Px-PB4-1910

THE PALEMBANG PORT AND SHIPPING STUDY

VOLUME III

CHANGES IN SHIPPING PATTERNS

Changes in Shipping Patterns

Table of Contents

SECTION	TITLE	PAGE
	Table of Contents	i
	List of Figures	iii
	List of Tables	iv
1.0	INTRODUCTION	1
2.0	TRENDS IN SHIP TECHNOLOGY	4
2.1	Ship Characteristics	10
2.2	Ship Operating Technology	16
2.2.1	Docking and Mooring Technology	17
2.2.2	Propulsion Technology	19
2.2.3	Materials in Ship Construction and Operation	24
3.0	CARGO HANDLING TECHNOLOGY	26
3.1	Cargo Handling and Transfer	26
3.2	Cargo Storage	29
3.3	Physical Form and Packaging of Commodities	31
3.4	Projected Trend in Cargo Handling Technology	34
4.0	DEVELOPMENT OF OCEAN SHIPPING	37
4.1	Changing Role of Ocean Transport	37
4.2	Ocean Transport Capacity and Investment	40
4.3	Shipbuilding Capacity	51
4.4	Effects on Interinsular and International Shipping Serving South Sumatra	51
4.5	Effects of Changes in Energy Supply and Balance on Ocean Transport Demand	59

SECTION	TITLE	PAGE
4.6	Projections of Demand, Supply and Cost of Ocean Transport	69
4.7	Interisland Transport and Barge Transport	71
5.0	PORT TECHNOLOGY DEVELOPMENTS	72
5.1	Terminals	73
5.1.1	Offshore	73
5.1.2	Inshore	74
5.2	Port Approaches	74
5.3	Port Equipment	75
5.4	Integrated Ocean and Feeder Transport	77
5.5	Deep Draft Terminal Developments	78
6.0	DEVELOPMENTS, CAPABILITY AND CAPACITY OF FOREIGN PORTS	80
6.1	Trading Ports (including potential trading partners)	83
6.2	Competing Ports (including potential projected competing ports)	83
7.0	DEVELOPMENTS IN SHIPPING AND THEIR EFFECT ON THE PORT OF PALEMBANG	86

List of Figures

FIGURE	TITLE	PAGE
2.0-1	Trends in Ship Technology	5
2.0-2	Classification of Containerships	7
2.1-1	Trend in Vessel Size	12
2.1-2	Tanker and Dry Bulk Carrier - Dimension Relationship and Draft Variation	15
2.2-1	Specific Fuel Consumption Vs Pounds/SHP	21
4.2-1	Projected Demand for Shipping Capacity (World)	42
4.2-2	Projected Supply of Shipping Capacity (World)	43
4.3-1	Output and Capacity of World Shipbuilding	52
4.3-2	Shipbuilding Delivery Projections	54
4.3-3	Relationship Between Vessel Size and Construction Cost of Bulk Carriers	55
4.3-4	Construction Cost of GC Liners, Containerships, and LNG Carriers	56
4.5-1	Fuel Cost Differential	68
7.0-1	World Fleet Type of Vessel - Regional Distribution	88

List of Tables

TABLE	TITLE	PAGE
2.0-1	Ship Technology Aspects	9
2.2-1	Basic Types of Power Plants	22
3.3-1	Container Types and Cargoes	32
4.2-1	Shipping Capacity	50
4.3-1	Shipyard Capacity and Existing Orders*	53
4.5-1	Cost of Energy and Energy Transport	60
4.5-2	Investment in Fuel (Energy) Production and Transportation Facilities	61
4.5-3	Consumption of Energy by Transportation	62
6.0-1	World Container Ports	81
6.0-2	Terminal Facilities for VLCCs	82

1.0 INTRODUCTION

Recent technological developments in ocean transportation have affected shipping terminals, cargo transfer, feeder operations, and all related activities. The large increase in the unit size of ships during the 1950-1975 period introduced major changes in ship structural configuration and hull design. The large unit powers required to propel such vessels resulted in the introduction of new prime movers and major developments in thruster design. Many commodities have assumed different physical form for each of handling. This has affected the configuration of ships and resulted in the development of new types of ships and cargo handling equipment.

The intimate interdependence of ocean transportation, terminal operations, and inland or coastal transport is increasingly recognized. Therefore, terminals are designed to serve the interest of integrated commodity transportation, and not just the parochial interest of a singular mode, such as ships.

Major changes in technology and operations are designed to meet specific requirements. In turn, significantly different financial and managerial approaches are called for. The trend is towards specialized ocean transportation links. The unit size of the modern shipping company or systems transportation operator is today much larger than that of a few years ago. This is particularly obvious in international shipping with Indonesia interisland shipping as yet operating under the more traditional conditions.

Increasing concern with social, environmental and other effects introduces another dimension to future

developments in ocean transportation. Automation of many ship functions, such as navigation, cargo transfer, cargo planning, ship berthing (or mooring) and more are available technologies. Efficient and reliable pollution prevention and pollutant separation technology for both air and water have been developed. A whole range of technology affecting human comfort are customary items on new vessels.

As with all rapidly developing technology, we progress in some areas more rapidly than in others. Consequently, we are often unable or unwilling to utilize all existing development. A large number of technological voids therefore exists. These vary from more effective underwater hull coatings to prevent fouling and hull deterioration, to advanced large propulsion and thrust devices with attractive specific weight and fuel consumption. The massive elimination of manual functions in the operation of increasingly large and complex ships has transformed most of the ship's crew into observers of control operations including control of predictable excursions. The monotony of the resulting tasks requires a complete reevaluation of the traditional functions of ship crews. Similar problems exist increasingly in port operations and other ocean transportation related activities.

The changes in ship, cargo handling and port technology and the resulting effects on operational methods and shipping economics have had drastic effects. It is the purpose of this section to review these technological developments in shipping and cargo handling methods and project developments which are likely to affect future shipping patterns and hence the

traffic distribution in the port of Palembang. In particular, we are concerned with the trend of developments in shipping, including ship size, commodity specialization, physical form of commodities, prospective new material handling methods, intermodal transfer technology, ship handling technology and automation, as well as changes in ship support services requirements that would influence the type and extent of facilities required in the port of Palembang, both to meet Short Term Improvements as well as long term needs of inter-island and international shipping. The major economic relocations of the last few years have resulted in a massive shipping slump and, in particular, in tanker shipping. Increased fuel costs affect both the demand for petroleum, coal and gas shipping as well as the type, size, and form of the optimum ship for a particular service. We are today at the crossroads of additional changes in shipping technology where economies of scale will be only one of the many criteria, and not necessarily the most important one.

2.0 TRENDS IN SHIP TECHNOLOGY

During recent years, waterborne transportation has been subjected to an ever-increasing amount of specialization, scale of operations and intermodal integration. This, in turn, has resulted in many new ship types, cargo transfer systems, port equipments, and other types of facilities.

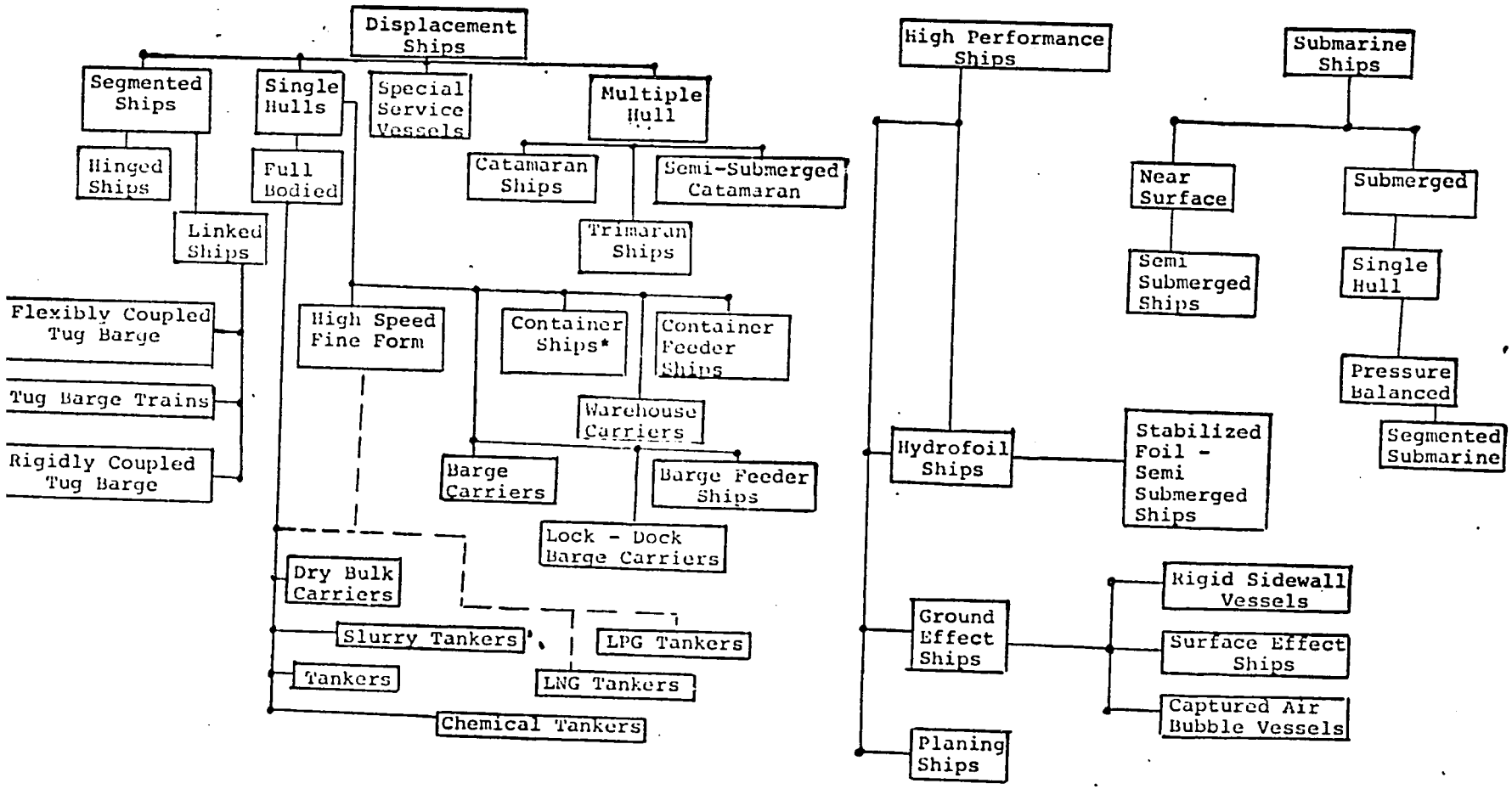
The functions of shipping have multiplied with changes in physical form, packaging and handling of cargoes. Similarly, many commodities never carried by ships before are now transported efficiently by waterborne vessels. Until recently, cargo-carrying ocean vessels could be simply divided into:

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 aspects of ship technology are presented in Figure III-2.0-1.

Developments in these technological areas have avvected ship design and operations as well as port and terminal requirements. Although most established facilities at Palembang are designed to meet the needs of established interisland and international shipping, which as yet uses traditional technology, consideration must be given to technological developments which are rapidly adopted by shipping and ports serving the South East Asian area. Technological changes will continue and our aim is, therefore, to project ship and port technology developments over the planning horizon



*See Detailed Chart

Figure III - 2.0-1

Trends in Ship Technology

to the year 2000. These results will then serve to establish the port design requirements which will assure that port facilities will meet future technological requirements and not have built in obsolescence.

In addition to one hull displacement ships, there are now under consideration or in use segmented 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. These are derivations from ocean push tug-barge designs using a number of flexible, semi-rigid, and rigid coupling systems. Some years ago, pin-jointed 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 III-2.0-1 can be further classified as in Figure III-2.0-2 for containerships.

Catamaran tug-barges have recently been constructed because they offer reliable ocean tug-barges coupling. While surface effect ships (SES, CAB and Rigid Sidewall Vessels) are now used only for short distances, passenger and auto transport, it appears that near term developments may permit the use of such vessels for high value cargo transport on short trans-ocean routes as well.

