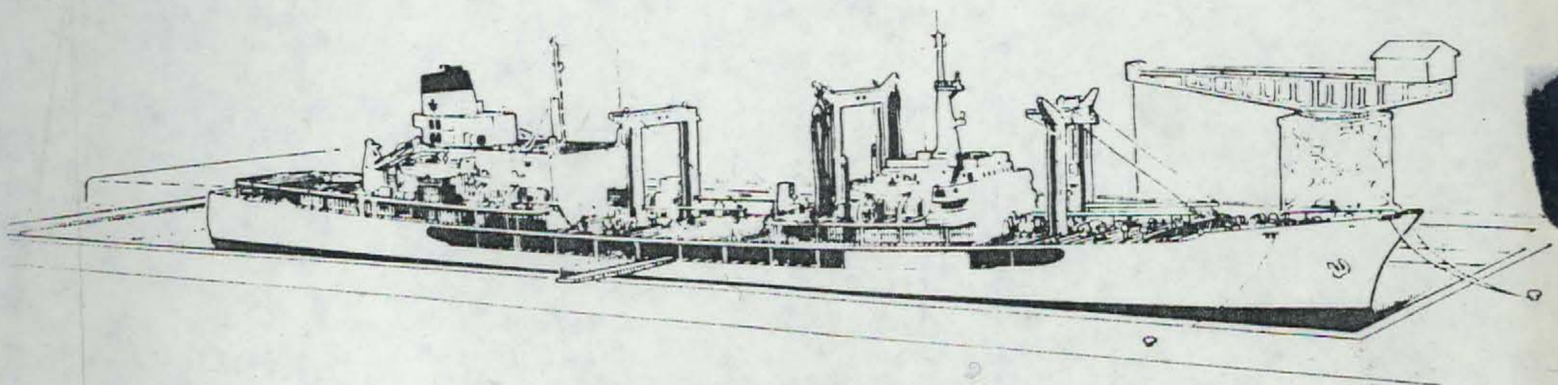
REPORT OF A

SURVEY OF THE CAPABILITIES OF CANADIAN SHIPBUILDING AND ASSOCIATED INDUSTRIES

(PARTS 1 TO 8 – UNCLASSIFIED)



PREPARED FOR THE

DEPARTMENT OF REGIONAL ECONOMIC EXPANSION

BY

EYRETECHNICS LTD

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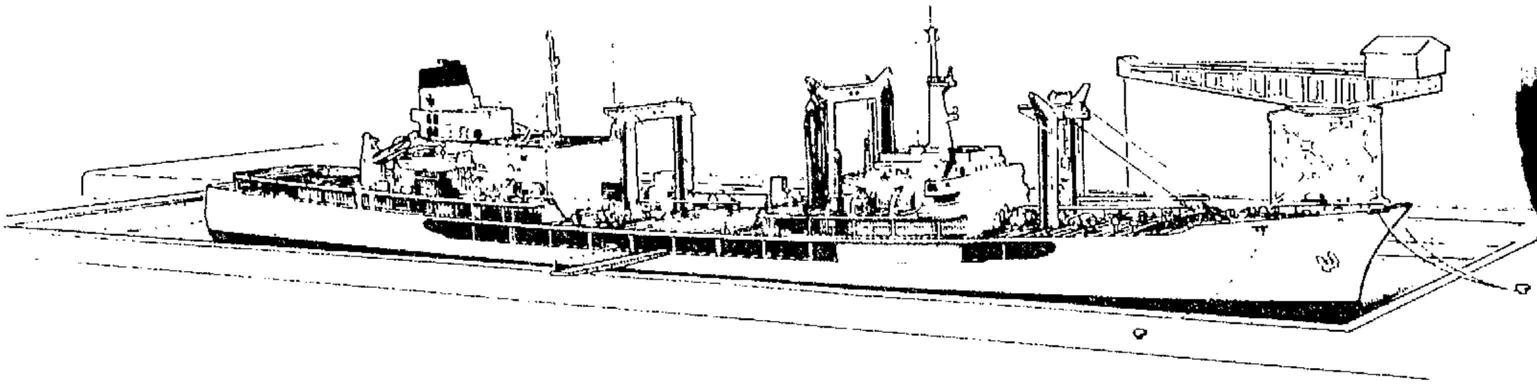

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INDEX

INTRODUCTION

This report is the result of a survey of Canadian shipbuilding technology, carried out for the Department of Regional Economic Expansion, contract reference number 2938, dated 10 September 1981.

The survey consisted of a "desk study" of the technological capability of Canadian industry with regard to commercial shipbuilding. Input data was obtained from various sources such as current trade publications, recently published papers, and special publications of organizations such as the Canadian Shipbuilding and Ship Repair Association. Labour and financing aspects were to be excluded, and commercial confidential information was to be contained in a separate part of the report.

This report consists of nine parts. It is structured to provide an overall picture of the ship acquisition process and the various elements of Canadian industry that contribute to this process.

Part 1, SYNOPSIS, contains a summary of Parts 2 to 8 inclusive. Thus, Part 1 and Part 9 (COMMERCIAL CONFIDENTIAL) can be treated as an executive summary of the report.

Referenced sources are provided in the LIST OF REFERENCES, and are indicated to in the text by a parenthesized number, e.g. (15).

PART 1

SYNOPSIS

A survey of the shipbuilding industry must consider the total ship acquisition process, which involves:

1. Owner Requirements.
2. Ship Designers.
3. Shipyards.
4. Equipment and Material Suppliers.
5. New Developments.

OWNER REQUIREMENTS

The owner requirements for ships and vessels are becoming more sophisticated, with more emphasis on complex specialized vessels and less emphasis on larger size. In the Canadian scenario, the requirements can be divided into government vessels, commercial vessels, commercial fishing vessels, offshore oil related vessels, and arctic vessels including LNG carriers.

Government vessels include the six Canadian Patrol Frigates for DND, Canadian Coast Guard patrol vessels and icebreakers, and patrol and research vessels for Fisheries and Oceans. There is also the continuing requirement for various sized ferry boats for Crown Corporations and provincial governments.

Canadian commercial fishing vessel requirements are difficult to ascertain, but because of catch limitations and the numbers of existing vessels in both Canada and abroad, the requirement is mainly limited to more modern and efficient replacement vessels.

Offshore oil requirements for the Canadian waters are probably not as numerous as touted in some circles, and the time frame is almost a decade away. This fact has been confirmed by the chairman and chief executive officer of Imperial Oil Ltd. (15) However, there is an apparently good export market for Canadian-built oil rigs as shown by the number of rigs being built by Davie Shipbuilding Ltd. (5)

Arctic vessel requirements appear to be the major near-future ship and vessel activity for Canadian shipyards. Dome Petroleum Ltd. publically announced requirements are substantial, and some of the aspects of the Arctic Pilot Project will also tax Canadian shipyards. The most controversial aspects of both these projects is the requirement for LNG carriers. Besides the size problems posed by the envisaged ships (375 meters long), the technological requirements for cargo containment systems (special steel, etc.), will tax Canadian shipyards.

SHIP DESIGNERS

This important aspect of the ship acquisition process has been generally overlooked when assessing the problems associated with the Canadian shipbuilding industry. There is no established Canadian facility to train naval architects and marine engineers. "The marine fields, both military and civilian, is overpopulated with British imports through no fault of the British but through the chronic and scandalous neglect of provincial and federal governments to provide the required education facilities to develop the Canadians to teach them." (16)

Canadian ship designers have not become established on a large scale because of the sporatic Canadian requirement. Many small to medium firms exist, but until the recent activity associated with the Canadian Patrol Frigate created two large design companies, the Canadian capability has never developed into a large, sustained capability. This program should show that the Canadian capability can be developed, but it will take more sustained ship design activity to ensure a lasting capability.

SHIPYARDS

Shipyard capability is difficult to assess because of several factors. The size of the facility may not be the only limiting factor because the yards ability to effectively process the construction material and equipment into a ship or vessel is equally important. This ability depends on how functional the yard is laid out, the capability of the production equipments (e.g., cranes, welding equipment, etc.), the size of the labour force, and because of the increasing sophistication of ships, the skill of the work force. (It would be nearly impossible for a shipyard to build an LNG carrier, with sophisticated alarm and control systems, if there were no skilled electrical tradesmen in the labour force to install the required wiring.) There are also management considerations, such as whether to tie up a drydock for construction purposes or to keep it available for repair contracts.

The majority of these assessment factors are beyond the scope of this survey, but one can get a relative appreciation of the shipyard capabilities by considering their maximum vessel length capability. The following tables show ship types within various length ranges and the Canadian shipyards' that can build ships within these size ranges. The shipyards' maximum length capability is based on information supplied by the yards themselves in various publications; so it must be emphasized that the table only considers length capability, and this is based on yard advertized capability. It does not consider production capability, labour skill, etc.

