether it is willing to make a major change in its operations. A break-bulk cargo operator, for example, must decide if it wants to become a large-scale carrier of unitized cargo, a change which will require a huge investment and equipment. Just as there is the danger that a company may blindly refuse to change its mode of operation, there is also the danger that a company may blindly change its mode of operation without properly examining its environment.

One alternative open to a subsidized line is to retire from the steamship business. In fact, the influence of profit-oriented conglomerates in the steamship industry may cause the elimination of some steamship operations. Another alternative is to become an unsubsidized line. Because containerization is subject to economies of scale, a small liner firm may elect to merge with another steamship company. The analytical steps up to now will act as a valuable tool in determining the firm's long-range strategy; however, a program for planning is only as creative as the alternatives posed and only as valuable as the ability of management to evaluate it.

Long-Range Planning and Vessel Design

Assuming the company has decided to continue as a subsidized operator, the most important factor necessary in carrying out the long-range strategy of the company will be its choice of vessels. Most subsidized lines currently are in the process of building or planning new construction or conversions. These activities are a result of a desire to adopt new technology or to fulfill a contractual obligation to replace their vessels. With the company's long-range strategy determined, the data already gathered can be used to provide the choice of ship design necessary to meet this objective.

Just as choosing the ship design is part of long-range planning, there are many other related factors involved in a decision to become a unitized cargo carrier. "What if" simulations, using the data from previous analyses, will be a valuable management aid in making many of the following decisions: the number and sizes of containers or barges, whether to buy or lease them, whether to establish inland container pools, and whether to own and operate its marine terminal facilities. New personnel will probably be needed and the sales force will need retraining. A marketing strategy must be developed to meet the needs of the shipper rather than simply allowing him to use the port-to-port service provided by the Company.

Obtaining CDS Funds

If a subsidized line has decided to change from a break-bulk cargo operator to a carrier of unitized cargo, it is imperative that it build or convert ships to carry out this strategy. The best planning process can result in dismal failure if the Maritime Subsidy Board will not allocate CDS to a firm for new construction. Since the Board has favored standardized ship designs for more than one company, a subsidized line must look at the consequences of choosing an established ship design. If the company has created a new design, it should consider trying to convince other companies to use this design too. Since fiscal year 1967 the Board has stressed productivity in its CDS allocations. Consequently, a company must consider whether the cost of making its design more productive, larger and/or faster, is worth the advantages, if any, in helping it to receive CDS funds.

If the CDS funds appropriated by Congress are not sufficient to finance the proposed new construction of the company, the firm may be forced to settle for converting present tonnage, a move that would require a smaller CDS allocation. Converting present tonnage has the advantage of being quicker as well as requiring a lower investment. Naturally, conversions have the disadvantages that part of the company's fleet is temporarily out of use, that the resultant ship design probably is less than ideal, and that its life is shorter than that of a new ship.

Updating of the Analysis

In the past a company may have waited eight years from the time its original initial decision was made until the final ship in that flight was in service. Consequently, a subsidized line must be able to evaluate changes in the environment and, if necessary, be prepared to change its design and even its long-term strategy. Sensitivity analysis will show that the choice of ship design will probably be based on a number of critical factors, such as a high growth rate for containerizable cargo, liberal work rules for unloading cargo from barges, or a certain construction cost for a new type of ship.

At the time a decision on ship design is reached, procedures should be established to continue measuring these critical factors in the future. If a critical factor changes unfavorably, an alternative strategy must be available. Periodically, perhaps every six months, the new information on these critical factors should be recorded and used to update the original analysis. Such factors as unexpected growth, or technological breakthroughs in construction techniques should be analyzed to see how they affect the initial decision. After ship construction is completed, the company should continue updating the analysis so that it can be used in the long-range planning process between vessel replacements. The analyses may also prove valuable in determining schedule or route changes, effects of new labor rules, and effects of actions by the competition.

Organizational Structure

The proposed strategy for planning vessel replacement will require more time and effort than most subsidized lines are currently allotting to this function. However, when a company is considering an investment of over $100 million, the preinvestment analysis is not the place to cut corners. Since the penalty of designing the wrong ship can be the failure of the company, the importance of proper analysis should not be underestimated.

The number of staff members assigned to research and planning in the past has varied widely with different companies. Some subsidized lines have relied on executive committees to analyze data collected by operating personnel. On the other hand, Matson managed to build up a staff of more than 30 persons devoting themselves fully to the task of research; however, this group carried outside contracts in addition to serving the internal needs of Matson.[19] Most subsidized lines will probably decide to organize somewhere between these two extremes.