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

Submarine cargo carriers have been extensively investigated. Designs for submarine liquid bulk cargo 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

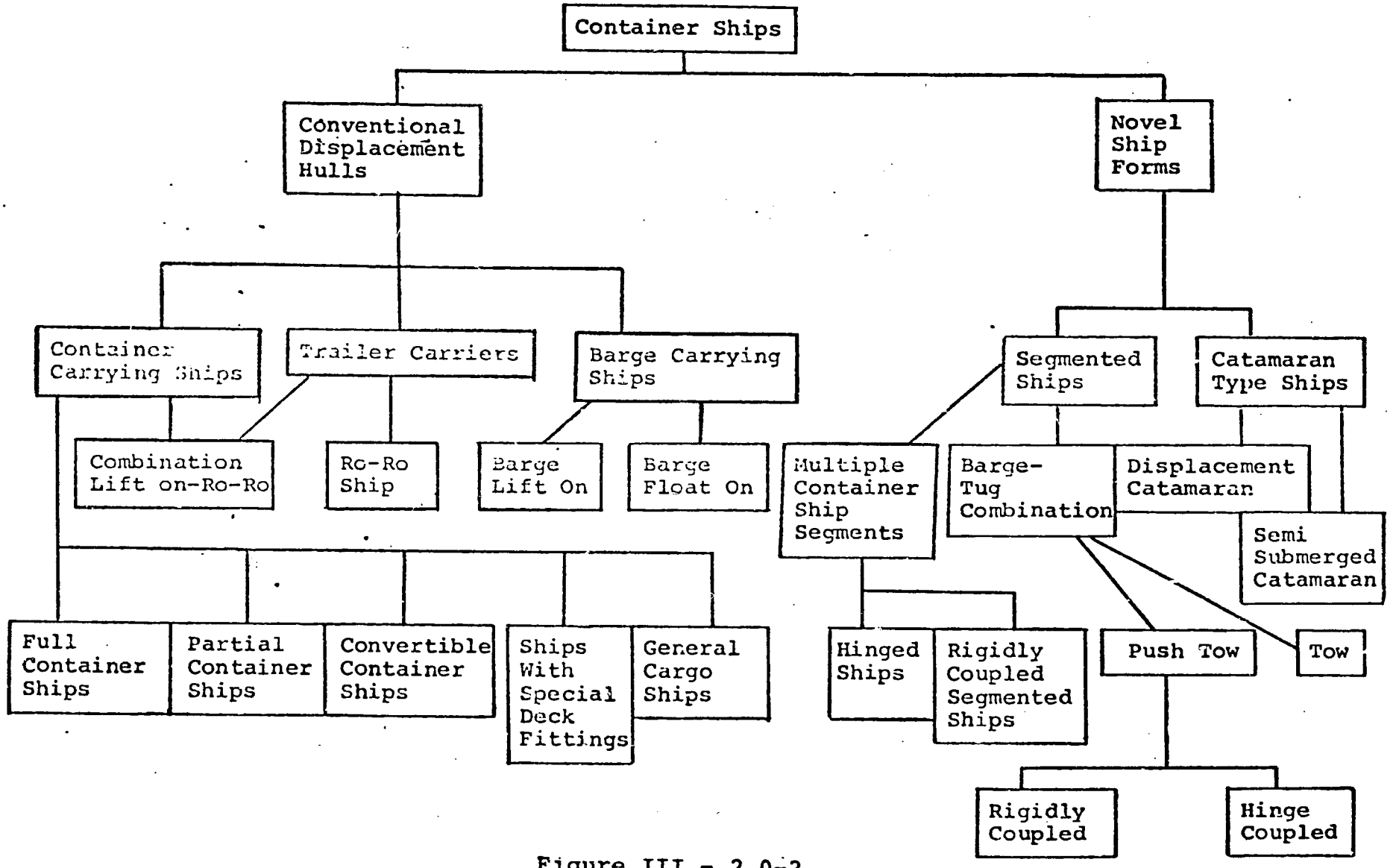


Figure III - 2.0-2

Classification of Containerships

more conventional displacement type vessels.

Bulk commodity transportation is similarly in a flux. Many more commodities are now moved in bulk than ever before. Physical form changes, such as liquid or two-phase slurry flows of dry-bulk commodities are increasingly popular. New efficient mechanical, hydraulic, pneumatic, electro-magnetic or other bulk material transfer and handling devices have revolutionized bulk commodity transportation. Condition and environmental control of commodities in transport permit close maintenance of quality requirements. New methods of bulk storage permit effective bulk transport network flow planning. All these and other factors have introduced major economies of scale to bulk commodity transportation, but have also brought new technological problems. Some new aspects in ship technology are presented in Table III-2.0-1.

All the above factors have a pronounced effect on the short and long development of shipping patterns in Indonesia. Considering these factors in turn we divide our study into:

a) Trends in ship characteristics (2.1)
b) Trends in ship operating technology (2.2)
c) Developments in cargo handling methods (3.0)
d) Effect of likely developments in shipping on shipping traffic potentially served by the port of Palembang (4.0)
e) Influence on the type, form and capacity of port facilities and equipment required in the port of Palembang (5.0)

In the following sections, the factors causing changes in shipping patterns are discussed.

Table III 2.0-1

Ship Technology Aspects

Machinery

- Steam - Advanced Steam Free Piston Drives
- Cogas
- Gas Turbine (various cycles)
- Coday
- Codog
- Direct Drive Diesel
- Geared Diesel
- Nuclear Plant (compact including Shielding-Safety-Control)

Transmission

- Superconducting Electric Conversion
- Electric Conversion - DC/AC - Solid State Rectification
- Epicylic Gears - Nested Gears, etc.

Propulsion

- Fixed Pitch Propellers (various Skews - Thicknesses, etc.)
- Controllable Pitch Propellers
- Contra - Rotating Propellers
- Water-Jet
- Two phase Jet
- Supercharged Two Phase Jet
- Nacelle Superconducting Drives

Energy Conversion

- Fossil Fuel - Combustion
- Nuclear Fuel
- Fuel Cell
- Thermionic

Control

- Electronic
- Pneumatic
- Hydraulic
  - Remote
  - Automatic
  - Semi Automatic
    - Casualty Switching
    - Programmed Start-Up - Switching
    - Manual Start Up - Switching
- Monitors - Recorders - Alarms
- Navigation - Inertial - Satellite
  - Automatic - Semi Automatic

Ship Handling

- Automatic Mooring Water/Air Jet Fenders
- Anchoring
- Position Keeping
- Maneuverability
  - Side Thrusters
    - Bow-Stern-Retractable-Waterjet
- Boats and Rafts

Cargo Handling

- Cranes
- Winch and Derricks
- Steulken and Heavy Lift
- Elevators - Pallet Loaders
- Gantries
- Belt Loaders - Unloaders
- Pneumatic Loaders - Unloaders
- Aircushion Devices
- Hydrocushion Pallets
- Channel Movers
- Bridge Cranes
- Monorails
- Side Porters
- Ramps (Retractable) Fixed
- False Decks - Rolling Decks
- Conveyors - Escalators
- Liquid-Dry-Slurry Pump-Piping
- Linear Motor Drive
- Snaking - Towing Devices
- Marine Railways - Dollies
- Lowboy Trailers - Forklifts
- Container Loaders - Jacklift

Terminal Facilities

- Piers-Marginal-Finger-Floating
- Stable Platforms
- Fendering and Mooring
- Shiphandling
- Marshalling - Warehousing
- Cranes - Gentries - Mobile elevators
- Continuous Chain Warehouses - Loaders
- Multi Level Storage
- Air/Hydro Cushion Devices
- Mobile Equipment
- Cargo Weighting - Masking
- Management Information Systems
- Terminal Facilities Control
- Computer Use for Cargo - Information and Facilities Control
- Documentation Handling

Interface Technology

- Barge Handling
- Intership Movement of Cargo
- Helicopter/Ship Cargo Handling
- Stern - Side Handling of water borne equipment
- Ground Effect Machine/Ship Handling

Ship Types

- Displacement Ship
- Mammoth Bulk (Liquid or Dry) Carriers
- Container Ships
- Catamaran - multiple hull displacement ships
- Semi Submerged Catamarans
- Semi Submerged Vessels
- Submarines (Near Surface or Deep)
- Hydrofoils
- GEM
- Captured Airbubble
- Planing Hulls
- Articulated Ships
- Segmented Ships
- Barge Carriers
- Wet Well - Dry Well Ships
- Hybrid Ship Types
- Dock Ships
- Ro-Ro Ships
- Warehouse Ship Types
- Barge Trains

Hull Technology

- Developable Surface Hull
- Flat Stiffened Panel Hull
- Long-Transverse-Hybrid Formed Hull
- High Strength Steel Ships
- Aluminum or Hybrid Metal Hulls
- Plastics - Fiberglass use in Hull Construction
- Insulation and Coating
- Auto Corrosives
- Frictional Resistance Reducing Coatings
  - Polymers - Coatings
  - Air Emmission
- Modularization
- Alignment - Automated Welding

2.1 Ship Characteristics

Total direct and indirect operating costs of dry and liquid bulk carriers are expected to generally decrease with size up to a limit and as a function of investment cost, and operating including fuel costs.

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 success. As a result, the total cost of transporting bulk cargoes differs appreciably even for identical ships.

It now appears that although tanker sizes continue to increase, the rate of growth of economic tanker capacity will diminish appreciably, and is expected to level off at below the popular VLCC size of the last few years. The average size of crude oil tankers 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. increase 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 tankers 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, has 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 experience has dictated the use of most of these ships on defined and specialized trade routes. Excess containership capacity is expected to increasingly infiltrate traditional liner services to Asian countries.

The general expected trend in maximum vessel size for tankers, dry bulk carriers and containerships is presented in Figure III-2.1-1. There are some indications that although the maximum size of vessels

