Instituto Panamericano de Ingeniería Naval
Instituto Pan-americano de Engenharía Naval
Pan-american Institute of Naval Engineering

XI CONGRESO PANAMERICANO DE INGENIERIA NAVAL,
TRANSPORTE MARITIMO E INGENIERIA PORTUARIA.

A PROJECT EXPORT CASE.
AN ANTARCTIC RESEARCH AND RESUPPLY VESSEL.

PAPER N° 33

JAN KINGO
Manager, Sales and Marketing - WARTSILA MARINE IND. INC.
FINLANDIA

A PROJECT EXPORT CASE. AN ANTARCTIC RESEARCH AND RESUPPLY VESSEL

Kingo, Jan; Manager, Sales and Marketing
Wärtsilä Marine Industries Inc., Helsinki, Finland

1. Introduction

Today there seems to be a worldwide growing demand for building certain technically very demanding vessels in countries, where the domestic shipbuilding industry has no, or only little experience and knowledge of tendering, designing, building, testing and commissioning of such complex vessels.

There is a great variety of reasons for this apparent trend, such as political and trade political reasons, special legislation and restrictions in export and import regulations, industrial employment conditions and last but not least cost competitiveness when building locally. Also in many countries shipbuilding is being regarded as strategic industry and therefore kept operative by saving shipbuilding orders to the domestic yards by governmental help in form of favorable financing or direct subsidies.

The building of specialized vessels requires many special skills and management of technology on different fields of expertise during tendering, design and construction phases. A shipyard with only little experience of the type of vessel in question has to use the services of outside consultancy firms often to a high degree. Such projects consequently become complex to manage. Having many different parties involved in the project can create problems in the coordination of the work of all parties and communication and flow in information becomes laborious. Much attention has to be directed to the definition of responsibilities and interfaces between the parties for avoiding gaps and overlapping in their respective duties. Therefore, the fewer the parties are, the easier it is to overcome the potential risks and problems as described above.

One solution to the problem areas described above is a shipbuilding project jointly carried out by the local shipyard and a shipyard with experience of designing and building of the type ships in question.

This paper first describes generically the joint approach to a shipbuilding project and presents some essential sectors of a shipbuilding project, and finally the project export case of building an antarctic research an resupply vessel in Australia is presented.

2. Mode of Operation

2.1 Traditional Approach

Traditionally the customer (owner or operator)) initiates the shipbuilding project by setting the technical and operational criteria for the required product or services required and asks for quotations from shipyards known to be capable of carrying out such project. After a round of bidding, the successful shipyard enters into construction contract with the owner for the newbuilding and carries out the project.

Usually the building shipyard manages the whole project itself, and often, depending on the complexity of the vessel and the overall project, buys defined technical services from outside consultancy firms on special sectors where there is lack of knowledge or resources in its own organization.