Every company should have a corporate planning director who has both the responsibility and authority associated with long-range planning and corporate strategy. At the very least this man must keep up to date on published research and outline and review work done by outside consultants. Hopefully, he can organize a small staff inside the subsidized line which can devote its energies to researching and analyzing the environment for planning purposes.

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19. This group has now diminished in size to concentrate solely on the problems of Matson.

The exact organizational structure to cope with the planning process will vary according to the environment and long-range strategy of each company. A company whose strategy is to become a worldwide supplier of integrated transportation services and logistics can expect to build up a substantial research staff. On the other hand, a very small break-bulk cargo operator who services only a small share of the market and desires to continue in this strategy may feel he can put little emphasis on planning. However, it is imperative this this company analyze the suitability of container operations of its trade route and realize the consequences of having full containerships as competition.

Many companies may feel that, because of lack of internal competence in certain areas, consultants should be used to a large extent in the planning process. This may be appropriate for some companies; however, the subsidized line must have the capability to understand and evaluate a consultant's report and the expertise to implement the course of action recommended.

The management of a steamship line providing break-bulk cargo service for several decades will now have to acquire competence in the area of intermodal transportation in order to enter the unitized-cargo market. This knowledge is not so critical for companies operating barge-carrying ships as for containership operators. In some instances the barges can be emptied and loaded directly at the port; thus, the liner firm is providing only a port-to-port service. However, to the extent that the barges carry general cargo rather than just bulk cargo, a containership operator will eventually compete for this cargo offering a door-to-door service. Consequently, to understand and evaluate his competition and also his general cargo market, the barge-carrying ship operator must understand the inland transportation system.

Probability of Success

The proposed strategy presents a process which forces management to look beyond the status quo and allows them to plan for the future in a systematic manner. Using this procedure will ensure that vessel replacement will become part of long-range planning.

The reader may respond to this proposed strategy by saying, "Sure, if you want to spend large amounts of money on research and computer simulations, you can come up with some interesting results; but is it all worth the cost and can you guarantee that you will get a more profitable flight of new ships?"

It is not possible to pinpoint how much money should be spent on analysis. However, if a company is considering an investment of $100 million on new ships, containers, other equipment, and start-up costs, is it unreasonable to spend five per cent of this investment on planning and analysis? How about one per cent? Or one-half of one per cent? Or one-tenth of one per cent? If subsidized lines merely use planning processes of the break-bulk cargo era, even this last figure will not be met in many cases. Although a specific amount of money for future planning cannot be given, there can be no doubt that more emphasis must be placed in this area in this era of unitized cargo.

Using the proposed strategy for planning vessel replacement does not guarantee success. In the first place, it is not obvious that all necessary data of the origin-to-destination movement of cargo can be accumulated at present by expending a great amount of time and effort. Secondly, factors beyond the control of the subsidized line, such as government regulations, labor union rules, and erratic growth or decline of cargo movements of certain commodities, cannot always be accurately predicted.

Nevertheless, using the proposed strategy should increase the probability of success over a company that ignores formulating a long-range strategy or treats the problem superficially. Costly mistakes can be avoided if a company understands its environment. Current diseconomies in a system can be eliminated if a firm has done more than follow tradition. Changes in markets, competitors, strategies, etc., can be anticipated, and response to unexpected change can even be allowed for, if a company looks ahead imaginatively. Planning cannot guarantee success, but no planning can guarantee incurring economic penalties. Companies that cannot afford to plan cannot afford to be in business in the current complex environment of the maritime industry.

GOVERNMENT REGULATIONS AND FLEXIBILITY IN OPERATIONS

The Disadvantages of Subsidy

Sea-Land and Matson have both been successful innovators in the field of containerization. As unsubsidized lines they have not been impeded by government regulations.[20] Containerization started in the domestic trades as a result of the threat of financial ruin, the protection from foreign competitors and subsidized lines in these trades, and the ability to obtain war-built vessels at an artificially low cost. As these two lines grew, they finally expanded into the U.S. foreign trades and are now direct competitors of the subsidized lines.

The subsidized lines have two main advantages over the unsubsidized companies: construction differential subsidy and operating differential subsidy. The CDS funds allow the subsidized lines to build in U.S. shipyards while paying only the foreign shipbuilding cost. For the unsubsidized lines to construct new ships in U.S. yards would cost them about two-thirds more than if they went to foreign shipyards. The unsubsidized lines do have the option of building overseas; however, these ships cannot be

20. Various government agencies regulate the freight rates of all U.S. common carriers, both subsidized and unsubsidized. The regulations referred to here are those affecting the company's ability to operate its equipment and its finances as it wishes.

used in the domestic trades and for three years cannot carry the 50 per cent of government-sponsored nondefense cargo reserved for U.S. bottoms.