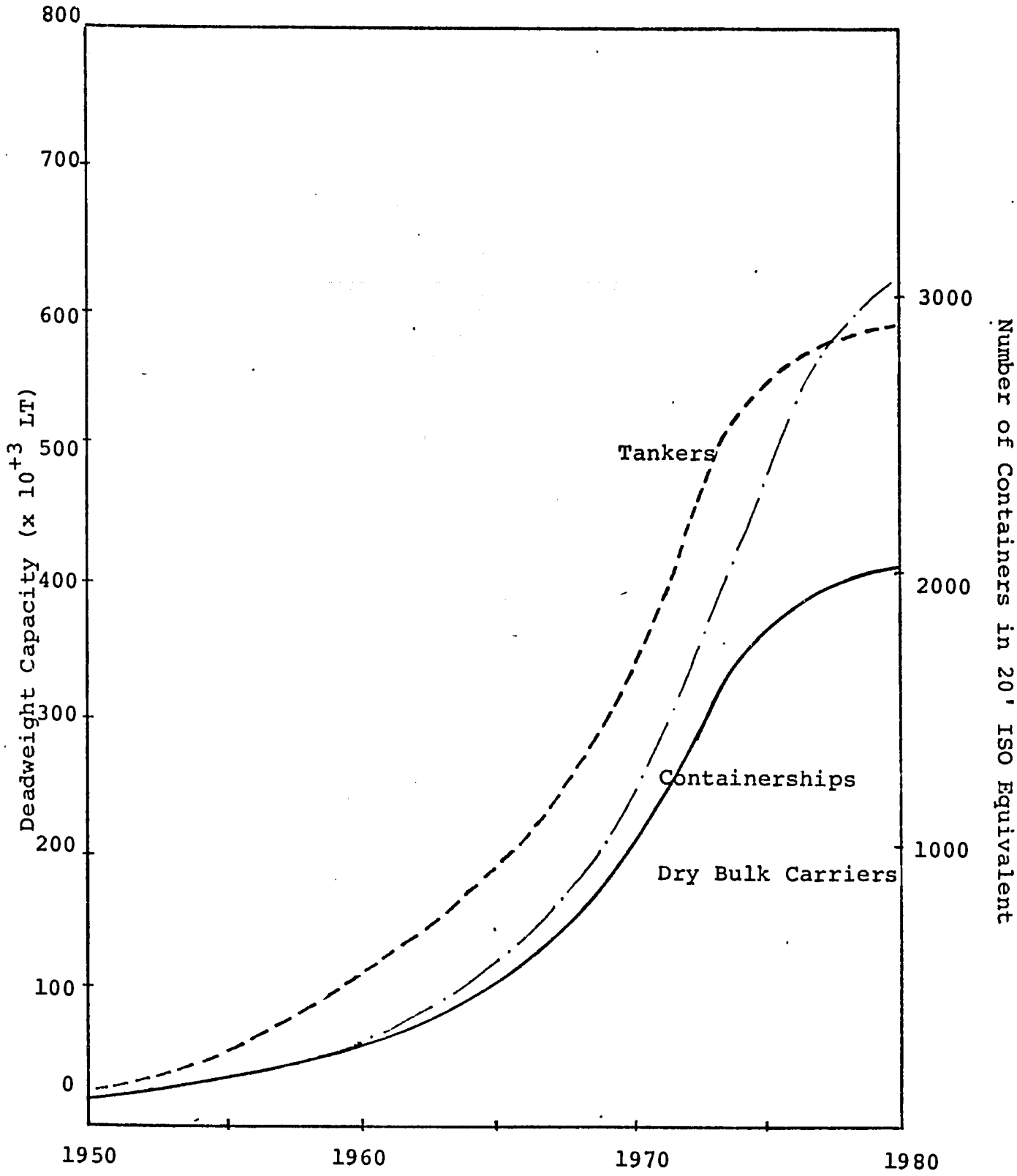


Figure III-2.1-1
Trend in Vessel Size

will continue to grow, the growth of the average ship delivered or in operation will slow down to a near standstill after 1975, when the tonnage demands for the major high intensity bulk trade routes are met by the delivery of mammoth carriers on order. The existing tanker tonnage in 1976 is expected to meet crude tanker demand until the mid nineteen eighties. This trend will continue with some demand for small product tankers and small to medium sized dry bulk carriers.

Among high performance ships, the rigid sidewall SES appears to offer the most significant near-term potential. SES of 2000 tons displacement with transocean capability are expected to be operational in 1977-1980. SES of 10,000 tons displacement are planned for 1985.

Catamaran and semi-submerged catamaran ships are of increasing interest. Though such vessels are currently only used for stable platform barge feeder service and research work, with some exception, transocean catamaran cargo and passenger carriers of about 10,000 DWT are expected to be in operation by 1985. Their high volumetric 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 high value trades.

An important consideration in port planning is the overall relationship of ship dimensions to ship deadweight capacity and thereby to the economy of size. Although containerships with fully loaded drafts in excess of 40 feet have been built, there are few in the Asian trades which are expected to operate at fully loaded drafts exceeding 36 feet within the next ten years because of the comparatively low density of container-

izable cargo on these trade routes. As a result, dry and liquid bulk carriers are generally the ships which will determine the depth requirements at ports. Figure III-2.1-2 shows the relationship of draft of dry and liquid bulk carriers to their deadweight, length and beam.

For example, a 50,000 DWT bulk carrier will range in draft from 35-40 feet, and have a length of 670-690 feet, and a corresponding beam of 100-110 feet.

Ocean barging has become a major component in many bulk trades. Well over 50% of coastal petroleum transport in the USA, for example, is today performed by specialized push-towed ocean going barges of sizes up to 80,000 DWT. It is expected that transocean barge transport will enter the short to medium range transocean trades before the end of this decade. Oceangoing barges and tugs are appreciably cheaper to purchase and operate than equal capacity and speed self-propelled ships. They furthermore offer advantages in operational manning, scheduling flexibility and design. Similarly, oceangoing barges operate at appreciably lesser draft than ships of equal deadweight capacity and provide inexpensive floating storage or warehousing which is important in trades with or among developing countries. It is expected, therefore, that ocean barging will continue to make major inroads into short and medium bulk commodity routes traditionally served by conventional ships.

Another type of vessel, increasingly popular on short feeder routes, is the handy sized container, Ro-Ro, or bulk carrier. These are usually simple vessels designed for their specific trade. Their sizes range from 3,000 - 10,000 DWT and they are universally

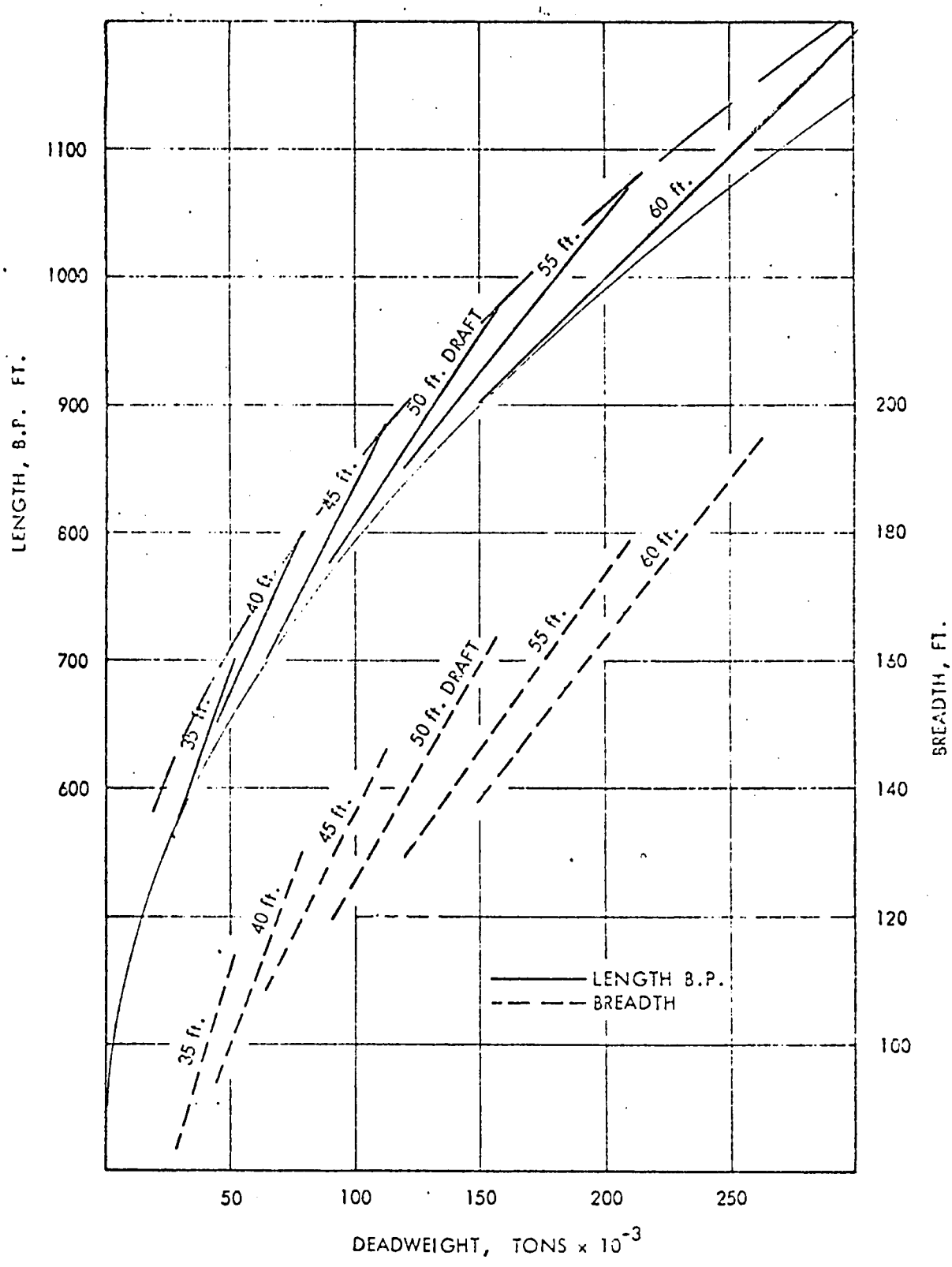


Figure III -2.1-2

Tanker and Drybulk Carrier -

Dimension Relationship and Draft Variation

equipped with superios maneuverability, and efficient cargo transfer and storage to assure fast turnaround and, as a result, high utilization.

Major advances have also been made in the development of LNG, LPG and other types of liquified gas carriers. They are the most publicized of a large number of vessels which carry cargoes efficiently by a change of the traditional physical form of the cargo, which is transformed into a more efficient form for ocean transport. Other carriers in this category are slurry tankers, and various types of chemical carriers.

The development of these transports has attracted many new cargoes to ocean transportation. It is expected that they will play an increasingly important role in ocean transport.

2.2 Ship Operating Technology

The changes in ship type, form and dimension have been paralleled by changes in ship operations. In this section, we will only discuss these as they effect port facilities and operations with cargo handling and transfer covered in Section 3.0.

Even with the increase in size and complexity of modern ships, manning is continually reduced. Large VLCC tankers sail today with crews of as few as 26 and fast complex containerships may have as few as 28 men crews. This is largely the result of the introduction of labor-saving devices and automation. Only running and emergency repairs are generally performed by ship crews these days, with voyage maintenance and repair work delegated to shorestaff. Full or semi-automation is used in:

a) Machinery or propulsion system control with remote and/or automatic controls
b) Navigation with autopilot systems
c) Collision avoidance and grounding avoidance systems based on radar and depth sounder control
d) Cargo system and ballast control
e) Damage detection and countermeasure control
f) Traffic and routing control including weather routing by computerized optimum routing and course determination
g) Ship information systems such as logkeeping, cargo information, ship condition, accounting and other data is stored, retrieved, aggregated and processed automatically by special purpose centralized computer on many ships
h) Docking, mooring, including berth approach systems by laser or acoustic docking control combined with constant or controlled tension mooring winch systems

There are numerous ship operations and systems not mentioned above which can and occasionally are automated. These include cargo control, cargo planning, cargo transfer sequencing, machinery scheduled maintenance, ship supply, accounting, environmental control and more.

2.2.1 Docking and Mooring Technology

From a docking point of view, the most important recent developments are in the area of maneuvering assist devices such as bow and stern side-thrusters, active rudders and side water jets. Also important are

auxiliary stopping devices such as stopping flags, separating rudders and more. Increasing use of controllable, reversible-pitch propellers introduce additional improvement into the maneuverability and docking ability of all kinds of ships. These are also important developments in close-quarter navigation, docking communication and control, such as acoustic or laser sensors which serve to accurately determine direction and distance to berth. The above developments are all designed to improve the safety and time requirements of docking maneuvers.

They are also a step towards automation of docking and mooring operations which will in the future be performed by many ships using only bridge control, often without the assitance of tugs or even mooring (line handling) crews.

We are approaching the time when new ships will be largely unmanned. They will have only a skeleton crew of as few as ten men, independent of the size of the ship. This crew will be supervisory, with all basic ship functions performed automatively. Machinery spaces are expected to be completely unmanned, with only a supervisory bridge watch being kept to over-ride automatic controls in times of emergency.

Collision avoidance and automation of most ship functions by feedback, analog or digital computer control is available technologically. Maneuvering assist devices are installed today on many important new vessels. Docking or better mooring of vessels still requires unnecessary manpower. Automation of this function will become more attractive now when an increasing number of ships are designed to serve specified ports or terminals

throughout their life, and terminal systems can be adapted to specific ship characteristics. Full automation of ships with essentially zero manning is available now, but will not be accepted for many years to come. It is expected, though, that commercial ships will sail with skeleton supervisory crews of 12-25 men whose sole function will be to inspect performance of fully automated ships and over-ride controls only in case of malfunction. Recent experience with fully automated cargo systems on tankers, for example, show that a much higher degree of reliability is attainable than by reliance on human decisions only.

Ship supplies are increasingly unitized. Many new vessels carry containerized shipstore systems, with complete dry and refrigerated store containers exchanged for unstocked units at the terminal ports. Mechanical hoist and rail systems are incorporated to allow the ship to handle and store containers independently.