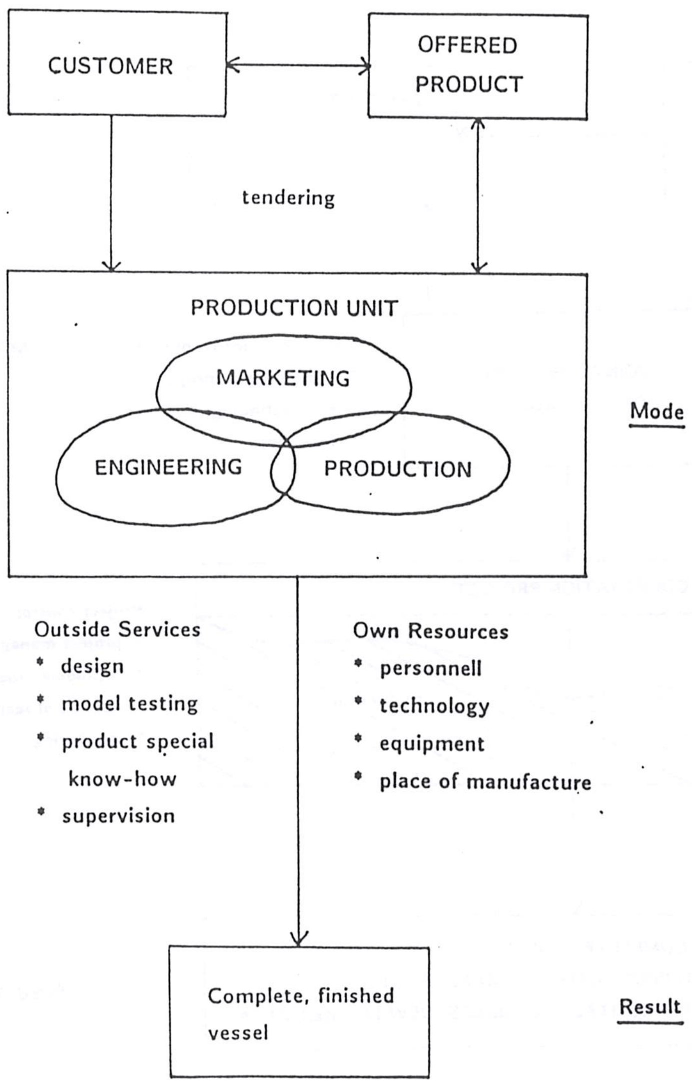


Figure 1. Traditional mode of operation

This mode of operation sets high requirements for the shipyard's operations, especially for the project management. Especially in case the vessel differs much from the previously delivered products of the shipyard and contains many technically demanding features, then the total project becomes complex.

2.2 Joint Operations

In this approach the project of tendering and building of a complex vessel is carried out by the local shipyard in cooperation with a shipyard responsible for the technology transfer activities. In a complex project this cooperation should start well before the tendering for the specialized vessel is released. Thus the parties can tailor an optimum product for the customer and determine the division of activities and responsibilities for maximizing the operational efficiency in the project.