The ODS funds are given to subsidized lines to put their vessel operating expenses on an equal basis with those of foreign lines. For a Mariner class vessel, these funds can amount to $700,000 per year. Unsubsidized lines do not receive this form of government aid.

Although not receiving the forms of government aid described above, the unsubsidized liner firms possess many advantages which aid them in their innovations: (1) unrestricted movement of ships; (2) unrestricted acquisition of vessels, and (3) unrestricted financial operations.

Trade Routes and Sailing Frequency

The unsubsidized lines are not restricted in their trade routes, schedules, or frequency of sailings as are the subsidized lines. This means that the unsubsidized fleets can move their operations to certain areas to meet peak demands whether these conditions are caused by commercial factors or movement of government cargo restricted to U.S. bottoms. Unlike subsidized lines, they can charter vessels, either U.S. or foreign flag, as they wish. Consequently, if they want to enter a new trade route with little investment, the extra ships needed can be chartered.

As of June 30, 1971, the 12 subsidized lines provided service on 28 different trade routes.[21] Trade routes 5-7-8-9 are actually considered as one trade route on the North Atlantic since any company running on one of these routes provides service on all four. Consequently, there are really 25 different trade routes being used. Each subsidized line provides service on an average of 2.1 subsidized trade routes. Therefore, under the present situation, as the unsubsidized lines continue to expand their operations to reap the benefits of economies of scale, they will be free to serve any or all of the 25 different trade routes while the subsidized lines will be severely restricted.

Obtaining New Vessels

In addition, the unsubsidized lines are not ensnarled in bureaucratic red tape while trying to run their operations. Government procedures can be particularly harmful in acquiring new ships. During a period of transition it is essential that a company have the proper type of vessels to meet the competition. However, when many subsidized lines are crying for new vessels at the same time, the government programs become less able to respond quickly. Before the Maritime Subsidy Board allows a contract with CDS to be awarded, it must conduct both technical and economic

21. 1971 Annual Report of the Maritime Administration, pp. 71-72.

studies. Government agencies may propose twelve or thirteen hundred changes before the vessel design is approved.[22] Moreover, not only must a company wait to have its design approved, but it must also compete against other subsidized lines when CDS funds are limited.

A steamship line hopes to choose a design which will maximize its return on investment to the company. On the other hand, the government is interested in producing the most benefits for each dollar of CDS. Therefore, it often rewards high productivity in designs and also considers the savings in ODS which can come from replacing many older ships with a smaller number of new ones. Consequently, CDS allocations may bypass ship designs promising the highest return on investment to the company in favor of less profitable ones which will produce more benefits from the viewpoint of the government. In this instance, the subsidized line with the ship design promising the better return on investment to its company must simply wait until Congress appropriates enough CDS to reach its place in the waiting line.

Even after the contract is awarded, construction may be delayed until the shipyard has completed some of its previous backlog of work. The subsidized line may have to wait longer for his ship to be built in a U.S. yard than his foreign competitor does purchasing his vessels in the world market. Consequently, the subsidized line may have little incentive to innovate by building a new ship design if a foreign competitor can copy this design and have a vessel in service before the subsidized ship is launched.

The unsubsidized lines can get quick delivery of their vessels by either using foreign shipyards for new construction or U.S. yards for conversions. For example, Sea-Land recently completed a containership conversion to a capacity of 622 35-foot containers. Less than a year elapsed for contract negotiations, vessel design, model testing, detail engineering, shipyard fabrication, erection, and testing time.[23] Subsidized lines making applications to the Maritime Subsidy Board for either conversions or new construction have waited more than twice the time just to get a contract awarded. Prudential Lines, the first company in the world to decide to build LASH design vessels, waited about three years before the government awarded a construction contract. Prudential waited about one and three-quarters years for the keel to be laid. After almost five years of waiting, they had little to show for their efforts. However, while this subsidized line was still waiting for its ships, another line

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22. U.S. Congress, House, Committee on Merchant Marine and Fisheries, Subcommittee on Merchant Marine, Long-Range Maritime Program, Hearings, 90th Cong., 2nd Session, April-May 1968, p. 185.

23. "Speedy Conversion Pays Off for Owner," Marine Engineering/Log, Vol. 75, No. 1, January 1970, p. 66.

received delivery of a LASH vessel from a foreign shipyard, although it contracted for construction at a later date than Prudential.