2.2.2 Propulsion Technology

The most important developments are expected to occur in ship propulsion.

a) medium-speed diesel propulsion (heavy fuel burning) with extensive supercharging, and therefore higher mean effective pressures are feasible. Future diesel engines will consume less than 0.35 lbs. of residual fuel per SHP/hr.

b) In certain trades and for very large unit outputs (40,000 SHP plus) steam turbine propulsion will remain of interest. Boilers may be fed by coal, synthetic (coal derived liquid

fuel) or powdered coal suspension in liquid fuel. Reheat boilers will be greatly improved by the use of better materials and multi-stage feed-heating and air preheating will become of greater interest. This type of plant will singularly be of application to LNG carriers.

c) Marinized industrial type gas turbines with preheat and interchanger heaters are now available. While initially of primary interest for application on LNG carriers and containerships, this type of propulsion plant is expected to later offer real competition to diesel propulsion on other types of vessels.

d) Direct drive diesels are expected to hold their own because of simplicity and low fuel consumption, but will increasingly suffer because of weight and cost as medium speed diesels and gas turbines cover higher unit outputs and achieve reliable operations when burning residual fuels. Relations of specific fuel consumption versus specific weight of marine propulsion plant are shown in Figure III-2.2-1. The range of power plants of potential use for marine propulsion is listed in Table III-2.2-1. The most dramatic improvements are achievable in combined plants, such as diesel and gas turbine, steam and gas turbine and diesel and low pressure steam.

The main question is the potential use of nuclear propulsion on shipboard. Nuclear plants can be built (pressurized water) with fuel costs of about 55% that of

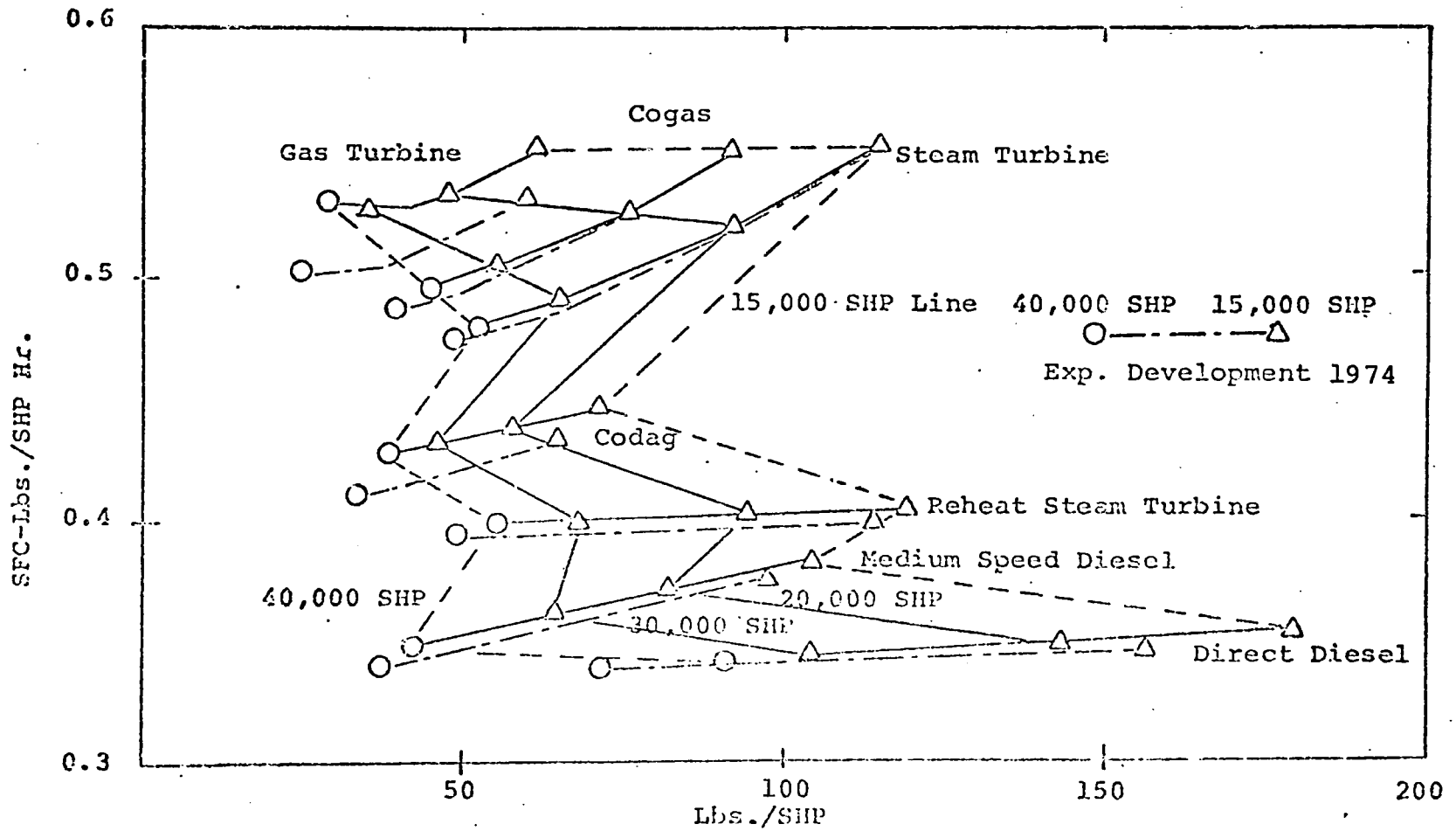


Figure III - 2.2-1

Specific Fuel Consumption vs. Pounds/SHP
(Marine Propulsion Plants)

Table III-2.2-1

Basic 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 Steam Turbine with

      1. Natural Circulation Boilers (Simple or Reheat)
      2. Forced Circulation Boilers
      3. Once-through Boilers
      4. Hybrid Boilers

   B. Nuclear with reactors that are

      1. Water Cooled (Pressurized water-boiling water)
      2. Gas Cooled
      3. Other Coolants and Moderators

IV. Fuel Cells

V. Superconducing Electrical Machinery (This is really a transmission system alternative.)

VI. Thermoelectric Power Conversion

VII. Thermo-Ionic Power Conversion

VIII. Magnetohydrodynamic Propulsion

Typical Combined Power Plants

I. Gas Turbine & Diesel or Steam
II. Diesel & Gas Turbine or Steam

equivalent output diesel plants, for outputs in excess of 40,000 SHP. The initial cost differential for a 40,000 SHP plant is about $26 million and for an 80,000 SHP plant about $38 million, including shielding and collision protection. Fuel cost savings will amortize this added capital cost in about thirteen years for the 40,000 SHP plant and in 8.5 years for the 80,000 SHP plant. In other words, a nuclear propelled tanker of 400,000 DWT with a seventeen knot speed (60,000 SHP) would save about 14% of its total operating costs over a twenty year life, assuming constant October, 1975 fuel costs and a 10% rate of interest. The main problem is environmental, social, and political acceptability of nuclear-propelled ships. One possible approach is the use of a nuclear tug propelling a jumbo tank barge. The tank barge would be equipped with take home power to propel it at maneuvering speed (6-8 knots) and permit its entry as a conventional propelled vessel into ports. The nuclear tug would be designed to remain outside a 12-200 mile limit from the coast and only enter coastal waters at specified intervals and at specified nuclear maintenance equipped ports.

Considering the next decade though, the probability of major technical, regulatory, social, and political developments permitting extensive use of nuclear marine propulsion are very slim. As the lead time for nuclear vessels is in excess of six years, we do not expect nuclear propulsion to have an impact on marine transportation before 1984.

2.2.3 Materials in Ship Construction and Operation

The most important developments in material use are expected to be in:

a) Fabrication and welding of conventional steels

b) More extensive use of fiberglass and composite materials in superstructure and outfitting of ships

c) Improved material surface preparation and coatings which eliminate wastage. Such improved coatings will also greatly reduce ship maintenance costs and downtime. They will similarly reduce adhesion of barnacles and other speed-reducing factors. In turn, docking and inspection frequency and time will be lower.

d) High-tensile steels are expected to be in greater use because the cost differential will be lower as a percentage of erected steel cost. The hull weight saving will result in appreciably higher percentage revenue-earning capacity and lower fuel cost when compared to 1972-73 or earlier. Therefore, more extensive consideration will be given to the use of higher-strength steels than before.

In addition to the above developments in materials use which affect primarily vessel construction, there are developments in materials which affect ship operations. These are of use in inerting of cargo spaces, fire fighting, pollution prevention or retention, pollution clean-up and general ship maintenance. In recent use increasing use of various types of steel matrix or composite materials is also made in floating marine structures or ships.

Prestressed reinforced precast concrete, for example, is used in the construction of floating and gravity storage platforms as well as barges, floating breakwaters and more recently ships. Ferro cement is used in the construction of vessels of up to 220' in length as are fiberglass and various composite material substances. An important development is the availability of modern adhesives, many of which provide joint strength exceeding that of conventional welded, rivetted or screwed joints. In fact, many adhesives provide a joint that is stronger then the connected materials. Adhesives permit joining of many diverse materials permitting more effective material use in shipbuilding for lower cost construction and operation.

3.0 CARGO HANDLING TECHNOLOGY

The role of ports is undergoing major changes. Ports serve increasingly larger hinterlands. Ports are now, therefore, generally referred to as either regional or local (feeder) ports. This trend has a major influence on port planning, jurisdiction, regulation and development.

Ports are an interface between inter or intra-modal transport and not a service by themselves. As a result, ports are decreasingly called upon to serve as a distribution or collection center, but are designed to perform basically inter or intra transport transfer service.

3.1 Cargo Handling and Transfer

The technology of cargo handling and transfer is greatly affected by changes in physical form and packaging of cargoes. The major developments can be summarized as follows:

a) Container and trailer movements will enter the minor break bulk trades of the world. As a result, it is expected that well over 50% of all break bulk ton-miles of ocean shipping will be handled by containerships, with first and second generation containerships replaced by third generation ships from major routes serving the minor or newer trades. (Over 46 ports handling less than one million tons of break bulk cargo per year are currently planning or building new container terminals.)

b) Container transfer in many major terminals (100,000 ETU year plus) are expected to be

automated with conveyor, mono-duo-rail or other continuous flow transfer methods installed. Automatic stacking and retrieval methods are also expected to be installed in such terminals within the next ten years. Container handling rates of 100,000 ETU's per simple berth are now accepted.

c) Dry bulk handling in slurry form, or by pneumatic pumps at rates of thousands of tons per hour will become more accepted. More than 50% of coal and ore in ocean trade is expected to be transferred to and from ships in slurry form by 1985. On long routes with short loading feeders, it may be loaded dry and unloaded as shipboard mixed slurry (Marcona System, etc.).

d) More commodities will be handled in bulk. Cement which is still largely shipped in break bulk is expected to be handled almost exclusively in bulk by 1985. Wine, milk, juices, chemicals, solvents, paints, latex and many more commodities will be served by specialized transfer systems serving specialized bulk carriers.

e) Aerial tramways, monorails, and similar transfer system will provide low cost and simple transfer not only for offshore terminals, but also to connect inland storage to offshore or coastal terminals where right-to-way costs, shortest route, connection, and distance are major considerations.

f) Underwater conduits may well be in operation

serving offshore terminals or bottom loading/ unloading systems for ships.

g) A significant number of dry bulk carriers are being equipped with self unloading gear (graps, conveyor, bucket, clamshell, catenery, etc.) with capacities of 400-800 tons per hour. This approach is attractive where delivery of dry bulk cargo is intermittent, low rate, and destined to small ports. It may also make sense where the ocean distance is very short. The availability of economic fixed shorebased unloaders such as Huelett, Buckett, belt, continuous bucket chain, catenery, clam systems makes it usually more attractive to place the unloading system ashore. Not only is there an opportunity for higher equipment utilization, but shore based equipment can usually also be better maintained and more cheaply installed and operated. Finally, we must consider the last deadweight capacity resulting from onboard carriage of such heavy equipment.

h) Palletization has been universally accepted for the handling of non-containerizable break bulk or general cargo. It offers major advantages in handling and stowage rates as well as stacking and storage. Although only few automated or mechanical pallet shiploaders are in use, in hold and pierside forklift pallet handling permits at least a 30% improvement in cargo handling rates compared to sling or net type operations. Although

standard (4' x 4' or similar metric) pallets are usually used for bagged, barrel, or other packaged cargo, larger pallets are increasingly being used for cars, machinery, plywood, rubber boles and other types of cargo. Pallets may strap cylindrical tanks or be equipped with cornerposts for easy and efficient stacking.

i) While Roll-on/Roll-off (Ro-Ro) cargo transfer has largely developed to facilitate vehicle (trailers, trucks, cars, etc.) transport and transfer, an increasing number of Ro-Ro vessels now carry also containerized and palletized cargo moved onto and off the ship by forklift, sideloader or tractor trailers. This type of operation is particularly attractive on short to medium range trade routes with a high percentage of bagged, outsize or other not readily containerizable cargo.