LENGTH RANGE (METRES)	SHIP TYPES	SHIPYARDS CAPABLE
GREATER THAN 250	Containerships Oil Tankers Bulk Carriers LNG Carriers	Davie Shipbuilding Ltd., Lauzon, Quebec St. John Shipbuilding & Dry Dock Co. Ltd., Saint John, N.B.
200-250	Containerships Roll-On Roll-Off Ships Oil Tankers Bulk Carriers Lake Bulk Carriers	Collingwood Shipyards, Collingwood, Ont. Marine Industries Limited, Tracy (Sorel), Quebec Port Arthur Shipbuilding Co., Thunder Bay, Ont. Port Weller Dry Docks, St. Catherines, Ont.
150-200	Cargo Ships Roll-On Roll-Off Ships Oil Tankers Drill Ships Jack-Up Oil Rigs Semi-Submersible Oil Rigs	Burrard Yarrows Corp., Esquimalt, B.C. Burrard Yarrows Corp., North Vancouver, B.C. Vancouver Shipyards Co. Ltd., North Vancouver, B.C.
110-150	Cargo Ships Ferryboarts Drill Ships Jack-Up Oil Rigs Semi-Submersible Oil Rigs	Allied Shipbuilders Ltd., North Vancouver, B.C.
60-110	Ferryboats Offshore Fishing Vessels Offshore Supply Vessels Tugboats Icebreakers Patrol Vessels Research Vessels Storage & Process Barges	Bel-Aire Shipyards Ltd., North Vancouver, B.C. Ferguson Industries Ltd., Pictou, N.S. Marystown Shipyard Ltd., Marystown, Nfld. Rivtow Shipyards, BC Marine Div., Vancouver, B.C.
LESS THAN 60	Offshore Fishing Vessels Inshore Fishing Vessels Tugboats Barges Patrol Vessels	Breton Industrial & Marine Ltd., Port Hawkesbury, N.S. Georgetown Shipyard Inc., Georgetown, B.C. Halifax Industries Ltd., Halifax & Dartmouth, N.S. North Sydney Marine Railway Co. Ltd., North Sydney, N.S. Purvis Naveon Shipyard Ltd., Selkirk, Man. Rivtow Shipyards, John Manly Div., Vancouver, B.C. Shelburne Marine Ltd., Shelburne, N.S.

EQUIPMENT AND MATERIAL SUPPLIERS

There does not appear to be a problem with regard to ship material suppliers. The Canadian steel industry can supply the usual shipbuilding requirements, and, provided a reasonably steady market is created, may also be able to supply the more advanced material for special applications (e.g., LNG carriers). This ability of the Canadian steel industry could be a competitive advantage for Canadian shipbuilding, provided a reasonably steady market was established based on a coordinated national industrial strategy.

Canadian ship equipment suppliers can provide most of the shipbuilding requirements, although many of these companies are only sales and service outlets for foreign manufacturers. The major problem is in the area of ship propulsion systems: propulsion engines, propulsion gearing, and specialized propellers. Small variable pitch propellers can be made in Canada, but large units must be imported. Similarly, low power gearing units are made in Canada, but there are no facilities to produce large units required for large ships.

Diesel propulsion engine manufacturing in Canada is limited, with most of the Canadian diesel engine suppliers acting as sales and service organizations for foreign-built engines. A notable exception is Bombardier Inc. which manufactures marine diesel engines in the 700- to 4000-horsepower range. (To put the problem in perspective, a 220 metre bulk carrier would require about 20,000 shaft horsepower.)

Ships in the 200-metre and above size range usually rely on steam propulsion. There are no Canadian suppliers of marine propulsion boilers and turbines.

Gas turbine propulsion has replaced steam in some of the higher power applications. However, the Canadian suppliers of marine propulsion systems for ships and vessels rely on some form of prime mover (usually diesel or gas turbine); so while there are Canadian suppliers of these systems (for ships up to about 130 metres in length), they rely heavily on imported prime movers and often the generators and motors as well.

NEW DEVELOPMENTS

There are a number of new developments in ship design that could eventually affect the Canadian shipbuilding industry, but not in the near future. These include:

1. The SWATH-type ship.
2. Hydrofoils.
3. Air cushion vehicles.
4. The Wing-In-Ground (WIGS) vessels.
5. Longitudinal construction.

The increasing requirement for sophisticated process control barges (ore processing, gas liquefaction etc.) will affect the shipbuilding industry in the near term, primarily in the mix of their workforces. Similarly, electronic developments based around the micro processor, will also cause an increase in the electrical/electronic trades. Other ship related developments such as icebreader technology, LNG storage technology, and gas liquefication technology will also affect the quality requirements of the shipyard work force.

Ship construction developments required to modernize and streamline existing yards, are mainly in the area of material flow from various construction stages. This will require considerable rearrangement of some of the existing Canadian yards. Welding technology will also have to be improved as the ship requirements become more sophisticated and if the industry is to remain internationally competitive. This could also lead to the introduction of robotic technology that is currently spreading through other industries.

PART 2

THE SHIP ACQUISITION PROCESS

The ship aquisition process, excluding financing and personnel aspects, involves the following:

1. The owner.
2. Naval architect and marine engineering consultants.
3. The shipbuilder.
4. Numerous secondary industries that supply material and equipment for the ship.

The involvement of each of these is shown on the attached diagram, and is briefly explained in the following text.

REQUIREMENT DEFINITION

When an owner contemplates acquiring a new or updated ship or vessel, he usually considers one or a combination of the following alternatives:

1. Replacement or conversion of average or obsolete vessels.
2. Expansion or modification of services on an existing route, in an effort to enlarge their participation.
3. Development of new service or carrying a different kind of cargo on an existing route aimed at capturing an increased percentage of the trade.
4. Development of a vessel to undertake an old or new industrial operation at sea.
5. Development of a vessel to support commercial or industrial vessels engaged in ocean technology.

The owner must then make decisions regarding various economic parameters, such as:

1. Number of ships or vessels.
2. Projected economic life-years.
3. Itinerary and schedule of departures, including anticipated average loading conditions.
4. Dry bale cubic and deadweight.
5. Refrigerated cargo cubic and deadweight, number of boxes, and temperature level for each box.
6. Liquid cargo cubic and deadweight, type of deep tanks.
7. Number of passengers and crew and habitability standard.
8. Limitation on vessel acquisition cost.

9. Dry bulk cubic and stowage factor.
10. Special cargo lockers, cubic and deadweight.
11. Number, weight, and size of vehicles to be carried.
12. Special provisions for container stowage.
13. Type of containment system for special cargo, such as LNG, ammonia, chemicals, etc.
14. As to tankers only, number of segregated cargos and cargo pumping rate.
15. Type of stabilization (if any).
16. Location of bunkering ports, fishing grounds, or industrial projects to be serviced.
17. Types of machinery plant owner is willing to consider with respect to future crewing and maintenance.

The owner must also consider a number of restrictions under which his ships or vessels must operate, for example:

1. Limiting lock width, length, draft, or similar limitations because of harbor channel or canal features.
2. Spacing of fixed bulk unloading gear ashore.
3. Limiting heights of bulk cargo handling equipment ashore or container cranes ashore.
4. Tidal range at all ports.
5. Dry dock facility limitations.
6. Depth of water to be worked for industrial vessels
7. Geographic seaway location for input into vessel motion requirements and analyses.
8. General plan for cargo handling including data on port facilities, heavy lift requirements, and special problems (i.e., tidal variations, sideport requirements, etc.).
9. Ice conditions.
10. Tonnage limitations.
11. Loadline rules.
12. Coast Guard regulations.
13. Classification society requirements.
14. As to tankers only, classification by Coast Guard grade of most hazardous cargo to be carried and limiting capacity of shoreside tankage.

Depending on the size of the owner's operation, he may do all or part of the requirements definition in-house, or he may contract all or part of it out to consultants. This stage in the vessel acquisition process often overlaps into the concept design stage and even the preliminary design stage and the contract design stage, because the owner may wish to specify certain machinery and equipment.

CONCEPT DESIGN

The very first design effort, concept design, translates the mission requirements into naval architectural and engineering characteristics. Essentially, it embodies technical feasibility studies to determine such fundamental elements of the proposed ship, such as length, beam, depth, draft, fullness, power; or, alternative sets of characteristics, all of which meet the required speed, range, cargo cubic, and deadweight. It includes preliminary light-ship weight estimates usually derived from curves, formulas, or experience. Alternative designs are generally analysed in parametric studies during this phase to determine the most economical design solution or whatever other controlling parameters are considered determinant. The selected concept design then is used as a talking paper for obtaining approximate construction costs which often determine whether or not to initiate the next level of development, the preliminary design.

This activity is often contracted out to naval architect and marine engineering consultants.

PRELIMINARY DESIGN

A ship's preliminary design further refines the major ship characteristics affecting cost and performance. Certain controlling factors such as length, beam, horsepower, and deadweight would not be expected to change upon completion of this phase. Its completion provides a precise definition of a vessel that will meet the mission requirements: this provides the basis for development of contract plans and specifications.

This activity is often contracted out to naval architect and marine engineering consultants.

CONTRACT DESIGN

The contract design stage yields a set of plans and specifications which form an integral part of the shipbuilding contract document. It encompasses one or more loops around the design spiral, thereby further refining the preliminary design. This stage delineates more precisely such features as hull form based on a faired set of lines, powering based on model testing, seakeeping and manoeuvring characteristics, the effect of number of propellers on hull form, structural details, use of different types of steel, spacing and type of frames. Paramount, among the contract design features, is a weight and centre of gravity estimate taking into account the location and weight of each major item in the ship. The final general arrangement is also developed during this stage. This fixes the overall volumes and areas of cargo, machinery, stores, fuel oil, fresh water, living and utility spaces and their interrelationship, as well as their relationship to other features such as cargo handling equipment and machinery components.