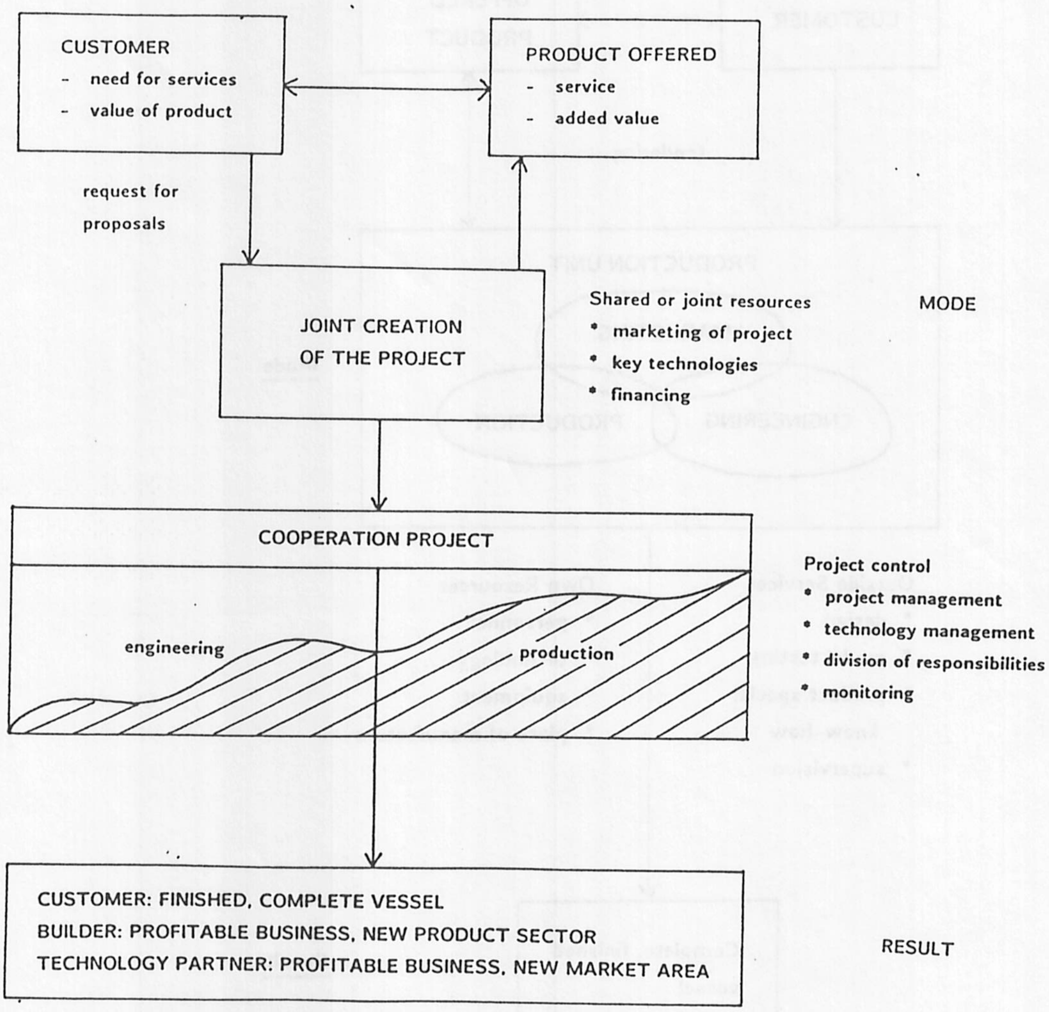


Figure 2. Changed mode of operation

The form of the cooperation can vary from formal partnership or joint-venture to a straightforward contract between the parties where the building shipyard buys certain services from the other shipyard.

A shipbuilding project jointly carried out will benefit both parties. In addition of a profitable business to the parties, the technology transfer aspect will benefit the building yard by becoming familiar with new vessel type design and new design and construction methods. This acquired knowledge can be used to promote the shipyard's future business.

3. Shipbuilding Project

Pre-Contract Phase:

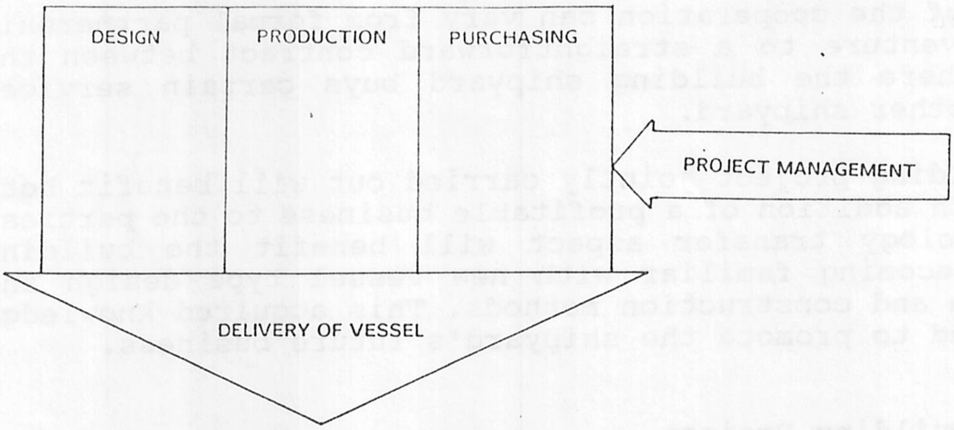
The pre-contract phase of a shipbuilding project includes the development of the vessel's design and specifications according to the owner's requirements for price estimating and signing the shipbuilding contract. The technical development has to be done to the level that there is confidence in the finished product meeting all the performance, capacity and quality requirements.

The construction price estimation requires defining the technical characteristics for all major equipment and materials for receiving vendor quotations. The manhours for further design work and labor manhour required for building the vessel are to be estimated.

In addition to above a project plan must be made including resource planning and critical path network for the construction. This master plan will demonstrate the activities in the project and gives a reliable estimation for the duration of the project.

Post-Contract Phase:

The post-contract phase can by simplified to following:



- IN BUDGET
- IN TIME
- ACCORDING SPECIFICATIONS
- ACCEPTED PERFORMANCE
- SUITABLE QUALITY

3.1 Cooperation Areas

A complex shipbuilding project to be carried out by the local shipyard in cooperation with a shipyard responsible for the technology transfer should be based on the strong areas of both partners.

This cooperation shall start well before the shipbuilding contract is placed, already when the first conceptual design is made. By this arrangement the product can be tailored to meet the owner's requirements and also to reflect the building yard's requirements deriving from its facilities, equipments, working methods and available skilled labor force.