3.2 Cargo Storage

The major developments in cargo storage are expected to occur in the use of collapsible containers with rigid or flexible walls. Flexible, inflatable or erectable containers for dry bulk, liquid bulk, or break bulk cargo will be in general use to eliminate back-haul or empties. We also expect a much higher degree of standardization and exchangeability of containers of all sorts. These will be based on standard pallets and rigid wall containers will simply be one form of stackable pallet.

New inerting, ventilating and cycling or agitation techniques are expected to provide greater cargo safety.

While vertical cell type containerships provide the bulk of containership capacity, future generations of containerships are expected to include warehouse type vessels in which blocks of containers are moved horizontally in and out of a shelf type vessel with stern and/or side access to the shelf storage decks.

There is also increasing interest in multihull type vessels such as catamarans or semi submerged catamarans. These vessels are designed to straddle finger pier and lift off or discharge completely pre-coupled blocks of containers or prestored warehouses.

Storage or cargo in general cargo ship hold is also undergoing major change with air cushion pallet, portable jacking, portable forklift, or portable tower-elevator equipment facilitating working within ship holds to facilitate loading or unloading of cargo.

Improvements have been made to permit pseudo bulk cargoes to be moved in bulk. Pseudo bulk cargo is the name given to bulkable liquid or dry cargoes which usually do not move in sufficient quantities to warrant specialized ship use or which require special handling if shipped in bulk. The advent of barge carriers, container sized tanks, parcel tankers and parcel bulkers, now provides an opportunity for bulkable cargoes to be moved in bulk even if shipments are as small as 40 tons. The use of these modern methods of pseudo bulk cargo storage also eliminates the need for special loading/unloading equipment at the loading or unloading port (or on shipboard). Bulk handling equipment is then only needed at the shippers and/or consignees own facilities. New methods of cargo containment, insulation, storage compartment material use, design and surface treatment permit maintenance of cargo quality for in excess of

that achieved now. As a result, we now ship liquefied natural and refined gas, refined vegetable oils, solvents, wine, milk, fruit juices, vegetables and other commodities which are highly susceptible to environmental conditions. Latex, rubber, process coffee, agricultural produce and similar cargoes will as a result be shipped in the future by cheaper methods and in a form which permits better integration with inland feeders, while maintaining a higher level of quality control in transport. A major advantage of the newly developing storage methods is the reduced requirement for extensive and expensive packaging for cargo maintenance and stowage.

3.3 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 III-3.3-1. 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

Table III - 3.3-1

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

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 (Marcona 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 psecialized receiving terminals.

The availability and method of processing various plastic packaging materials has introduced major changes in the physical form and opportunity for packaging of break bulk dry cargo. Many cargoes which were difficult, if not impossible to transport by sea because of fragility, sensitivity to environment, surface finish, or simple usable life when exposed can now be hermitially, safely, and inexpensively packaged for transport by sea. As a result, many new commodities are now so transported.

There are also many novel methods for the packaging and handling of manufactured goods such as cars, machinery, appliances, electronics, communications equipment and more. Disposable and collapsible reusable containers or packages are increasingly used.

Liquid and dry bulk commodities are now often unitized by the use of collapsible flexible containers made of rubber, plastic or reinforced fabric. Such units may be carried on board or may be towed over short distances. The advantage of such containment extends to both loading and unloading points where the collapsible containment provides efficient temporary storage of the goods. In general, it is found that the physical form change and use of modern packaging or containment of goods offers major economies not only in the cost of transfer and shipping, but also in storage and feeder transport costs.

3.4 Projected Trend in Cargo Handling Technology

Container transfer rates of up to 30-35 containers (20' equivalents) (or 300-500 tons) per hour are today

achieved by container gantry cranes. As a result, transfer rates of up to 1200 tons/hour per berth served by 3 gantry cranes have been noted. Similar transfer rates are achievable by barge carriers served by shipboard equipment such as barge gantries or synchro-lift elevators. Future developments are expected to involve automated container terminals which include automatic container transfer to and from trucks, rail-cars, and barges, to and from ships. Automatic container identification and routing methods using computerized read-off equipment are already available and can be readily adapted to existing container transfer and handling systems. 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 conveyors, 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 as much as a hundred tons/hour per hatch will be achievable for most palletized cargoes. Most of the equipment for these operations will probably be shorecased to achieve meaningful equipment utilization. Dry bulk cargoes can now be transferred at rates of up to 5000 tons/per hour depending on equipment used and commodity handled. In slurry form transfer

rates of up to 12,000 tons/hour of slurried cargo can be achieved. These rates are expected to double by 1985.

Liquid bulk cargo has benefited by the largest increase in handling rates. Some existing mammoth tankers offer discharge rates in excess of 20,000 tons/hour now, though the method of transfer may change appreciably. Increasing use of mammoth tankers and remote offshore deepwater terminals, for example, may require multi-stage 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 5,000 m^3/hour are achievable today, a rate that is expected to double by 1980.

Additional developments are occuring in specialized handling such as lumber, newsprint, petrochemicals, etc.

Modern timber (barge or ship) carriers are usually equipped with continuous chain type loading gear which permits logs to be loaded from the water continuously and with practically no human help. Pools of logs are floated against the side of the vessel, and are aligned and maintained as a rigid, floating block by constant tensioned wires. Twin log loaders then roll log by log up the side and over the deck and into the hold of the vessel. Loading and discharge rates by these methods approach as much as 400 tons/hour.

Specialized newsprint carriers, cement vessels and others are similarly equipped with modern and efficient cargo handling equipment.

4.0 DEVELOPMENT OF OCEAN SHIPPING

4.1 The Changing Role of Ocean Transport

While it is too early to say how changing economic factors (or realities) such as the effects of increased energy costs, shift of capital balance, increased costs of major commodities, changing commodity flows, and others will drive developments in ocean transport, there are a number of factors which will definitely affect future development.

a) Crude petroleum will be carried in decreasing amounts as more crude is refined by the producers and more crude is produced nearer the consumers. This trend is expected to result in a leveling of crude ton-mile transport by 1978-1979 and a gradual reduction of total crude ton-mile transport demand by 1%/year thereafter.

b) As a result, the demand for large crude carriers can be expected to decrease, while the demand for smaller product carriers will increase. The greatest market opportunities today are for handy sized 20-80,000 DWT product carriers.

c) The large increase in fuel cost has resulted in new concepts of economic cost, size and speed of ships of all types in all the different trades. Similarly, choice of design and use of ship propulsion plant, method and system must now be reviewed. Steam turbine vessels are becoming less popular and combined (steam-diesel-gas turbine) plants are being considered again.

d) Changes in major commodity flows, physical form and value of commodities introduce opportunities for new types of ships, cargo transfer and cargo stowage. It also introduces demands for new and better facilities in ports. Because of the capital intensity of new transfer systems, timely decision making is imperative.

e) Offshore platforms serving as resources exploitation (oil, ore, gas, etc.) terminals or commodity storage facilities will increasingly serve as one end of an ocean transport trade route. There may be interplatform trades and shipping services which use no conventional ports at all.

f) Increasing nationalization of major commodity (oil, gas, beauxite, ore, etc.) production will force traditional oil, gas, aluminum, steel and other primary commodity corporations to retrench in refining and marketing activities. Ocean transport and distribution is expected to become a battlefield with both nationalized, producers and traditional refiner/marketeers trying to gain controlling interests. The major loser is expected to be the independent ship operator who historically provided the bulk of such shipping capacity.

g) Increasing cartelization of commodity trades is expected to result in major restriction to the free action of market forces (charter, tramp, etc. markets).

h) New shipping technology will replace traditional shipping at an ever increasing rate.

i) An increasing percentage of world shipping will be owned and operated by quasi-government bodies and government owned/controlled companies. This will effect conference and other freight or shipping agreements. This trend is emphasized by the 40-40-20 rules adopted by many developing nations and in part justified by recent UNCTAD agreements.

j) As a result private operators are expected to combine into increasingly larger units or cartells to counter the effect of national shipping companies. Both of these trends may well result in the scuttling of conventional competitive charter or conference pricing of shipping services. New methods for equitable costing of shipping services may therefore be required which reduce worldwide rate wars, large scale subsidization and other artificial price factors.

k) Transport modes will be increasingly integrated into origin-to-destination systems with singular responsibility for movement, documentation, through-charge, through-bills and insurance. Therefore, we expect shipping companies to become integral parts of pipeline, drilling, trucking, rail, and other transport companies.

l) The traditional freedom of the seas is expected to be progressively curtailed as more of the world oceans and all the restricted

ocean passages (channels, bays, etc.) are incorporated under the territorial jurisdiction of coastal states. As resource exploitation moves into the deep ocean, it must be expected that ultimately all the worlds' oceans become subject to national or international jurisdiction of increasing complexity and restriction.

m) The increasing use of the oceans will also introduce new interferences and operational constraints.

n) Concern with the environment and maintenance of natural resources will furthermore impose operational requirements restricting ocean transport operations.

These are just a few of many new factors affecting the role and operation of ocean transport. The non-resolution of simple near-term problems at the recent "Law of the Sea Conference" in Caracas and elsewhere provide indications of the difficulties ahead. These are particularly constraining for the western industrialized nations, many of which depend on trade for economic and national survival. It is, therefore, felt that a very major confrontation is bound to arise, the results of which will affect the future of world relations and development. Indonesia will similarly be affected. It borders some of the world's busiest waterways (Mallaca Straits, Sunda Straits, etc.) and trades primarily with the industrialized nations.

4.2 Ocean Transport Capacity and Investment

Traditionally, demand and supply of shipping

are subject to major fluctuations of over supply and shortage. 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 an historic high and had as a secondary effect, the placement of enormous orders for new construction. This large increase in tonnage ordered, in turn, resulted in major expansion programs by the world shipping industry. Yet by 1974, 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 III-4.2-1, while Figure III-4.2-2 presents the projected total supply of shipping in the two major categories of liquid bulk and dry cargo. It is noted that excess tanker tonnage in 1976 is expected to exceed 32 million GRT. This excess will continue to grow to nearly 48 million GRT by 1979 whereafter supply and demand of tonnage are expected to converge again. As a result, it is assumed that tanker charter rates will start a recovery at the end of 1978 and continue a gradual rise to peak again about 1981. Dry cargo ships were affected by the slumping of shipping freight and higher charter rates of the last year, but to a much smaller extent. While there is a distinct over supply of containerships on dense container routes, the excess of available tonnage is not severe.