The accompanying specifications delineate quality standards of hull and outfit and the anticipated performance for each item of machinery and equipment. They describe the tests and trials that shall be performed successfully in order that the vessel will be considered acceptable.

This activity is often contracted out to naval architect and marine engineering consultants. Equipment suppliers would also provide some input at this stage.

DETAIL DESIGN

The final stage of ship design is the development of detailed working plans. These plans are the installation and construction instructions to the ship fitters, welders, outfitters, metal workers, machinery vendors, pipefitters, etc. As such, they are not considered to be a part of the basic design process. One unique element to consider in this stage of design is that up to this point, each phase of the design is passed from one engineering group to another. At this stage, the interchange is from engineer to artisan, that is, the engineer's product at this point is no longer to be interpreted, adjusted, or corrected by any other engineer. This engineering product must unequivocally define the desired end result and be producible and operable.

This activity is usually part of the shipbuilding contract and as such is done by the shipyard.

SHIP CONSTRUCTION

After award of a contract, the shipbuilder will determine in detail the construction procedures and methods by which the ship or vessel will be built. The procedures and methods will be dependent on the yard's facilities such as:

1. Building site (e.g., a building basin or graving dock, a conventional sloping shipway, or a ground-level assembly area where the ship is completed for launch).
2. Steel fabrication and assembly areas.

3. Materials storage and handling facilities (e.g., cranage).

The construction process itself must be carefully planned because it is the integration of several overlapping activities, such as:

1. Lofting.
2. Fabrication.
3. Assembling.
4. Propulsion plant installation.
5. Pre-outfitting.
6. Outfitting.
7. Launching.

The purchase and delivery of material, equipment and general ship outfit is also an integral part of the shipbuilding process. Many secondary industries provide inputs to the shipbuilder as they supply the following broad categories:

1. Anchors and cable equipment.
2. Auxiliary machinery.
3. Cargo handling equipment.
4. Communications equipment.
5. Electric plants and systems.
6. Fire detection and extinguishing systems.
7. Heating, ventilation and air conditioning systems.
8. Hull structure components.
9. Hull structure material.
10. Living area furnishings.
11. Machinery control systems.
12. Navigation equipment.
13. Pollution abatement equipment.
14. Propellers.
15. Propulsion gearing.
16. Propulsion plants.
17. Steering equipment.

TRIALS AND DELIVERY

Early in the construction stage, a test schedule is developed listing all components and systems subject to test, and testing is then carried out as the components and systems are completed.

When the vessel is substantially complete (and after successful completion of dock trials and other tests), to be reasonably sure that all machinery installed will perform satisfactorily, trials will be conducted in the open sea and deep water to demonstrate designed power, speed, and rpm capabilities. A typical official sea trial agenda for the ship would include the following events:

1. Compass and radio direction finder calibration.
2. Pre-trial shaft drag for torsionmeter zero.
3. Standardization trials.
4. Turning circles.
5. Z-manoeuvre.
6. Turbine water rate test.
7. Economy trials - 4 hours.
8. Ahead steering test.
9. Emergency steering test.
10. Post-trial shaft drag for torsionmeter zero.
11. Crash ahead from astern.
12. Crash astern from ahead.
13. Astern run - 30 minutes.
14. Astern steering test.
15. Boiler overload test.
16. Mechanized control demonstration.
17. Anchor handling test.

Specialized vessels such as LNG carriers must be subjected to additional trials, depending on their function and regulatory body requirements.

The owner or his representative (the function may be contracted out) is involved with the official sea trials. On successful completion of these trials, the owner accepts the vessel.

CONTAINERSHIPS

The general cargo ship, designed to be capable of carrying all of its cargo in unitized containers, is designated as a full containership. Containers weigh about 30 tons each and come in standard sizes; and all are basically selected to allow their use as trailer trush bodies or to be carried on railroad flat cars.

Containerships are usually larger than cargo ships, ranging in size from 100 to 270 metres in length, with displacements up to 58,000 tons, and up to 34,000 DWT. They are also usually designed for exceptional speed (up to 33 knots) and thus require large propulsion systems. Steam propulsion is usually employed for the larger containerships, although some have been designed with gas turbine propulsion. The smaller containerships can and do utilize diesel main propulsion. However, the energy crisis is altering the design of containerships to smaller and slower vessels, thus requiring less power and hence using less fuel.

ROLL-ON ROLL-OFF SHIPS

The ro/ro, or trailership, is designed to handle wheeled trailers by means of stern and bow ramps and some by side ports as well. Ro/ro ships being built now are usually a combination of ro/ro and containerships. Ro/ro ships also require special port facilities.

Typical ro/ro ship lengths are 160 to 200 metres, displacing 12,000 to 28,000 tons, but with lower deadweight in the range of 2,000 to 16,000 DWT depending on the mix of trailers and containers.

BARGE CARRYING SHIPS

The barge carrying ship is essentially a containership, carrying larger containers that are handled to and from the water instead of the dock. It can operate in less developed ports, and does not have to wait for dock-side space.

These ships are in the 270-metre length range but have very low deadweight, below 1,000 DWT.

PART 3

OWNER REQUIREMENTS

Over the past quarter century, there have been significant changes in owner requirements for ships and vessels. Ships have become more specialized and new vessel requirements are emerging. This part of the report briefly describes the majority of ships and vessels that owners may wish to have constructed. Potential Canadian requirements in the near future are dealt with in Part 4.

GENERAL CARGO SHIPS

The general cargo ship is thus designated because of its ability to carry a variety of commodities in a variety of forms (such as socked, boxed, paletized, refrigerated, containerized) with the possible accommodation for bulk materials such as grain in designated holds and special oils in task compartments.

General cargo ship lengths have remained in the 137- to 168-metre range, with displacements from 15,000 to 25,000 tons.

CARGO LINERS

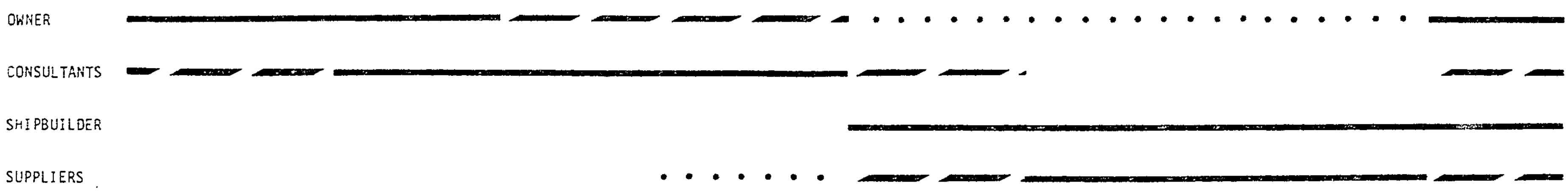
Cargo liner is the designation given to those general cargo ships engaged in international trade between specific ports on a regular schedule. Some modern cargo liners have been designed for 23- to 25-knot speeds, but are usually in the 20-knot range. The deadweight tons (DWT) capacity (weight of cargo, fuel, lubricating oil, fresh water, stores, passengers and baggage, crew and their effects) is in the range of 12,000 to 15,000 tons, although, special cargo carriers (lumber, newsprint, etc.) may be in the 15,000- to 20,000-DWT range.

GENERAL PURPOSE CARGO SHIPS (TRAMP SHIP)

The general purpose cargo ship, more commonly called the tramp ship is a general cargo ship that has no set trade route or schedule. It plies between ports all over the world, following the dictates of each particular cargo consignment. It is usually equipped with heavy lift cargo gear (100 tons or more). These ships are designed for slower speeds and larger DWT in the range of 15,000 to 20,000 DWT.

SHIP ACQUISITION PROCESS

REQUIREMENT DEFINITION	CONCEPT DESIGN	PRELIMINARY DESIGN	CONTRACT DESIGN	DETAIL DESIGN	VESSEL CONSTRUCTION		TRIALS AND DELIVERY
Alternatives Economic Parameters Restrictions.	Translates requirements into characteristics	Refines performance and cost characteristics	Develops plans and specifications for shipbuilding contract document	Develops detailed working plans for installation and construction	Activities include: -Lofting -Fabrication -Assembling -Propulsion Plant Installation -Preoutfitting -Outfitting -Launching	Supplies include: -Hull Structure Material -Propulsion System -Electric Plant and Distribution System -Auxilary Machinery -Navigation Equipment -Outfit and Furnishings -Specialized Equipment	Dock trials Sea trials



LEGEND: Primary Involvement
Partial or Optional Involvement
Peripheral Involvement

OIL TANKERS

The size of oil tankers has grown steadily since the 1940s from 25,000 DWT to the Very Large Crude Carriers (VLCC) of over 500,000 DWT and 400-metres length. The propulsion power has also increased from the range of 13,000 shaft horsepower to over 50,000 shaft horsepower. The propulsion power is usually steam, although diesel has been used to power vessels of up to 228-metres length and 80,000-ton displacement (65,700 DWT). Draft is usually a limiting port factor, and so tankers intended for port discharge are limited to 75,000 to 100,000 DWT.

DRY BULK CARRIERS AND ORE/BULK/OIL CARRIERS (OBO)

The dry bulk carrier is primarily intended to carry dry cargo (grain, iron ore, etc.), but more recent ships are capable of carrying a different cargo (oil, etc.) on the return voyage. These ships are referred to as ore/bulk/oil carriers (OBO).