Investment Performance

Operating flexibility has helped the unsubsidized perform well financially. Note that for the years 1965-1968 no subsidized line listed in Fortune, "Fifty Largest Transportation Companies," surpassed the return on investment produced by Matson and Sea-Land, as shown in Exhibit II-2.[24] Since the subsidized and unsubsidized lines operated in different environments, the values of R.O.I. in Exhibit 2 are not directly comparable. However, this exhibit does show that, by innovating, Sea-Land and Matson have been able to get a higher return on their investments operating in their unsubsidized environment than have their corresponding subsidized counterparts.

Recommendations for the Subsidy Program

The Merchant Marine Act of 1970 has done much to aid the subsidized steamship industry. No longer will a lack of CDS funds exist to prevent subsidized firms from buying ships. Liberalization of certain regulations will give subsidized lines more freedom in their operations and fewer bookkeeping chores. Although much has been done to give the subsidized firms more flexibility, still more remains to be accomplished.

Trade routes should be consolidated into regions giving each subsidized line a larger area within which to operate. Regulations regarding minimum and maximum numbers of sailings should be liberalized to give subsidized companies more freedom and to provide them with fewer bureaucratic procedures. Regulations regarding chartering should also be made more flexible. The procedures for obtaining CDS funds and government-guaranteed mortgage financing should be streamlined. It is important to note that these recommendations should be carried out without penalizing the unsubsidized lines that have performed a valuable public service by bringing innovation to the maritime world.

Some persons may feel that allowing subsidized lines to have greater flexibility in their operations over more trade routes would only lead to destructive rate cutting and disaster. However, at the present time chaos does not exist even though 75 per cent of the U.S. commercial oceanborne commerce is carried by foreign-flag carriers. If the majority of the vessels serving the United States which are foreign are not severely hindered by

24. Smaller companies not listed in Fortune, "Fifty Largest Transportation Companies," might have had a greater R.O.I. than Matson or Sea-Land. In the future, however, smaller companies will not be able to take advantage of economies of scale possible with unitized cargo.

EXHIBIT II-2

STEAMSHIP LINES IN FORTUNE

"FIFTY LARGEST TRANSPORTATION COMPANIES"[1]

Steamship Line	Net Income as a Per Cent of Invested Capital			
	1965	1966	1967	1968
McLean Industries (Sea-Land)[2]	21.4	18.3	20.5	20.3
Matson Navigation	11.3	13.4	9.6	9.9[3]
United States Lines	6.7	5.9	0.02	*
American President Lines	9.5	10.2	9.6	8.5
Moore-McCormack	1.9	8.3	*	*
Lykes	N.A.	N.A.	3.6	6.9
American Export Isbrandtsen	8.0	5.7	2.3	4.9

N.A. - Not Available. This company not listed in Fortune that year.

* indicates a net loss for the company that year.

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1. Fortune, July 15, 1966, pp. 258-259, June 15, 1967, pp. 222-223, June 15, 1968, pp. 214-215, May 15, 1969, pp. 196-197. The fifty companies chosen are those with the highest operating revenues.

2. The vast majority of the business of McLean Industries was conducted by its subsidiary Sea-Land. In 1969 McLean Industries merged with R. J. Reynolds Tobacco Company whose transactions do not appear in this exhibit.

3. Matson was merged into Alexander and Baldwin in March 1969. This figure is for Alexander and Baldwin, including Matson Navigation.

U.S. government regulations, why should one small segment of the ships be penalized just because they are subsidized?

The recommendations to allow subsidized lines more freedom in the management of their finances would simply provide the opportunity for these companies to operate in a normal business-like manner in a competitive environment. As Manual Diaz, former President of American Export Isbrandtsen Lines stated:

> If the management of a subsidized liner company is so inefficient and so incapable of competing in today's business world, it should not be protected-- it should be allowed to go into bankruptcy.[25]

Government safeguards could be maintained by obligating the lines to replace their ships at the end of their actual economic life as determined by environmental conditions and by periodic auditing of the company's books as is done for normal businesses. Since the granting of the above reforms would give the subsidized lines more freedom in the planning of their resources, this would place still more importance on their planning ability. With the forces of the marketplace more directly affecting the subsidized lines, the public investment in the U.S. Merchant Marine will produce a stronger subsidized liner fleet.

CONCLUSIONS

Unitized-cargo operations demand new types of planning in the subsidized steamship industry. Ship replacement must now be viewed as an integral part of corporate strategy and long-range planning. Using the strategy for planning subsidized vessel replacement proposed in this paper will help management in achieving this objective. The suggested changes in government regulations will eliminate one of the institutional obstacles to such a system of planning and will produce a stronger U.S. subsidized liner fleet.

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25. Long-Range Maritime Program, Hearings, op. cit., p. 525.

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The letters f and t refer to figures and tables, respectively.