The large variations in methods of shipping dry

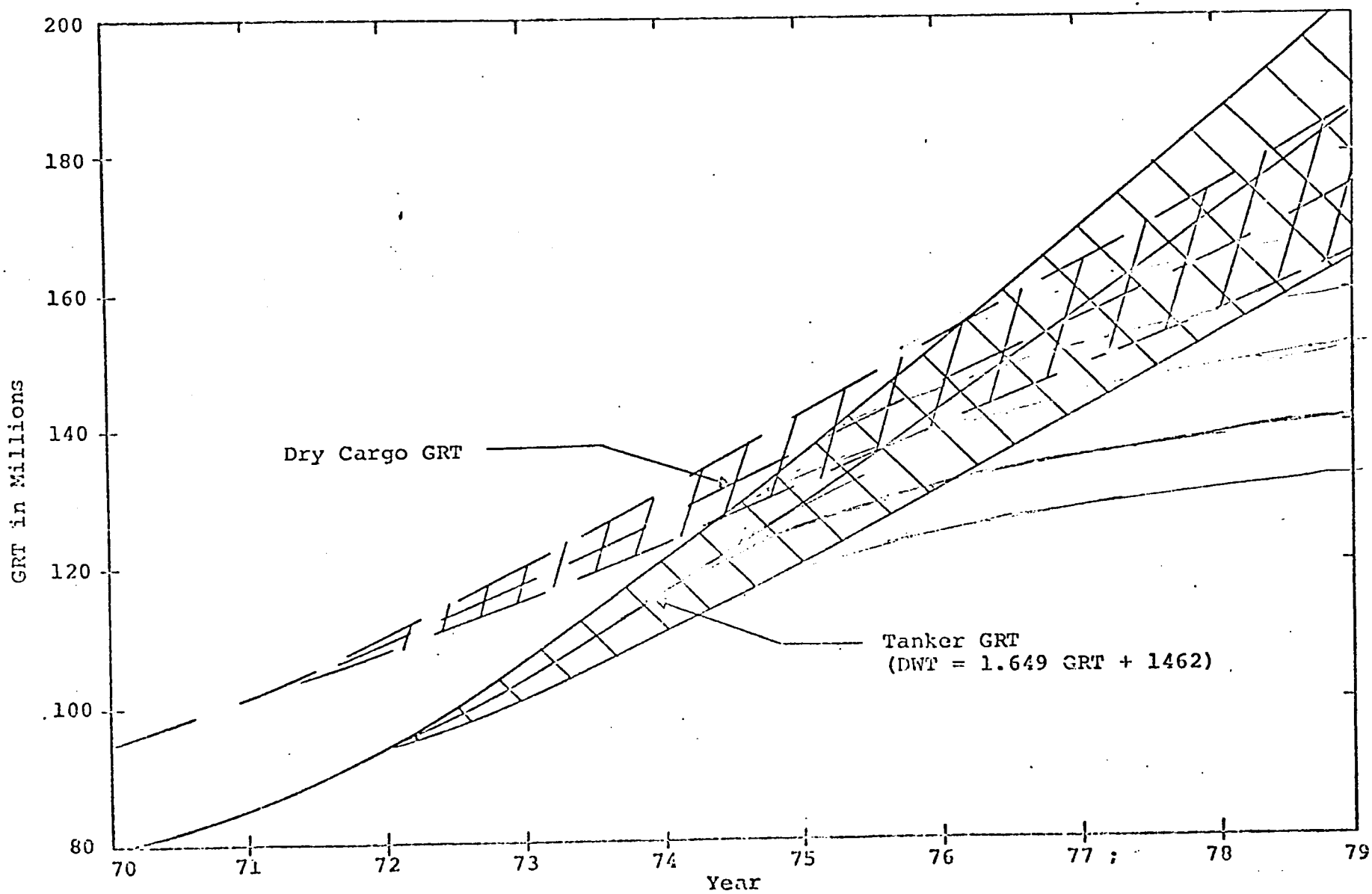


Figure III - 4.2-1

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

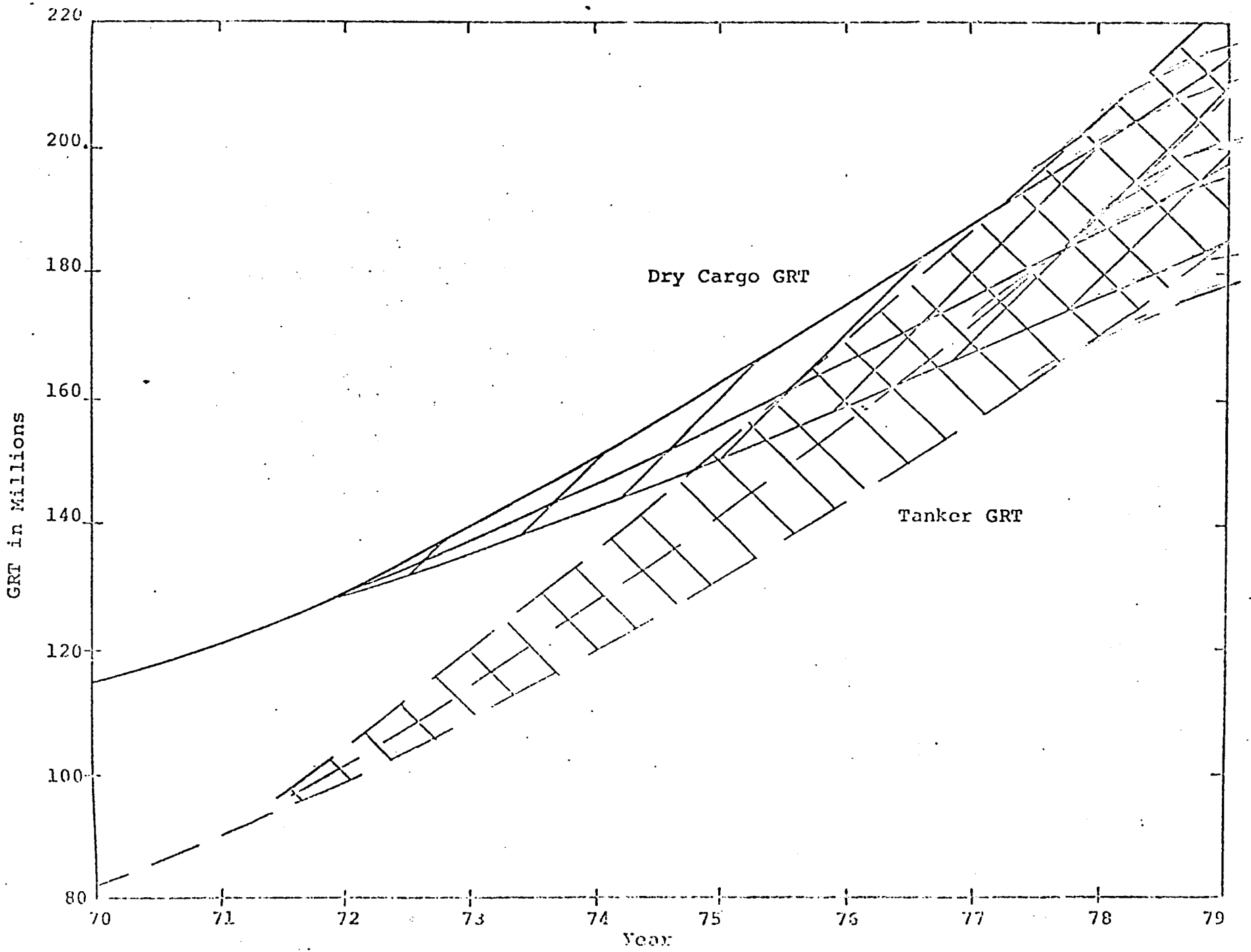


Figure [illegible]

Projected Growth of [illegible]

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.

The energy crisis in 1973 resulted in a short-lived renewal of demand for new tonnage (largely VLCC tankers) with a resulting upsurge in orders for new tanker construction and very temporary rise of charter and shipping rates. But 1974-75 resulted in a continuous decline in demand and, therefore, charter and freight rates.

During the years 1969-1973 the demand in loaded ton-miles had been growing at an average rate of 18%. During that time, the average loaded on way crude route distance jumped from 4600 to 6700 miles. Since then actual ton-miles of crude carried have actually declined and are now in January 1976 about 2% below those in an equivalent period during 1973. The 1968-1973 situation was fostered by the closing of the Suez Canal, coupled with the replacement of Venezuela by the Persian Gulf as the major source of European oil. It is felt that such increases in route lengths as we saw through that period will not be maintained in the future. Furthermore, after 1978, the percentage of world oil emanating from the Persian Gulf is expected to decline drastically as Alaska, Venezuela and Indonesia cover the bulk of continental US imports or inputs. The demand for product tankers is a fraction of that for crude tankers. 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 8% from 1976 to 1978. After 1978, while crude transport demand is expected to level off and continue a gradual decline, product tanker demand is expected to continue to increase at 4-8% per year.

Growth rates in demand for oil in the various regions were generally higher in the last five years than they will be in subsequent periods. The consolidation of new finds principally in the North Sea, Venezuela, Mexico, Alaska, and the introduction or reintroduction of new Middle East Pipelines, as well as the massive effect of the oil price increase on consumption, is expected to result in the above mentioned leveling off of ocean transport demand for crude oil tankers.

The average dry bulk carrier increased in size from 10,000 DWT in 1936 to 16,000 DWT in 1960 and 25,000 DWT in 1970. We assume a continuation of this trend and expect average dry bulk carriers to reach a size of 42,000 DWT by 1980. The total dry bulk tonnage demand is expected to increase from about 50 million GRT in 1970 to about 130 million GRT in 1980.

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. There are included under the 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 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.

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 1972. This factor is reduced to the average expected annual growth in GNP of developing countries in 1980. The basic assumption made was that the 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.

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 12-15% in this trade is reasonable. 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 new established average loaded route lengths will be increasingly stable.

The resulting expected annual growth rates (for 1975-1984) in demand are 5.4% per annum for container cargo moved in container and/or barge carrying ships, and 3.5% 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.

While shipbuilding on order is leveling off, with tonnage on order in 1976 just about equal that of 1973, the order books in the next few years are expected to show a definite decline of about 5-8% in tonnage per annum both as a result of few new orders and cancellations. Therefore, total tonnage delivered in 1977 and 1978 is expected to be of the order of only 26.8 million GRT and 25 million GRT respectively.

The cost of shipbuilding has gone up by an average of 16.8% from 1973-74 and 26% from 1974-75 or by nearly 47% over this two year period. Although a similar 18% cost increase has been incurred in the 1975-76 period, shipyards, particularly in Japan, are quoting prices which are actually below 1974 prices and in many cases definitely below cost. The total

amount of world investment in new shipbuilding in 1973 was over $15.2 billion, $17.8 billion in 1974 and $19.4 billion in 1975. Expenditures during 1976 are expected to fall below $18 billion.

The fastest growing component of world shipping is the bulk fleet. The total dry and liquid bulk fleet DWT increased in 1974 by over 17.5%, while tanker DWT increased by over 19%. 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-4.2-1. The average tanker has now a deadweight of over 85,000 DWT; combined carriers, 86,000 DWT, bulk carriers, 46,500 DWT; and general cargo ships, 13,500 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 58,000 DWT.

The average age of ships in the bulk fleet continues to decrease and is now less than 5 years. The average age of ships in the general cargo fleet remains at about 8.0 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 2.3 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 existence average a speed oe nearly 22 knots. It is interesting to note

Table III-4.2-1

Shipping Capacity (Dec. 1974)*

(Estimates)

(Vessels 4000 DWT and Over)

	No.	DWT (Million)	GRT (Million)
Tankers	4,488	248.9	129.9
Combined Carriers	316	33.8	20.0
Bulk Carriers	2,832	109.2	61.4
General Cargo Ships	11,506	126.0	100.2
TOTAL	19,142	517.9	311.5

*References:

1. Fearnley and Egers Chartering Co., Ltd., "World Bulk Fleet", (1972-1974 monthly)
2. U. S. Maritime Administration, "Merchant Fleets of the World", (1971 - 1973)
3. Fairplay Publications

though that the large increase in energy costs has reduced the economic speed of service of many ship types. As a result design speed of ships has not increased on the average since 1974.

4.3 Shipbuilding Capacity

World shipbuilding capacity has increased rapidly since 1960, largely as a result of the construction of over 20 new larger tanker shipyards which today comprises a capacity of over 34 million GRT (1974). Total output of the world shipbuilding industry amounted to about 26.5 million GRT in 1974 and 27.0 million GRT in 1975.

The output and capacity of the world shipbuilding industry are presented in Figure III-4.3-1. Shipyard orders (June 1972) are presented in Table III-4.3-1 and shipbuilding delivery projections in Figure III-4.3-2.

Relationship between vessel size and construction cost of bulk carriers is shown in Figure III-4.3-3 and for container, LNG and general cargo carriers in Figure III-4.3-4. The costs of a vessel ordered in 1974 for delivery in 1977 costs generally 1.83 times as much as a similar vessel ordered in 1968/69 for delivery in 1971/72.