These ships range in length from 240 to 315 metres with deadweight from 70,000 to 245,000 DWT.

LIQUEFIED NATURAL GAS TANKERS (LNG)

Liquefied natural gas has been transported at sea since 1959. Complex considerations are involved in carrying this flammable liquid cargo at a temperature of about -162°C (-260°F), and there are a number of different approved containment systems for this cargo. (LNG carrier requirements are more fully explained in Part 4.

Ships capable of carrying 125,000 cubic metres of LNG are common, and designs for ships of up to 300,000 cubic metres have been prepared and given basic acceptance by classification societies. The extremely low density of the cargo creates relatively light full load drafts, and hence the ships can be accommodated in many channels and ports. The shallow draft limits the single screw horsepower to about 45,000 and thus speeds are limited to around 20 knots.

GREAT LAKE SHIPS

The Great Lake fleet consists primarily of bulk freighters carrying ore, coal, stone and grain. A limiting length of 222.5 metres (730 feet) overall, a beam of 22.9 metres (75 feet), and a draft of 8.2 metres (27 feet), was established for ships transiting the St. Lawrence Seaway. The enlarged Soo Lock (Sault Ste. Marie) can accomodate ships 305 metres long, 32 metres wide, and drafts close to 9.8 metres.

A type of bulk carrier unique to the Great Lakes is the self-unloader. Cargo is carried in continuous hoppers from where it can be fed to conveyor belts running the full length of the cargo space to a bucket-chain elevator that deposits it on a shore conveyor belt.

INTEGRATED TUG/BARGE AND TOWBOATS

The term tug/barge describes push-towing at sea, with the tug attached to the barge through a structural framework. The advantage of this arrangement is in the low manning requirement (only tug crew) as compared to the requirement for an equivalent large ship.

Inland river towboats operate in a similar concept but they are not fixed to the barge.

FERRYBOATS

Ferries are now primarily used to carry automotive equipment of all types, along with their passengers, between two points on a highway. The frequent stops and starts of ferry vessels militates against steam propulsion, and thus they are usually diesel-powered (although gas turbines are becoming popular because of their very light weight).

FISH CATCHING VESSELS

Fishing vessels come in all sizes, from oar-propelled dories through 76-metre tuna catchers to giant mother ships and processing ships, with an infinite variety of forms, arrangements, propulsion machinery, and deck gear. They can be broken down into four generic groups, classified by the type of fishing method employed.

Most employ a net towed behind the vessel, which is then brought aboard and the fish released into the holds. This type includes trollers and draggers which are used primarily for bottom fish.

The seiner or purse seiner vessels carry a net which is set out in such a manner as to encircle a school of fish. The net is then closed at the bottom, hoisted aboard, and the fish are released into the holds. These vessels are used to catch tuna, salmon, herring, anchovies, and other fish that travel in schools. Gillnetters are another form of this vessel and they use nets strung such that fish will swim into them and be caught by the gills.

Trollers, long liners, and bait boats use hooks and lines to catch fish. The troller will string up to eight lines out the stern of the boat. The long line vessels pay out long lengths of heavy line, buoyed at each end, which have separate lines with baited hooks secured at intervals. Bait boats carry large bait in stern tanks that is thrown overboard to attract tuna which are then caught by hook and line on poles. These classes of vessels fish for tuna, salmon, swordfish, halibut, and some cod.

The fourth group of fishing vessels comprises those that set out traps, secured to a buoy on the surface, on the ocean bottom. After an interval, the vessel returns and picks up the trap. This type of fishing is primarily used for crabs, lobster, and other crawling shell fish from the bottom.

OFFSHORE DRILLING PLATFORMS - FIXED

Fixed platforms are used for production drilling of multiple wells at locations previously explored by more adaptable mobile units. They are prevalent in water depths up to 90 metres (300 feet), although a number have been built for depths to 300 metres (1000 feet) or more. They are basically civil engineering structures, although portions could be built by shipyards and floated into place.

SELF-ELEVATING DRILLING PLATFORMS - JACK-UP RIGS

Jack-up rigs have a barge-type hull with sufficient buoyancy to safely transport the drilling equipment and supplies to a desired location, after which the entire unit is raised to a pre-determined elevation above the sea surface. They may have legs which penetrate the sea bed or legs with enlarged lower ends to minimize penetration. The legs penetrate the main structure and are jacked-up (actually down) via rack and pinion or other means.

The main advantage of jack-up rigs is that drilling is done from a basically motionless platform and without need for special equipment to cope with sea motion. Jack-up range in maximum depth capability from about 15 metres (50 feet) to over 90 metres (300 feet). The hull sizes vary between 45 and 75 metres in length, and 40 to 65 metres in beam. Leg lengths are 45 to 130 metres.

SEMI-SUBMERSIBLE RIGS

Semi-submersible rigs depend on the buoyancy of widely spaced vertical columns mounted below the platform or deck. The lower ends of the columns are usually joined together to form two submerged hulls that provide better transit speeds and also incorporate self-propulsion.

Deck sizes range from 30 to 120 metres in length and 11 to 16 metres in beam. The stability columns are about 10 metres in length. Transit drafts are around 6 metres and operating drafts are around 25 meters.

DRILL SHIPS

Drill ships have a large drilling derrick with a massive support structure, extending above the main deck amidships, and a large pool opening extending down through the hull to accommodate the drilling operation. They range in size from 120 to 165 metres in length, displacing from 11,000 to 21,000 tons.

OFFSHORE SUPPLY VESSELS

The offshore supply vessel is primarily used to transit fuel, fresh water and other supplies to drilling rigs; but often it has the additional capability for towing and handling the positioning anchors of the rigs. Typical ships are in the 60-metre length range, displacing about 2,000 tons.

TUGBOATS

Tugboats vary in size from the 15 metre 300-horsepower barge jockeys, through the range of large harbour and offshore tugs that manoeuvre large cargo vessels and drill rigs, to the 76-metre 20,000-horsepower deep ocean tow and salvage tugs.

ICEBREAKERS

In addition to thicker hull plating, icebreakers have a comparatively wider beam and a shorter length. They are designed to ride up onto the ice and crush it by their weight which is increased when water ballast is pumped into the forward trimming tanks. Side trimming tanks are also used to give a rocking motion. They range in size depending on the function (harbour clearing, arctic, etc.) and require comparatively more propulsion power than other ships of equal size.

PART 4

CANADIAN REQUIREMENT

The Canadian owner requirements for ships and vessels differ slightly from world requirements because there is less emphasis on cargo ships and more on ice-strengthened constructed ships and vessels of other types. The unique Canadian situation with regard to a deep sea float provides little opportunity for Canadian shipyards to build large cargo liners, containerships, etc. Thus, the most notable Canadian construction in this area is the Great Lake bulk carriers and relatively small oil tankers. However, the increasing activity in the arctic and east coast offshore oil locations has caused a marked increase in ice-strengthened requirements for ships and vessels operating in these areas. There is also the increasing requirement for icebreakers to provide assistance to these other ships and vessels.

In general, the Canadian requirements can be divided into the following:

1. Government vessels.
2. Commercial vessels.
3. Commercial fishing vessels.
4. Offshore Oilfield-Related vessels.
4. Arctic vessels including LNG carriers.

GOVERNMENT VESSELS

The largest-near future requirement for government vessels is DND's announced program to build six Canadian Patrol Frigates, and in the long term, that program could involve up to 20 such vessels. These will be sophisticated vessels, containing advanced weapons, communications and other electronic systems. Machinery systems will also involve special mountings and be of special design to reduce underwater noise. (2) These ships are to be designed and built in Canada.

The Canadian Coast Guard has also announced an ambitious building program for over the next decade. Their requirements are primarily for patrol vessels of various sizes, but a polar class icebreaker is also included in their plans.

The Department of Fisheries and Oceans also has a continuing requirement for new and replacement vessels. These are mainly patrol vessels of various sizes, plus small research vessels.

There is also the continuing requirement to add to, and replace, existing ferries of Crown corporations and provincial governments.

COMMERCIAL VESSELS

Large Canadian commercial vessel requirements are mainly limited to Great Lake bulk carriers and ocean tankers, both in the 20,000- to 25,000-gross tonnage range. There is also the continuing requirement for various types and sizes of tugs and barges.

COMMERCIAL FISHING VESSELS (3)

In the Canadian scenario, an offshore fishing vessel is over 65 feet and an inshore fishing vessel is under 65 feet in length. There are nearly 40,000 fishing vessels registered in Canada, although about one third are under 25 feet and approximately 150 are over 100 feet in length. These fishing vessels have been limited in numbers by federal regulation, and even replacements are limited to 125 per cent of the length of the replaced vessel.

Replacement vessels are generally bigger, are far more efficient, and are usually constructed to enable easy conversion from one form of fishing (such as seining) to another (such as trawling). There is also a developing interest in Canada to acquire factory/freezer trollers that would catch, clean, gut, fillet, skin, and process the fish for market.

However, there appears to be little likelihood of increased Canadian activity in fishing vessel construction. There is a world surplus of fishing vessels because of catch-limiting regulations. Also, the Northeast Fisheries Centre, Woods Hole, Massachusetts recently predicted that by the end of the century, rising energy costs would place the fishing industry into a position of fishing with "passive" methods such as using stationary nets on the ocean bottom which trap fish instead of dragging for them at enormous energy cost.