The extent of the cooperation depends greatly of the type and size of the projected specialized vessel, the capabilities and resources of the building yard.

The cooperation can take place on following sectors:

* Engineering
  - Design services from conceptual design to total design including workshop drawings.
  - Assistance in estimating.
* Procurement
  - Setting technical characteristics for shipyard's purchasing operations.
  - Providing cost-competitive equipment and machinery packages.

* Production

    - Technical assistance during the building period on different fields of special expertise.

    - Quality control.

* Project management activities

When defining a cooperation between two shipyards, a thorough analysis of the parties' capabilities and the different phases of the project has to be made in order to ensure that all aspects of the complex project are covered and the risks of the project are minimized.

3.2 Project Preparation

Before work on a project begins, a comprehensive project execution plan is to be developed to allow realistic assessment of project status at a given point in time throughout the project duration.

A rolling wave concept can be adopted in which the plan is first developed based on preliminary data and is then expanded as the project scope becomes more defined and as more detailed information becomes available.

The overall project parameters are defined using standard company procedures and generic project data and schedules which are made specific to suit yard practices and methods and client requirements. The steps involved in defining project parameters include:

- Define scope of project through the use of a Work Breakdown Structure (WBS).

- Identify the engineering scope of work and develope a work package structure.

- Define the Project Organization Breakdown Structure.

- Establish a responsibility matrix and assign responsibilities.

- Develope a Uniform Project Numbering System based on the WBS.

- Define the Contract Packaging Structure System based on the WBS.

- Define the Contract Packaging Structure (CPS) and Procurement Method.

The total scope of the project is clearly defined in a systematic logical manner using a hierarchial work breakdown structure (WBS). Using a hierarchial format permits the project data base to be broken down into major categories, with each of these categories further subdivided in several stages.

Such an approach provides for summarizing project data at the different levels of detail. The system is completely flexible in that a generic WBS can be modified to suit a particular client's requirements.

The WBS defines the entire physical scope of the project to be designed, constructed, estimated and schedules, as well as providing a basis for the breakdown of engineering services. Establishing the WBS early in the project is critical, since all other project data and documents use this WBS number as their root.

3.3 Project Baselines

After the project scope has been defined, this information is used to develope the integrated project baselines of:

- technical (Design Report)
- cost (Capital Cost Estimate)
- schedule (Project Master Networks)

These three components are always related to each other throughout the project in that a change in any one will generally result in a change in the other two components.

The baselines consist of a technical design report, a capital cost estimate report, and a project master network on a summary basis with specialized "subnets" for engineering, procurement, construction and commissioning. These three main documents are "frozen" at a particular point in time and become the overall project plan.

The overall project plan is then expanded into detailed work plans, containing sufficient information so that the project work may be carried out logically and systematically. The detailed work plans define engineering, procurement, construction and commissioning activities and responsibilities to a greater degree than the overall project plan. Project procedures, comprising detailed instructions as to how the project execution is to be carried out are also developed at this time.

3.4 Project Control

The first stages of the three project baselines (Design Report, Capital Cost Estimate and Project Networks), once approved, are transformed into control documents against which actual project performance is monitored, and control exercised.

Deviations from any one of these baselines are carefully monitored and recorded since a change in any one of these components will mean a change in the others. Any design changes will result in changes to the capital cost estimated and often to the schedule as well. A change in the project schedule will result in a change in the total project cost.

Therefore, project procedures are developed defining the methods of handling changes to any one of these baselines, and of determining the effect a change in one baseline has on the other components.

Project control is performed within three integrated major categories of:

- Project Engineering Control;
- Project Cost Control; and
- Project Schedule Control.

3.5 Design

This section presents the scope and objectives for the design work in the project.

The objective is to perform the work for ensuring that the design meets the criteria set forth by the owner, fulfills all appropriate rules and regulations and the general design and workshop drawings maintain high quality, can be produced according to schedule and the technical solutions are suited for efficient construction.

The following describes the different phases of the design work.