4.4 Effects on Interinsular and International Shipping Serving South Sumatra

Interinsular shipping in Indonesia has traditionally been affected by Dutch shipping technology. As a result, most RLS or other interinsular shipping has been and is being performed by small self-propelled coasters of 500-5000 DWT with rare exceptions.

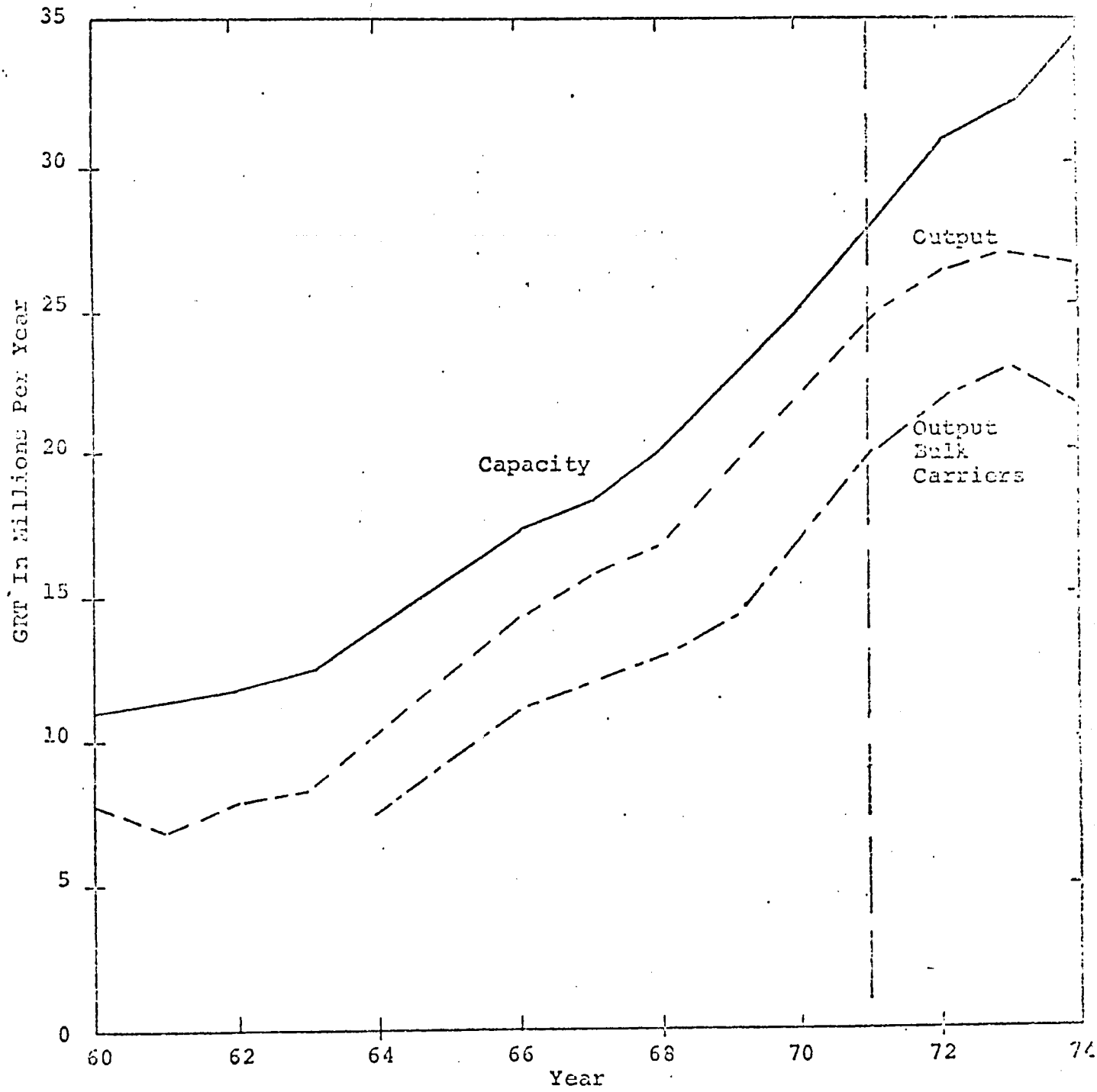


Figure III-4.3-1

Output and Capacity of World Shipbuilding

Table III-4.3-1

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 1972

** Some existing yard capacity is expected to be eliminated. Therefore, indicated yard capacity (1974) is less than existing capacity (1972) plus expansion capacity.

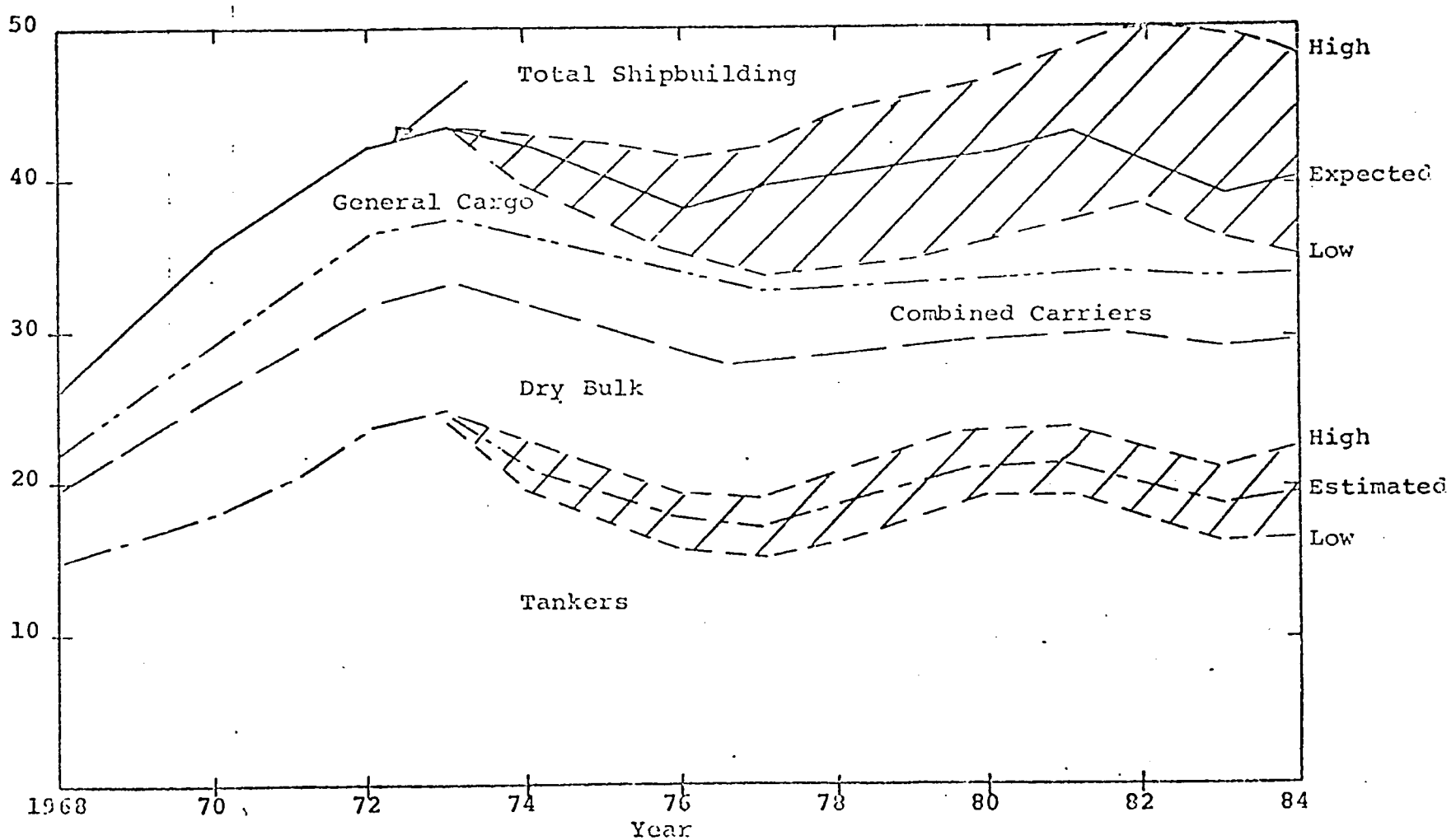


Figure III-4.3-2

Shipbuilding Delivery Projections
(World)