OFFSHORE OILFIELD REQUIREMENTS

The ship and vessel requirements for the Canadian East Coast offshore oil and gas activities must be considered in the realities of actual oil and gas finds and projected (or expected) production dates.

Seismic activity has apparently peaked and there is probably little need for new seismic survey vessels, observing that 13 seismic ships were active in 1980. (4)

Exploratory drilling began in 1966 and over 150 wells have been drilled. The only potentially commercial finds are at Venture D-23 southwest of Sable Island (gas and condensate) and at Hibernia P-15 320 kilometres east of St. John (light gravity oil). The exploratory drilling activity has now centred on step out wells from these locations, plus some activity along the Labrador Shelf. The drilling rigs used include the semi-submersible of SEDCO H class built in the Halifax Shipyards, the dynamically positioned semi-submersible SEDCO 709, jack-up units built in Davies Shipyard, and a unit built in Victoria, B.C. It is doubtful that new oil rigs will be required for the Canadian scenario because most of the rigs built in Canada are now operating in other parts of the world, and the current Davie Shipbuilding order for eight rigs is apparently destined for other locations in the world. (4) (5)

The earliest production could start off Sable Island in 1986 and at Hibernia as early as 1985. Development of production facilities will require specialized ships and specialized facilities. Potential requirements include:

1. Fixed platforms (Venture D-233 is in 20 metres of water and Hibernia in 80 metres of water, both within the depth limits of fixed platforms).
2. Subsea completion systems.
3. Offshore storage systems.
4. Pipelaying ships and/or barges. (4)

ARCTIC VESSELS

The two major arctic projects are the Beaufort Sea Development and the Arctic Pilot Project.

Information made public by Dome Petroleum Limited regarding their plans for the Beaufort Sea Development, includes the following vessel types:

1. Drilling/production barges.
2. Accommodation barges.
3. Storage-and-process barges.
4. Cutter suction dredges.
5. Hopper barges.
6. Swivel drillships.
7. A.M.L. - 10s.

8. Ice breaking tankers.
9. Safety vessels.
10. Supply boats.

The Arctic Pilot Project consists of various components. Generally, these are: the gas-gathering system at the gas field; a gas pipeline across the Island to Bridport Inlet adjacent to Viscount Melville Sound; the facilities at Bridport Inlet which include the gas-liquefaction (or process) barge, the storage barges, and the vessel loading equipment; the two ships which bring the liquid gas from the Arctic to the southern Terminal; and the Southern regasification facilities. (6)

The Arctic Pilot Project will thus require icebreakers, storage-and-process barges, plus other service vessels. However, the major shipbuilding-related requirement will be two LNG carrier ships. The size of the LNG ships required for the Arctic Pilot Project has already caused a controversy in Canadian shipbuilding circles. Each of the two proposed ships is about 375 metres long overall with a beam of 42 metres and a draft of 13 metres in ice. Displacement will be about 140,000 tonnes, and they will carry 140,000 cubic metres of liquid cargo in 5 tanks. (6)

LNG CARRIERS

The controversy over the Canadian LNG Carrier requirement warrants a brief explanation on the unique constuction aspects of these ships.

The containment system for the LNG cargo is the unique aspect of these ships. The cargo must be kept at -162°C, and so special equipment and insulation techniques must be employed. There are three different containment systems in use by U.S. shipyards. These are: (1)

1. Kvaerner-Moss: spherical tanks which are free-standing and consist of aluminum alloy tank plating, a layer of insulation, and an outside protective steel dome.
2. Conch: free-standing prismatic tanks consisting of aluminum alloy tank plating, a layer of fibrous glass, a face plywood secondary barrier, layers of balsa wood and polyurethane foam, and a steel outer bulkhead.
3. Technigaz: membrane tanks with a primary barrier of about 1 millimetre thick stainless steel with a series of perpendicular corrugations (which make it look like a waffle and allow it to absorb thermal contractions and

expansions), as a series of plywood and balsa wood layers, a layer of mineral wool, and an outer steel bulkhead.

These containment systems each use a different method of layering steel and insulating material. A special type of steel is required and, depending on the demand, it may or may not be available in Canada.

The low specific gravity of the cargo also causes a requirement for special ballasting arrangements.

PART 5

SHIP DESIGNERS

Canadian consulting companies with ship design capabilities vary from small organizations devoted to the design of fishing craft and barges to large organizations formed for the design of the Canadian Patrol Frigate. There is also a certain amount of joint venture agreements associated with ship design projects.

The following is a list of Canadian companies who have indicated naval architecture, marine engineering and ship design expertise: (7) (8) (9)

Robert Allan Ltd., Vancouver, B.C.

Arctec Canada Ltd., Kanata, Ont.

Arctic Offshore Design Ltd, Vancouver, B.C.
CBCL Ltd., Halifax, N.S.
Case Existological Laboratories Ltd., Victoria B.C.

Cleaver and Walkingshaw Ltd., Vancouver, B.C.
Cove Dixon Co. Ltd., West Vancouver, B.C.

Eyretechnics Limited, Ottawa, Ont.

German & Milne Inc., Montreal, Quebec

Harford Kennedy Wakefield Ltd., Vancouver, B.C.

Peter S. Hatfield Ltd., Vancouver, B.C.

Kris Kristinsson & Associated Ltd., West Vancouver B.C.

Marine Design Associates Ltd., Victoria, B.C.

Navtech Inc., Quebec City, Quebec

NORDCO Limited, St. John's, Nfld.

Saint John Marine Consultants Limited, Saint John, N.B.

SCAN Marine Inc., Longueuil, Quebec.

United Marine Systems Ltd. (Uni-Mar), Victoria, B.C.

Vickers-Stanwick Systems Inc., Ottawa, Ont.

PART 6

CANADIAN SHIPYARDS

There are numerous companies in Canada engaged in ship and boat building and repair operations. However, in order to limit the companies to those that fall within the scope of this survey, it was decided to consider only those companies that are members of the Canadian Shipbuilding and Ship Repairing Association.

Since this was a "desk study" and visits to, or contact with, individual yards was outside the scope of the survey, the input data was that supplied by the companies themselves in various publications, press and magazine articles, and even advertisements. Thus, the data contained in the following matrix table must be considered with these qualifications in mind. It should also be noted that blank areas in the matrix do not mean the company does not have the respective facility, it simply means data was not available. Similarly, vague or unqualified information appearing in the matrix is as obtained in the information source. (5) (7) (8) (9)

ALLIED SHIPBUILDERS LTD. North Vancouver, B.C.
Floating dry docks: a. 37 x 99 m, 750 tonnes b. 30 x 9 m, 250 tonnes
Side launching, 120 x 25 m, 7,500 DWT
Crane capacity to 35 tons
Steelwork, piping, electrical and mechanical shops
Has designed barges and other non-propelled craft up to 10,000 DWT Supply vessels, ferries, tugs, and specialty craft to 3,500 DWT
- Barges to 10,000 DWT - Propelled vessels to 3000 tons DWT - Tugs - supply vessels - ferries - Fishing vessels - shallow draft craft - Patrol service vessels - Barges & pontoons
- Ship repairing and conversion
- Industrial machine work

BEL-AIRE SHIPYARD LTD. NORTH VANCOUVER, B.C.
Marine elevator to 150 tons and 100 ft. long
Lauching way, 350 ft.x 70 ft. Lauching way, 350 ft.X 70 ft.
Fitting out pier, 400 ft.
Mobile cranes - 70 ton - 30 ton - 10 ton - 10 ton
Full range of service shops
- Offshore supply vessels - Tugs - Barges - Fishing vessels - Pleasure craft

BRETON INDUSTRIAL AND MARINE LIMITED Port Hawksbury, N.S.
Marine railways, 1400 tons (long), 300 tons (long) Floating dry dock 220 ft. x 64 ft. inside, up to 1600 tons (long)
One 175 ft. x 80 ft. x 50 ft. covered and heated
Fitting out pier - 240 ft. 30 ft. d - 170 ft.
Mobile cranes - 35 ton - 12 ton - 6 ton
Welding and machine shops
Design and engineering, electrical and mechanical ship systems
- Tugs - barges - work boats - High speed aluminum service and patrol vessels - Passenger ferries - Special service vessels
- Repair work to service craft, fishing vessels - Ship conversions and general repair in both steel and aluminum

BURRARD YARROWS CORP. North Vancouver, B.C.
#1 - 10,000 tons, 495 ft. x 98 ft., 29 ft. d #2 - 9,000 tons, 420 ft. x 84 ft., 27 ft. d Floating dry dock, 200 m x 45 m, 36000 tonnes.
#1 - 500 ft. long x 100 ft. wide #2 - 500 ft. long x 75 ft. wide
- Destroyer escorts - icebreakers - Passenger, automobile & rail ferries - Tugs - tankers - seismographic research vessels - offshore service vessels - large multipurpose barges - Special purpose barges
- Ship repair and drydock facilities * available for ships up to 1170 ft. long and 124 ft. wide
- Specialty and industrial engineering and repairs

BURRARD YARROWS CORP. Esquimalt, B.C.
Marine railway - 2,5000 tons, 278 ft. x 49 ft. 13 ft. to 19 ft. d Equimalt gravity dock, 1173 ft. x 126 ft. 40 over sill, 13 ft.-9 ft. over blocks
#1 - 220 ft. long x 50 ft. wide, covere #2 - 180 ft. long x 40 ft. wide, covere #3 - 560 ft. long x 100 ft. wide.
- Destroyer escorts - icebreakers - Passenger, automobile & rail ferries - Tugs - tankers - seismographic research vessels - offshore service vessels - large multipurpose barges - Special purpose barges
- Ship repair and drydock facilities * available for ships up to 1170 ft. long and 124 ft. wide
- Specialty and industrial engineering and repairs

COLLINGWOOD SHIPYARDS Collingwood, Ontario
Graving dock, 630 ft. x 65 ft. x 16-1/2 ft. over sill
- Maximum St. Lawrence Seaway 223 m (730 ft.) x 23.2 m (76 ft.) - Tankers, passenger/vehicle ferries, bulk carriers, tugs, for both Great Lakes and ocean service.
- Graving dock and dockside repair facilities for all Great Lake vessels
- "Collomatic Winches", hatch cover cranes, Kestner hatch clamps, - Heavy steel fabrication and machine shop services.