3.5.1 Basic Design for Estimation Purposes

- Ship specifications
- General arrangement drawing
- Machinery arrangement drawing
- Midship section
- Lines plan
- Weight estimate
- Stability calculations
- Hydrostatics
- Performance estimates

3.5.2 Contract Design

The objective of this phase is to develop the design package into a more detailed one that will form part of the contract for the construction of the vessel.

The tasks required in the performance of this phase are:

- modify and finalize requirements in cooperation with the owner;
- produce specifications for soliciting vendor quotations;
- select major component suppliers in cooperation with the owner/operator;
- perform a design check and finalize the design; and
- produce information required for production scheduling and planning.

The material produced in this phase include following:

a) Basic Documents and Calculations

Specification
Design report (updated)
Hydrostatics
Trim and Stability Calculation
Freeboard Calculation
Flooding Calculation
Lightship Weight Distribution Curve
Estimated Power Curve
Heat Balance Diagram
List of Suppliers
Electric Load Analysis

b) Basic Drawings

General Arrangement
Midship Section and Typical Transverse Bulkheads
Profile and Decks
Lines and Offsets
Capacity Plan
Fire Subdivision
Machinery Arrangement
Shafting Arrangement

c) Hull Structures

Shell Expansion
Structural Cross Sections
Deck Drawings
Stern Construction
Bow Construction
Rudder(s)
Superstructure and Deckhouse

d) Hull Outfit

Mooring Arrangement
Cargo Handling Arrangement
Life Saving Appliances Arrangement
Store Plan

Ventilation Diagram
Piping System Diagrams
Special Outfitting

e) Machinery

Engine Control Room Arrangement
Piping System Diagrams
Ventilation Diagram
Calculation of Main Shafting(s) and Propeller(s)

f) Electric Outfit

Electric Feed Schematic Diagram

g) Interiors

Plans of All Accommodation Areas

3.5.3 Detailed Design

The objective of this last phase of design is to produce all the detailed calculations, drawings and specifications required for the actual fabrication of all components and their assembly in order to produce the finished ship.

The contents of the detailed design is described below.

a) Basic Design (Final)

Ship Description
General Arrangement
Capacities
Hull Form
Hydrostatics and Stability
Performance in Open Water
Rules and Regulations
Standards and Materials
Trials

b) Hull

Hull Structures
Superstructure Structures
Hull Outfitting
Coatings
Corrosion Prevention

c) Interiors

Insulation
Lining
Deck Covering
Furniture
Galley Equipment

Provision Stores
Deck Stores
Work Shops
Doors and Locks
Stairs and Rails
Guidance Plates
Inventories

d) Water, Sewage, Ventilation and Fire Prevention

Fresh Water Preparation and Distribution Systems
Sewage Systems
Heating Systems
Cooling Systems
Garbage Disposal Systems
Ventilation and Air Conditioning
Firefighting and Prevention

e) Machinery

Propulsion Machinery
Gear Box
Shaftline
Propeller
Auxiliary Machinery
Fuel Systems
Lubrication Systems
Cooling and Heating Systems
Steam Systems

f) Machinery Outfitting

Compressed Air systems
Piping
Exhaust Air System
Hoist system

g) Ship Handling and General Systems

Anchoring and Mooring System
Steering System
Stabilizing System
Lifeboats and Workboats
Elevators
Cranes
Masts

h) Special Equipment

Special Systems depending on the type of the vessel

i) Electricity, Automation, Navigation and Communication

Main, Auxiliary, Harbour and Emergency Diesel Generators
Transformers
Electricity Distribution

Lighting
Control Systems
Automation
Alarms
Navigation Systems
Intercom
Cables

3.6 Coordination

Each shipyard has its own routines and standards set up for the construction of the ship. It is therefore essential in a cooperation project that the builders requirements, standards, working methods are carefully analyzed. After agreement on procedures to be used in the project, all this should be properly accounted for in order that the material produced can be efficiently used at the construction site. This should be secured by frequent communication between the yard and the design team and exchange of key design personnel between the parties during the different design phases.

In many cases best results can be achieved by conducting the detailed design at the building yard under the supervision of the party responsible for the general design. The local expertise in this solution guarantees the suitability of the output of the detailed design to the yard.

This will provide the local designers with experience in the design of complex vessels which can be used in future projects.

3.7 Project Management

This section presents the different project management activities that are of importance when building a complex vessel.