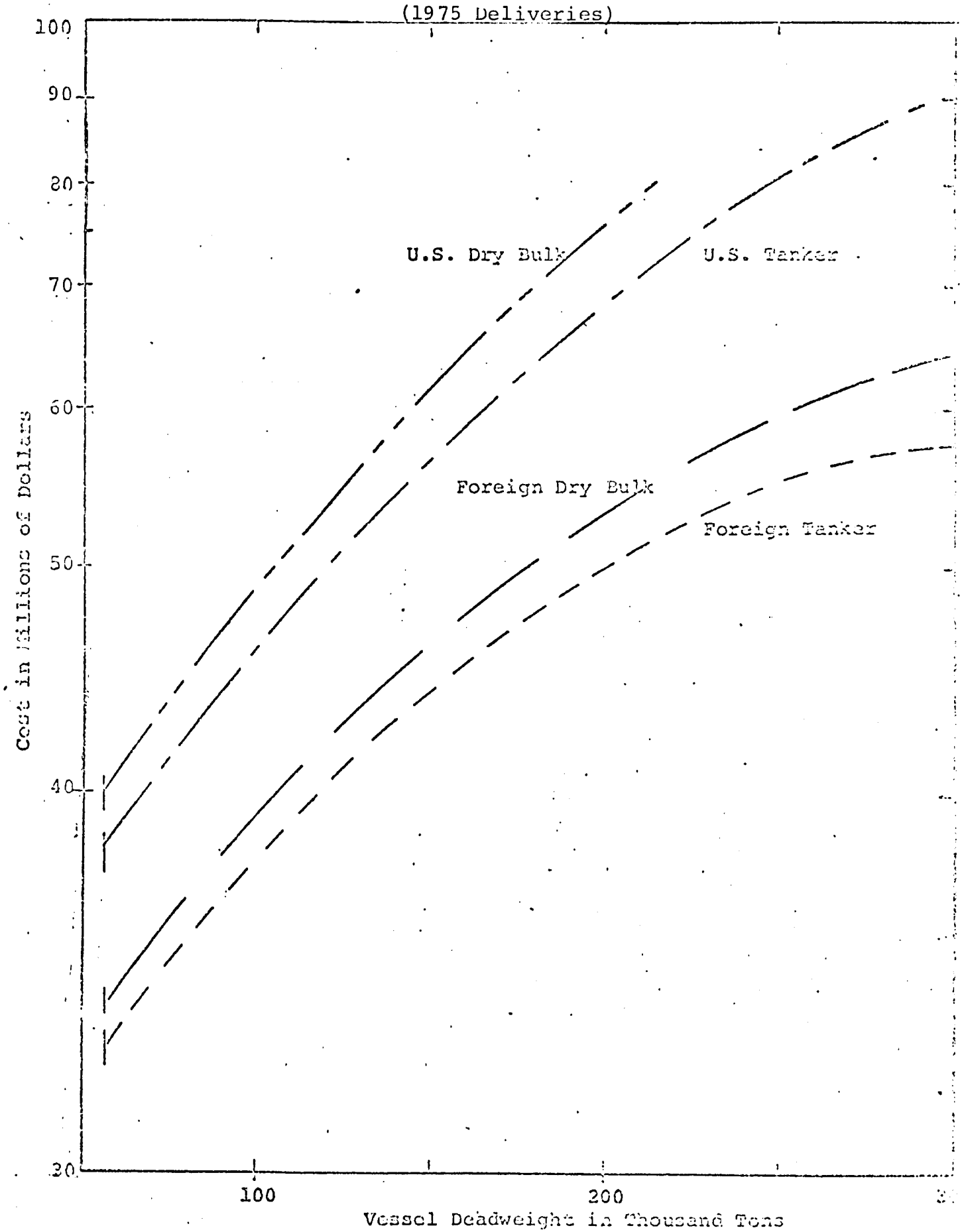


Figure III-4.3-3

Relationship Between Vessel Size and Construction Cost of Bulk Carriers

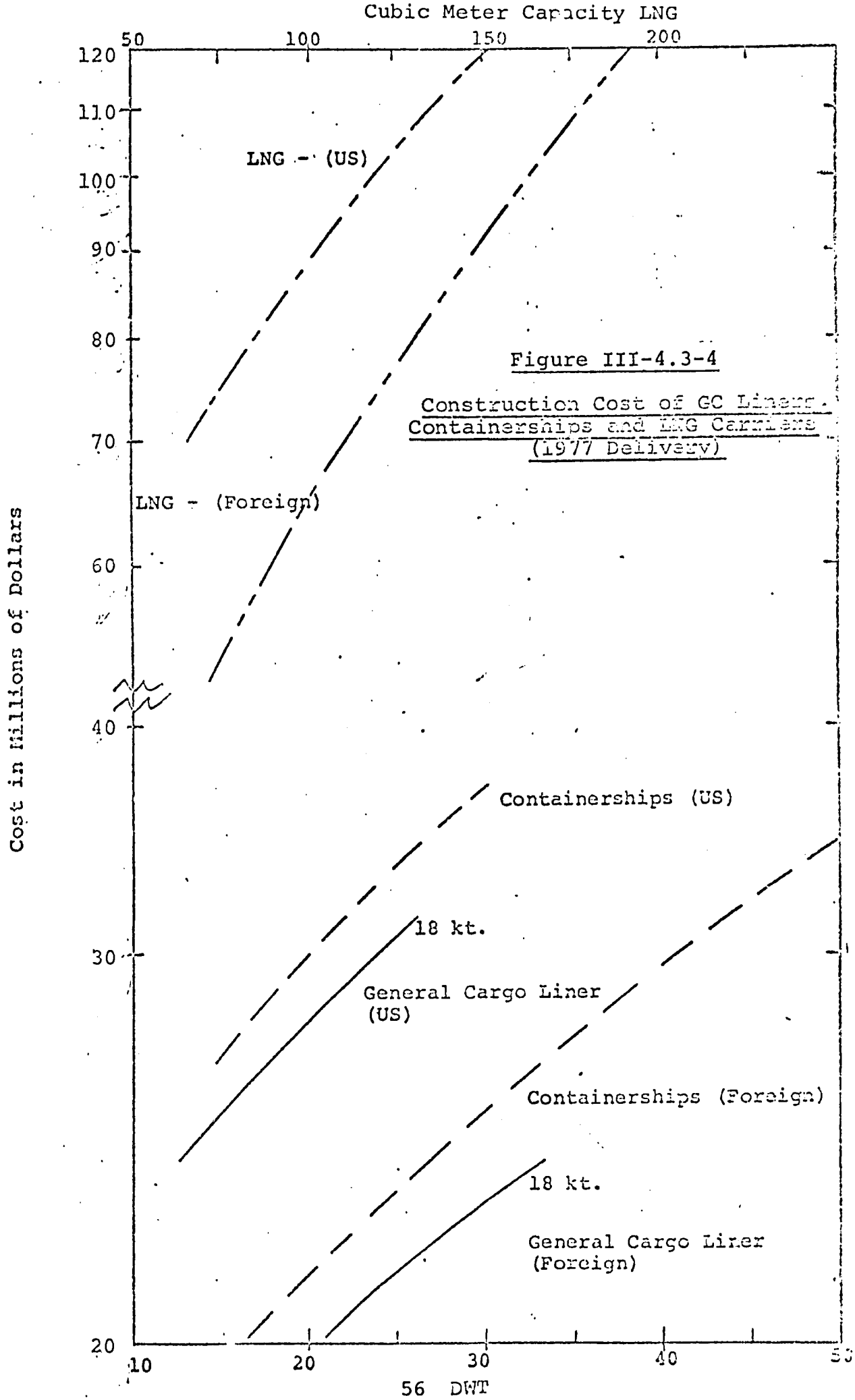


Figure III-4.3-4

Construction Cost of GC Liners, Containerships and LNG Carriers (1977 Delivery)

A large number of these vessels are similar in design and operation to vessels used historically by Dutch shipping in North Sea and coastal trades. Most of these vessels are designed for weather conditions in the northern hemisphere and for generally shorter routes then those used in Indonesia. They are similarly specifically designed for general break bulk cargo in small lots or consignments. While interinsular trade in Indonesia consisted effectively of small lot break bulk cargo until recently, we not note a drastic change in both the composition of cargo types and lot or consignment sizes. This is particularly obvious in trade with South Sumatra. An increasing amount of interinsular cargo consists of raw or semi finished materials such as rubber, plywood, timber, logs, and others and a large percentage of general cargo particularly transshipped imports are or will be unitized soon. The average amount of cargo handled per ship call has increased substantially and this trend is expected to continue. Improved port facilities in South Sumatra are furthermore expected to greatly reduce the amount of general cargo transshipped via Tanjung Priok or Singapore by interinsular shipping. As a result, the proportion of raw and semi finished materials in interinsular shipping is expected to further increase in the future. The presently used coaster type ships are not well suited for this type of trade because of their size, cost and design characteristics such as hold size, cargo handling equipment and hull form. This type of trade is more efficiently handled by mini-bulkers, self powered or push tow barges and other full bodied vessels with a much larger deadweight to displacement

ratio as presently used coasters. The operating costs on a ton-mile or ton delivered basis have been shown elsewhere to be 66% or less of those incurred by the presently used coasters. Use of mini-bulkers or barge type ships also provides vessels with lesser draft per deadweight and therefore a capability of serving many draft limited cargo facilities directly without river barging or other feeder connection.

Just prior to the writing of this report, there appeared an announcement that five general cargo liners in the international trade of Indonesia are to be converted to limited containerships. This is very appropriate. At this time the vast majority of vessels serving international trade under the Indonesian flag are conventional general cargo vessels, yet containerized and dry bulk shipping is increasingly infiltrating the foreign trade of the region and Indonesia, in particular.

It is estimated that by 1980 nearly 40% of general cargo movements in the Indonesian foreign trade will be moved by containerships. A large percentage of that cargo will be transshipped via Singapore container terminals or shipped by foreign containerships unless a larger number of Indonesian containerships become available. The same applies to dry bulk or bulkable cargoes such as fertilizer, coal, cement, rice, wheat, rubber, palm oil, etc. Indonesian shipping must not only increase in tonnage, but more importantly improve productivity by acquisition of vessel types more adapted to modern efficient handling of the type of cargo in Indonesian international trade. Many trades are of sufficient volume to justify application of

specialized types of vessels.

4.5 Effects of Changes in Energy Supply and Balance on Ocean Transport Demand

The cost of transport has always played an important part in energy economics. Energy transport is usually divided into primary and secondary energy transport.

Primary energy transport refers to transport of fuel from the source of fuel, such as oil well or coal mine, to the refinery or power station, while secondary energy transport refers to transport of fuel (or energy) from the refinery, power station, etc. to the ultimate consumer. Table III-4.5-1 shows the cost of energy and energy transport. It is noted that primary energy transport costs of petroleum exceed petroleum production costs, while those of all conventional fuels constitute 76% of total production costs.

Total (primary and secondary) energy transport costs are 178% of fuel production costs and 48.3% of fuel costs to the primary user. In other words, transportation constitutes the greatest cost and generally exceeds the combined cost of production and refining of fuels such as petroleum, natural gas, and coal. One of the reasons for this is the disproportionate amount of investment that used to be required for energy (fuel) transport as compared with investment for energy (fuel) production. Table III-4.5-2 shows the 1972 investment into production and transportation equipment. Even if refinery investments are included, (3.8 billion in 1972) transportation investment still far exceeded the combined invest-

Table III-4.5-1

Cost of Energy and Energy Transport (1972)

(Excluding Communist Countries)

(Billions of Dollars)

Fuel Source	World Consumption in BBY.	Cost			Price to	
		Production*	Primary Transport	Secondary Transport	Primary User***	Ultimate Consumer
Petroleum	14.2	5.6	6.72	12.80	38.0	NA
Gas	3.4	3.8	1.00	0.88	5.8	-
Coal	4.1	5.9	3.90	2.00	12.8	-
Total	21.7	14.3	11.62	15.68	56.6	-

*Excluding Royalties, Taxes etc. but including depreciation of all investment and all operating costs.

**Secondary Transport cost include all costs of distribution to ultimate retail consumer.

***Primary User - Refinery, Utility Station, Gas Company, Oil Distribution Company - These costs include profits, royalties, taxes etc.

Primary Transport Costs = 76% of Production Costs
= 20.5% of Cost to Primary User.

Total Transport Cost = 178% of Production Cost
= 48.3% of Primary User Fuel Costs.

Table III - 4.5-2

Investment in Fuel (Energy) Production and Transportation Facilities

(1972 investment in Billion of Dollars)

	Production		Transportation
Petroleum Gas	4.6 Production 2.1 Exploration	6.7	14.0
Coal		0.6	2.8
		7.3	16.8

Tankers 38 million DWT	$ 6.1 Billion
LNG-LPG - Terminals etc.	$ 1.3 "
Pipelines (Oil + Gas) Land	$ 4.8 "
Pipelines (Oil + Gas) Submarine	$ 1.8 "
Coal Conveyors, Rail, Slurry Pipelines, Transfer Equipment	$ 1.8 "
Coal Ships	$ 0.6 "
Total	$16.4 Billion

Table III-4.5-3

Consumption of Energy by Transportation (in BBY.)

(1972)

Primary	Petroleum	Coal
Tankers	0.80	-
General Cargo	0.50	0.20
LNG Carriers	0.05	-
Bulk Carriers	0.20	-
Pipeline System	0.20	-
Railways*	0.35	0.20
Automobiles (Pass.)	2.20	-
Trucks	0.85	-
Conveyors - Aerial Pipeways	0.10	-
Electric Transmission	0.20	0.12
Air Transport	0.40	-
	5.85BBY	0.42BBY

*Excludes 0.3 of electric rail propulsion.

Consumption of Energy in Transport of Energy

Primary	Petroleum	Coal
Tankers	0.80	-
LNG	0.05	-
Bulk Carriers (Coal)	0.08	-
General Cargo (Coal)	0.04	-
Pipelines	0.15	-
Railways	0.06	0.04
Conveyors etc.	0.02	-
	1.20BBY	0.04BBY
Secondary		
Trucks	0.15	-
Pipelines	0.05	-
Electric Trans.	0.20	0.12
	0.40BBY	0.12BBY

Total Energy Consumption for

Energy Transport = 1.60 BBY Petroleum and 0.16 BBY Coal

= 11.4% of total Petroleum Consumption.

ment in production, exploration and refining equipment. This picture is now changing with production investment in high cost production areas such as Alaska and North Sea.

The consumption of energy (fuel) by transportation is also quite appreciable. About 36% of all petroleum was consumed worldwide to meet fuel demand of transportation as shown in Table III-4.5-3. Consumption by private automobiles is obviously the major factor with nearly 15.6% of all petroleum consumed worldwide. Ocean transportation consumes about 1.55 BBY or nearly 8% of all petroleum. It is also interesting to note how much energy or fuel is consumed in transporting (or transmitting) energy. Primary energy transport consumed about 1.20 BBY of petroleum or 7.5% of total consumption with another 0.4 BBY or 2.9% to secondary energy transport for a total of about 10.4%.

The effects of changes in energy balance, fuel price, fuel availability and physical form of fuels on maritime transportation are manifold. The transportation demand of fuels, particularly petroleum, is expected to change dramatically within the next decade. Fuel price will affect choice of propulsion plant, size of vessels, economic design, speed, and methods of vessel operation, the method of energy conversion, bunkering strategy and fuel carried on board. Finally, physical form-change of fuels and changes in the balance of fuels produced and consumed will cause a major change in the type and quantity of demand for maritime energy (fuel) transportation.

Considering the impacts in more detail, let us first review the effect of fuel price. The drastic