DAVIE SHIPBUILDING LTD. Lauzon, Quebec
Lorne dry dock, 600 ft. long, 59 ft. wide, 22.08 water at sill.
#1 - Slipway, 198.1 m x 19.8 m #2 - Slipway, 228.6 m x 22.9 m #3 - Slipway, 236.2 m x 22.9 m #4 - Slipway, 189 m x 22.9 m
140 acres of plant facilities, 600,000 sq. ft. enclosed shops.
- Great Lake bulk corners. - Tankers - cargo vessels - offshore drill rigs - barges - icebreakers - Naval vessels - patrol and service vessels - ferries - dredges-trawlers - Tugs
Vessels of all types. Limiting factor width of dock gate 36.57 m, 150 ft. long and 40 ft. water at sill.
Specialized plate and welding fabrication for the hydro electric, nuclear, oil, gas, petrochemical, pulp and paper, steel, mining, research and transport industries.

FERGUSON INDUSTRIES LTD. Pictou, N.S.
Marine railway, 100 x 18m, 2000 DWT Marine railway, 1200 tonnes Marine railway, 3000 tonnes
Launching up to 350 ft. long
200,000 sq. ft. enclosed shops
- Steel fishing vessels - patrol boats - Passenger, automatic & rail ferries - Ocean tugs - barges - Ro-Ro vessels and cargo vessels to 110 m LOA and 4000 DWT
- Ocean vessels of all types up to 10,000 DWT
- Tanks & pressure vessels in steel, aluminum and stainless steel - Mine cars - fabricated structures electric power pulp & paper, steel mining, and petroleum industries

GEORGETOWN SHIPYARD INC. Georgetown, P.E.I.
Marine railway, 156 ft., 600 ton Marine railway, 78 ft., 100 ton Ship lifting facility (planned 80) 204 ft., 1200 ton
Indoor heated berth, 135 ft. length Side transfer (planned), 204 ft. length
- Small & medium size steel and aluminum vessels - Fishing vessels (trollers, seiners, etc.) - Commercial and naval tugs - Fishing research vessels - barges - Fast patrol & rescue craft - ferries
Repairs & conversions of ships of all types
Customized heavy metal fabrication, industrial repairs, machine shop work

HALIFAX INDUSTRIES LTD. Halifax Shipyards, Halifax Dartmouth Marine Slips, Dartmouth
Graving dock, 567 ft. x 80 ft. x 30 ft. Floating dry dock, 608 ft. x 83 ft. x 25 ft., 30,000 DWT Five marine railways from 96 ft. to 369 ft. in length up to 3,000 LT.
850 ft., 30 ft. draft 420 ft., 30 ft. draft 325 ft., 30 ft. draft
Over 50 acres. Machine, plate, pipe, sheet metal and joiner shops.
- Trollers 50 m LOA 11.8 m breadth 4 m draft.
Major conversions

HERB FRASER & ASSOC. LTD. Port Colborne, Ont.
Ship repairs afloat to boilers, hulls, machinery & electrical equipment, to vessels up to 730 ft. Conversions afloat.
Garbage incinerators, aluminum ladders and aluminum gangways.

IDEAL SHIP REPAIRS LTD. St. Catharines, Ont.
All work that can be done afloat
Boilermakers, steel fabricators, machinists

MARINE INDUSTRIE LIMITEE Tracey (Sorel), Quebec
Two marine railways - 180 m x 25 m, 5,000 tons - 83.8 m x 16.76, 2,000 tons
6 side berths 170 m length, 25 m breadth, for ships up to 170 m. Ships up to 225 m in length can also be built in two sections.
100 acres
- Multi-purpose cargo ships, - Container vessels - Tankers, specially reinforced for northern waters - Trollers - Ferries - Naval vessels
Overhaul, repairs and conversions of ships up to 25,000 DWT
- Hydraulic turbines and generators - Railway cars - Custom-made heavy machinery

MARYSTOWN SHIPYARD LTD. Marystown, Newfoundland
Syncrolift, 76.22 m x 18.29 m 3000 LT displacement
Two building berths up to 250 ft. long
450 ft. long wharf 250 ft. long wharf 200 ft. long fitting out quay.
one 5-ton, magnetic one 5-ton, overhead electric two 25-ton, overhea electric Mobile cranes
Main assembly and erection area is 383 ft. by 100 ft. Preparation, steel, paint, machine, electrical, joiner shops
- All classes and types of ships to 3000 LT displacement - Offshore supply & anchor handling tugs - Fishing vessels of all sizes & types
Vessels of all types to 3000 LT

NATIONAL SEA PRODUCTS LTD. Lunenburg, N.S.
2-sided wharf, total 525 ft.
Mobile, 7 ton
- Plate, machine, electrical, carpenters, welding and paint shops
Repairs to all types of fishing vessels.
Light industrial metalwork

NEWFOUNDLAND DOCKYARD St. John's, Nfld.
Graving dock, 570 ft. x 70 ft. Ship elevator, 300 ft. max. ship length
Rail travelling, 25 tons Rail travelling, 40 tons
Repair, conversion and refit work for all types of commercial, government, and naval vessels.
General engineering

NORTH SYDNEY MARINE RAILWAY COMPANY LTD. North Sydney, N.S.
Marine railway, 5 cradles, 30 tons to 600 tons
#1 150 ft. #2 230 ft.
2 mobile cranes
Machine, welding, diesel, marine electrical, wood-working, metal-fabricating shops
- Ferries - Barges - Special service vessels
Repairs & conversions to ships of all types
Paint, marine and industrial hardware

PORT ARTHUR SHIPBUILDING CO. Thunder Bay, Ont.
Dry dock, 747 ft. x 78 ft. x 35 ft. (full seaway size)
700 ft. x 68 ft., 6000 tons 250 ft. x 40 ft., 1700 tons
1400 ft. length, 18 ft. x 23 ft. draught
20-ton gantry crane over berth 20-ton 80 ft. boom revolving crane Mobile cranes 200-, 80-, 45- & 25-ton Loco crane 25-ton, 60 ft. boom
Computerized lofting and numerically controlled steel plates and piping system fabrication.
Activity generally confined to ship repair and major conversions.
Ship repairs and major conversions. Anti-ice bubbler for winter lay up & repairs.
Industrial and heavy machine work.

PORT WELLER DRY DOCKS St. Catharines, Ont.
730 ft. (222.5 m) x 80 ft. (24.38 m), 32,000 tons
750 ft. x 80 ft., 26 ft. draught, 32,000 tons
Engines, hull, propeller, piping, electrical and navigation equipment shops.
Self-unloading bulk carriers for inland & ocean traffic. Ice-strengthened ships, tankers, ro-ro ships. Passenger, rail and car ferries. Tugs and barges.
Ship repairs

PURVIS NAVCON SHIPYARD LIMITED Selkirk, Manitoba
Tuktoyoktuk dry dock, 4000 tons Selkirk marine railway, 1800 tons
Selkirk launching, 1800 tons Covered berth 40 ft. x 160 ft.
- Ferries, cruise vessels, tugs, barges crew boats, fishing vessels, work boats.

RIVTOW SHIPYARDS LTD. B.C. MARINE SHIPBUILDERS DIV. Vancouver, B.C.
#1 Slipway, 94.5 x 15 m, 1800 DWT #2 Slipway, 39.5 x 13 m, 800 DWT
Forging shop
Tugs and barges Ferries up to 64 m
Coastal and deep sea, all types
Agent for Liebherr Cranes

RIVTOW SHIPYARDS LTD. JOHN MANLY SHIPYARDS DIVISION Vancouver, B.C.
Tugs, fishing vessels, patrol vessels, crew boats - steel or aluminum to 50 m., barges to 65 m.
Coastal vessels 29 m x 10 m
Ship component manufacturing - doors, windows, quick opening manholes, propellers, Kort nozzles.