The principal objective of the project management activities is to provide the shipyard's management with the accurate information required to make the decisions and to implement actions which will ensure that a project will be completed on budget, on schedule and the product will meet the intended functional and qualitative requirements.

3.7.1 Risk Management

The objective of the risk management would be to:

- identify project risks as the potential arises;
- analyze the nature of the risk and its potential impact on the project; and
- recommend appropriate courses of action to reduce or eliminate the identified risk.

It is usual on project to investigate risks in at least the following categories:

- technical
- management
- production
- testing and acceptance.

3.7.2 Cost and Schedule Management

The objective of the cost and schedule management would be to exercise continuous control over the project by utilizing the systems and tools designed to:

- plan by defining the cost and schedule requirements of the project;
- monitor by instituting systems that monitor and compare the actual performance, (and forecast performance) against the Project Plan, and provided information on the exceptions and variances, both actual and expected; and
- control by instituting systems that require that decisions be taken and actions be carried out at all responsibility levels to ensure that performance meets the Project Plan.

3.7.3 Material Management

The objective of material management would be to:

- coordinate the procurement of materials and services functions;
- involve a procurement plan, fully responsive to the requirements of cost, schedule and quality;
- institute systems for monitoring the timetable for fabrication and delivery of materials and services produced; and
- exercise control over quality.

4. Aurora Australis

4.1 Background

In December 1987 it was commenced by the Australian Government that they would enter into final contract negotiations with P&O Polar, a subsidiary of P&O Australia Ltd., for chartering an icebreaking antarctic research and resupply vessel for 10 years. Soon after P&O Polar, the operator and buyer of the vessel, announced that the vessel would be built in Australia by Carrington Slipways Pty. Ltd. in Newcastle, New South Wales with the comprehensive assistance during the project by a foreign shipbuilding company Wärtsilä Marine Industries Inc., Helsinki, Finland, which would be responsible for the vessel's design and giving technical assistance to the shipyard during thee building period thus enabling the sophisticated complex vessel to be built in Australia.

However, this project was started already in 1986, when the Australian Government by its Antarctic Division, Department of the Arts, Sport, the Environment, Tourism and Territories, set out the basic requirements for the projected vessel. A conceptual design reflecting the requirements was prepared and subsequently an international request for proposal was sent to shipping companies all over the world for the charter of the antarctic research vessel. Over 100 proposals were submitted to the Antarctic division and after the comprehensive bid evaluation process the proposal made by P&O Polar was chosen.