SAINT JOHN SHIPBUILDING & DRYDOCK CO. LTD. Saint John, N.B.
Main dock, 1150 ft. x 125 ft. x 42 ft. over sill. Semi-tidal Dock, 440 ft. x 60 ft. x 22 ft. over sill.
700 ft. 400 ft. Launching berth, 400 ft. x 60 ft.
Three 350 ft. One 730 ft. One 500 ft.
Cranes from 6 to 75 long tons. Mobile cranes Floating crane, 400 tons Floating crane, 65 tons
Modern facilities for new ships up to approximately 90,000 DWT
Design facility
Product carriers to 100,000 DWT Bulk carriers, ferries, barges and tugs.
Major conversions, jumboising, surveys, ship and engine repairs.

SHELBURNE MARINE LTD. Shelburne, N.S.
Marine railway, 400 ft., 3000 tons
Five from 350 ft. to 500 ft. length
Two 25 ton mobile cranes Ten mobile cranes Travel lift crane, 160 tons
Plate, machine, electrical, carpenters, welding, and paint shops
Construction of vessels up to 110 ft. in length
Repairs to all types of steel and wood vessels
Light industrial work

VANCOUVER SHIPYARDS CO. LTD. North Vancouver, B.C.
Esquimalt graving dock, 1173 ft. x 126 ft. x 35 ft. over keel blocks Synchrolift, 90 m x 21 m, 1500 m tons displacement
Level building berth, 160 m long Side lauching berth, 160 m long
Engineering and drafting staff
All types of floating equipment, tugs, barges, ferries, vessels up to 160.01 m long 30 m beam. Maximum launch weight-7000 tonnes Semi-submersible & jack-up rigs
All types vessels up to 1100 metric tons displacement Deep sea vessels at loading berths Conversions, modifications & lengthening

VICKERS CANADA INC. Montreal, Quebec
Three floating dry docks, max. capacity 27,500 tons, 750 ft. length
1000 ft. 550 ft.
275-ton crane
Plate, machine and joiner shops.
Naval ship design agency for DND.
Specializing in ship repairs, conversions, and refit work, all types, commercial and naval, year-round service.
General engineering

W.F. WALSH LIMITED Montreal, Quebec	
	DRY DOCK FACILITIES
	BUILDING BERTHS
	REPAIR & OUTFITTING BERTHS
	CRANES
Machine, steel and plate, electrical shops	SHOP FACILITIES
	DESIGN FACILITIES
Barges	SHIPBUILDING ACTIVITY
Complete marine repair afloat	SHIP REPAIR ACTIVITY
Fabrication of tanks	OTHER ACTIVITY

PART 7

SHIP EQUIPMENT AND MATERIAL SUPPLIERS

There is a wide range of equipment and material required for ships and vessels, depending on their size, function, and complexity. It has been estimated employment by industries allied to the shipbuilding industry could amount to 4,000 persons. (5) The following list is arranged under general groupings of usual ship equipment. The Canadian suppliers listed may not always produce the equipment in Canada, but they receive it from affiliated companies in other countries. If the Canadian supplier is known to be an importer of some of the equipment, it is noted with an asterisk (*). (7) (8) (9)

ANCHORS & CABLE EQUIPMENT

Burrard Iron Works Ltd., Vancouver, B.C.

Lester Bolt & Chain Ltd., Richmond, B.C.

Brock Marine Ltd., Montreal, Que. *

Marine Equipment Ltd., Halifax, N.S. *

AUXILIARY MACHINERY

Alfa-Laval Ltd., Peterborough, Ont. *

APE Canada Inc., Mississauga, Ont. *

Diamond Canapower Ltd., Burlington, Ont.

Dowty Equipment of Canada Ltd., Ajax, Ont. *

Hamworthy Canada Ltd., St. Catharines, Ont. *

Aircraft Appliances & Equipment Ltd., Bramalea, Ont.

Byrton Jackson Div. Borg-Warner Canada, Scarborough, Ont.

Pumps & Power Ltd., Vancouver, B.C.

Velan Engineering Ltd., St. Laurent, Que.

CARGO HANDLING EQUIPMENT

Atlas Polar Company Ltd., Toronto, Ont. *

John T. Hepburn, Ltd., Toronto, Ont.

Allis-Chalmers Canada Ltd., Toronto, Ont.

Techwest Enterprises Ltd., Vancouver, B.C.

Gearmatic Co., Surrey, B.C.

HMW Industries Ltd., Halifax, N.S.

Montgomery Elevator Co. Ltd., Toronto, Ont.

COMMUMICATIONS EQUIPMENT

Canadian Marconi Company

Hermes Electronics Ltd., Dartmouth, N.S.

Spilsbury Communications Systems, Vancouver, B.C.

K.W. Wilk Associates Ltd., Nepean, Ont.

ELECTRIC PLANTS AND SYSTEMS

Atlas Polar Company Ltd., Toronto, Ont. *

BG Marine, Montreal, Que.

Canadian General Electric Company Ltd., Scarborough, Ont.

Cullen Detroit Diesel Allison Ltd., Burnaby, B.C.

Siemens Electric Limited, Montreal, Que. *

Island Control Ltd., Charlottetown, P.E.I.

Schmidtec Power Systems Ltd., Burnaby, B.C.

Hewitt Equipment Ltee., Pointe-Claire, Que.

FIRE DETECTION AND EXTINGUISHING SYSTEMS

Chubb Fire Security, Toronto, Ont.

Tri-Services L.A.S. Ltee., Lachine, Que.

HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS

Galt Equipment Ltd., Candiac, Que. *

Norris Warming Canada Ltd., Ottawa, Ont.

HULL STRUCTURE COMPONENTS

DAF Indal Ltd., Mississauga, Ont. *

MacGregor Canada Ltd., Pointe Claire, Que.

Pyramid Transit Products Ltd., Pointe Claire, Que.

Allied Enterprises Ltd., St. Laurent, Que.

Crosbie & Sons Ltd., St. Laurent, Que.

Waterway Manufacturing Ltd., Richmond, B.C.

HULL STRUCTURE MATERIAL

The Algoma Steel Corporation Ltd., Toronto, Ont.

INCO Metals Company, Toronto, Ont.

The Steel Company of Canada, Toronto, Ont.

Fibreglass Canada Ltd., Toronto, Ont.

LIVING AREA FURNISHINGS

Joiner Systems of Canada Ltd., Montreal, Quebec

MACHINERY CONTROL SYSTEMS

Canadian General Electric Company Ltd., Scarborough, Ont. *

J. Kobelt Manufacturing Co. Ltd., Vancouver, B.C.

Wagner Engineering Ltd., North Vancouer, B.C.

Prime Mover Controls Ltd., Burnaby, B.C.

ASEA, St. Laurent, Que. *

NAVIGATION EQUIPMENT

Canadian Marconi Company, Montreal, Que.

Decca Marine, Toronto, Ont. *

Internav Limited, Sydney, N.S.

Litton Systems Canada Ltd., Rexdale, Ont. *

Raytheon Canada Ltd., Waterloo, Ont. *

Sperry Gryoscope Division Sperry Inc., Ottawa, Ont. *

Wagner Engineering Ltd, North Vancouver, B.C.

POLLUTION ABATEMENT EQUIPMENT

Hamworthy Canada Ltd., St, Catharines, Ont. *

Kelvin Hughes, Nun's Island, Que.

PROPELLERS

Canadian Stone Marine Ltd., Iberville, Que.

Lips NV Canada Limited, Dorval, Que. *

ABCO Acadia, Bridgewater, N.S.

Lunenburg Foundry & Engineering Ltd., Lunenburg, N.S.

Osborne Propellers Ltd., Vancouver, B.C.

Maritime Industries Ltd, Burnaby, B.C.

Axel Johnson Inc., (KaMeWa), Montreal, Que. *

PROPULSION GEARING

APE Canada Inc., Mississauga, Ont. *

PROPULSION PLANTS - DIESEL

APE Canada Inc., Mississauga, Ont. *

Atlas Polar Company Limited, Toronto, Ont. *

Bombardier Inc., Montreal, Quebec

Canadian General Electric Company Ltd., Scarborough, Ont. *

Cullen Detroit Diesel Allison Ltd., Burnaby, B.C. *

GEC Diesels Inc., Toronto, Ont. *

ABCO Acadia, Bridgewater, N.S.

Colt Canada Inc., Dorval, Que. *

Hewitt Equipment Ltee, Point Claire, Que. *

PROPULSION PLANTS - ELECTRIC

Canadian General Electric Company Ltd., Scarborough, Ont.

Siemens Electric Limited, Montreal, Quebec *

PROPULSION PLANTS - GAS TURBINE

Canadian General Electric Company Ltd., Scarborough, Ont. *

Pratt & Whitney Aircraft of Canada Ltd., Longueiul, Que. *

Rolls-Royce (Canada) Limited, Montreal, Que. *

PROPULSION PLANTS - STEAM

STEERING EQUIPMENT

Wagner Engineering Ltd., North Vancouver, B.C.

Brock Marine Ltd., Montreal, Que. *

PART 8

NEW DEVELOPMENTS AFFECTING THE CANADIAN SHIPBUILDING INDUSTRY

New technological developments affecting the Canadian shipbuilding industry are, and will be, primarily associated with vessel developments, which in turn will drive the requirement for upgrading ship construction methods. Although, in certain areas, ship construction methods are and will also be affected by improved technology.

SHIP DESIGN

Over the past quarter century, there have been significant changes in the size, appearance and general characteristics of ships engaged in international commerce. The advance of design and construction technology through this period encouraged the development of ship types that could satisfy the growing economic demands for ships of greater capacity, propelled at faster speeds, with the ability for faster turn-around in port, in order to reach the ultimate goal of increasing ton-miles per day to maximize profit. The trend today is toward a consolidation and refinement of these advances with less emphasis on the development of larger, faster, or newer types of carriers. Sophisticated, specialized vessels have also become more of a requirement.

In the area of fast patrol and/or naval ships, development is progressing in the SWATH-type ship. The Small Waterplane Area Twin Hull SWATH vessel is fundamentally a derivative of the catamaran. It differs from the conventional catamaran in the distribution of buoyancy. Basically, the catamaran has two standard displacement hulls, whereas the SWATH consists of deeply submerged cylindrical hulls connected to an above-water box by slender surface piercing struts. Its claim to fame is significantly reduced motions and a larger deck space relative to that of equal displacement monohulls. (2)

Canada could re-enter the hydrofoil arena since that type of vessel shows considerable promise with its ability to maintain high speed in all but freak sea conditions. It would be necessary to keep ship size down (in the 300 to 600 ton range) to keep cost and technical risk at an acceptable level and to be cost effective. (2)

There is also increasing interest in air cushion vehicles in Canada, primarily for arctic operation. These vehicles have a distinct advantage as transportation systems over ice, snow, and open water. There are also developments taking place associated with the ice-breaking potential of air cushion vehicles. To date, air cushion construction has been mainly centred around the aircraft industry. However, there is no reason why it should not be considered by the shipbuilding industry, particularly as the size of these vehicles increases.

An area which is being further investigated is the development of wing-in-ground effect vessels (WIGS). Some preliminary work has been conducted in the USN and it is believed there are other countries more advanced in the exploitation of this impressive concept. If some of the assessments can be believed, it is feasible for quite large vessels to operate at very high speeds, relying on the lift created by very close proximity to the surface (land or sea). (2)

A ship design consideration that could have an affect on ship construction methods is the use of longitudinal construction. A Nordic yard has calculated that by using longitudinal construction giving horizontal corrugations to the hull instead of vertical corrugations, an improvement of about 4 per cent of propulsion efficiency could be reached. (13)

MODULAR BARGES

There is an increasing tendency to incorporate processing plants into barges and then towing them to remote locations for operation. This concept is part of the Arctic Pilot Project, and has already been used by Cominco Limited with an ore processing plant. The lead and zinc ore processing plant, built on the barge in Trois-Rivieres, is being towed by tug to the mine site 3,200 kilometres away on Little Cornwallis Island in the Northwest Territories. (10) This type of barge-processing plant construction activity could become more intense, and could tax the technology base of the shipyards as more sophisticated processes are assembled in this manner.

PROPULSION AND AUXILIARY MACHINERY SYSTEMS

A recent development in shipbuilding is the advent of complete package propulsion systems supplied to the shipyard by one supplier. It includes the engine, gearing, propeller equipment and relevant control equipment. The shipbuilder thus does not have to deal with 3 or 4 separate suppliers, each with their own drawings, special tools, field service engineers, and of course, warranties. (11)

Over the next 20 years, there will be modest improvements in propulsion systems and by the turn of the century we may expect the following:

1. Sophisticated machinery propulsion control systems will be in common use.

2. Electric cruise propulsion, with power supplied from larger capacity base-load ship service generators.

3. Superconducting and advanced normal conducting DC motors for propulsion and major auxiliaries.

4. Reversing gearboxes to gain the higher efficiency of fixed-pitch propellers.

5. Fuel cells for submersible and possible surface ship use. (2)

Although Canada is not likely to develop nuclear propulsion plants, it is likely that our neighbour to the south will be able to reduce the size of their plants for fitting in smaller vessels than currently is the case.

The renewed interest in coal as a fuel has spurred the development of the fluidized bed steam boiler, and this could be incorporated in the propulsion systems of ships. In fluidized bed combustion, the fuel to be burnt is injected into a fluidized bed of inert particles (for example ash and limestone) suspended in an evenly distributed upward high velocity air stream. The fuel, which can be solid, liquid or gaseous, is fed continuously into the bed in the quantity required to give the desired thermal output. The design of the boiler is such that a much higher heat transfer coefficient is obtained compared with that of a conventional boiler, thereby resulting in a reduction in heating surfaces and overall boiler size. (12)

Some improvements are expected in marine auxiliary systems that will improve efficiency while reducing maintenance and operating workloads. Some examples include:

1. Reverse osmosis water purification.

2. Heat pumps to better use available energy for heating and cooling.

3. Plasma arc incinerators to dispose of shipboard wastes. (2)

ELECTRONIC DEVELOPMENTS

The rapidly spreading industrial applications of micro processors have, in certain areas, already affected ship construction. However, their major impact is yet to be felt. This will be in the monitoring and control of various operations in the vessels themselves. Sophisticated systems are already used in certain arctic and offshore vessels, but the range of application (and cost effectiveness) staggers the imagination.

The impact of the micro processor on the shipbuilding industry will be primarily in the nature of the labour force. There will be a marked increase in the requirement for skilled electrical and electronic technicians as the vessels under construction require more built-in sensors, actuators, and of course, miles of connecting wiring. Yards experienced in naval construction and repair are already aware of this problem, but it will soon become more and more felt in commercial vessels. No longer will a shipyard simply rely on an electronic equipment supplier to do the installation; a dedicated portion of the shipyard work force will be required. This will be a problem for the shipyards that have always considered a shipyard force made up of metal workers and fitters.

OTHER DEVELOPMENTS

Icebreaking technology problems are mainly in the field of scientific and engineering activities, but will also impact on the shipyards. To cope with the specialized and thicker steel (expected to be 50 millimetres thick for the A.P.P. LNG carrier), the handling and fabrication equipment will have to be upgraded. There will also be a requirement for more highly skilled labour.

LNG storage technology, both on board carriers and in the Arctic area, will also pose a challenge to Canadian shipyards. Most of the scientific and engineering problems have been solved in other parts of the world, but construction in Canada will require considerable upgrading of facilities. Each of the five envisaged tanks on the LNG carrier will hold approximately 28,000 cubic metres of liquid cargo and the proposed storage area in the Arctic will require tanks of approximately 50,000 cubic metres each.

The gas liquefaction technology will also affect shipyards, because of the proposed barge mounted plant for the A.P.P. and also because of the current trend toward incorporating various processing plants on barges for Arctic deployment. The introduction of these sophisticated processes will require the shipyard labour force to change considerably.

SHIP CONSTRUCTION DEVELOPMENTS

The main ship constuction developments being introduced by new and modernized yards, are directed to achieving an assembly-line-type of flow of materials to assembly areas, and an orderly flow of assemblies to the final building site. It is difficult to justify expensive assembly-line equipment in the Canadian shipbuilding scenario because of the lack of multi-ship orders. However, the trend toward larger assembly areas and fewer building sites could offer some cost effective benefits to the Canadian shipyards.

Welding technology must be improved if Canadian shipyards are to be competitive and if they must deal with the high strength hulls of Class 7 icebreakers as well as the special requirements of LNG carriers. However, the improvements are not of major expense. Micro-processor-controlled welding is common throughout other industries and is being employed in some Canadian shipyards. High strength steel welding is not very different from ordinary steel except that low hydrogen electodes must be used and some preheat might be required for structures under conditions of high restraint. To meet the welding requirements of LNG tanks, special welding techniques, such as procedures using controlled rates of heat input and interpass temperature control, are required. However, these techniques can be easily introduced. The major problem will be obtaining skilled workmen.

Robotic technology is spreading throughout industry, with over 20,000 industrial robots in use world wide. The applications are: part handling, tool handling, adaptive control applications, and assembly. Robots can be programmed to do jobs such as spray painting, arc welding, and other repetitive functions. They are being used in the shipbuilding industry in some other countries, and could also be applied in Canada. The cost of a robot varies from $5,000 to $100,000, depending on its (his/her) sophistication. However, they save time and money, improve productivity, give flawless job performance, and lower labour costs. (14)

OFFSHORE OIL DEVELOPMENTS

The Venture field near Sable Island does not present any particularly unique problems. The water is shallow and the wind and sea conditions are not more severe than those encountered in the North Sea. The type of offshore facility that will be needed for developing a gas field there is commonly used in other places in the world and can be readily built in the Maritimes. (4)

Developing an oil field at Hibernia does involve some unique problems that have not been faced elsewhere in the world. Although the water is relatively shallow, 80 metres (275 feet), compared to that of some other developed offshore areas in the world, and the wind and sea conditions are no more severe than that of the North Sea, the production facilities at Hibernia will have to be able to cope with the occasional incursion of ice and icebergs onto the site. This situation has no parallel in another offshore region that has been developed. The operator, Mobil, is looking at two alternatives.

The first is to place all the control mechanisms on the sea floor and to make production platforms that house all the separating, metering, storage, and accommodation facilities in floating units. The platforms could then be moved out of the path of any ice or icebergs. (The actual platform would look very much like the big semi-submersible drilling units). (4)

The second method is to build an extra-strong permanent-type platform that would be fixed on the sea bottom and protected in some way with a barrier or by an iceberg towing system, or by some combination of the two. At the moment, the operator has not officially indicated a preference.

Regardless of which of the above types is eventually chosen, the facilities could be built on the East Coast, although some additional fabricating facilities would need to be developed. (4)

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