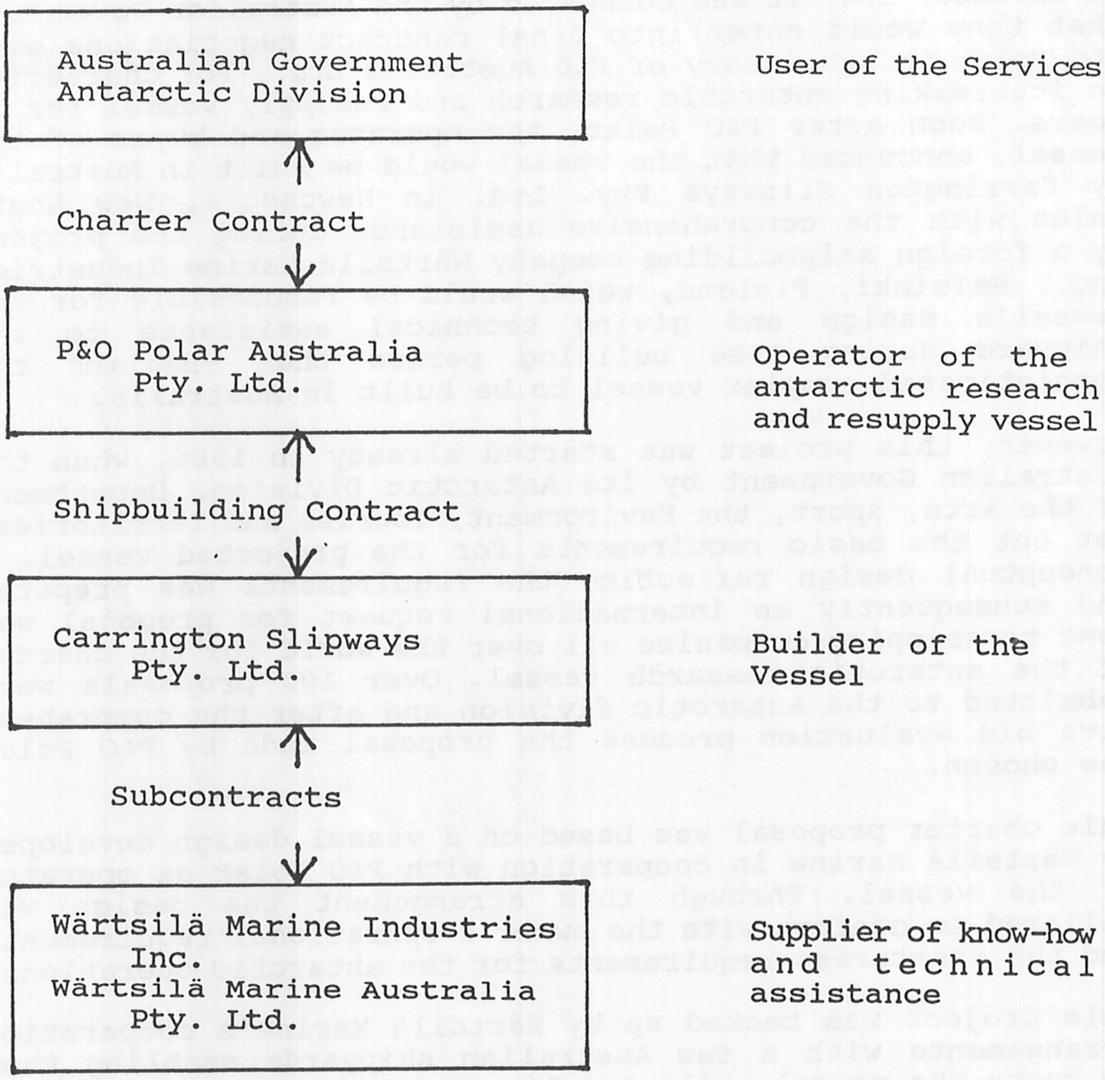
This charter proposal was based on a vessel design developed by Wärtsilä Marine in cooperation with P&O Polar as operator of the vessel. Through this arrangement the design was tailored to conform with the owner's operational requirements and the charterers requirements for the antarctic operations.

This project was backed up by Wärtsilä Marine's cooperation arrangements with a few Australian shipyards enabling them to quote the vessel built locally to the shipowner.

This was the starting point of the cooperation project between Carrington Slipways Pty. Ltd. and Wärtsilä Marine Industries Inc. for building Australia's first ice-breaker and sophisticated research vessel.

4.2 The Project

The parties:



The cooperation between Carrington and Wärtsilä Marine was formalized through entering into contracts, which made Wärtsilä Marine the main subcontractor responsible for the technology transfer activities required for successfully carry out the project.

Wärtsilä Marine's role in the project became following:

* Designer of the vessel.

* Supplier of the total design including the detailed design required by the shipyard for building the vessel.

* Supplier of technical assistance to shipyard during the building period.

*   Supplier of material and equipment packages.

4.2.1 Requirements for the Design

According to the original requirements for the vessel by the Antarctic Division, the vessel had to be multifunctional in order to support Australia's operations in the Antarctic region. These requirements included

- Extended operations in the Polar regions
- Independent transit in Polar sea ice conditions
- Supply of research stations on the Antarctic continent and sub-Antarctic islands
- Marine research including oceanography, hydrography and acoustic biomass surveys
- Commercial scale trawling
- Helicopter operations

This and the more detailed requirements was the starting point for the design development. The objective for the design work was to have a ship which

- fulfills all requirements,
- is safe and reliable to operate,
- is efficient and economical in operation,
- contains features for easy and straightforward maintenance,
- has low building price.

The task for meeting all the objectives to the satisfaction of the charterer, owner and the building shipyard was demanding. The final design was developed after consultations with the Antarctic Division, P&O Polar and the building shipyard.

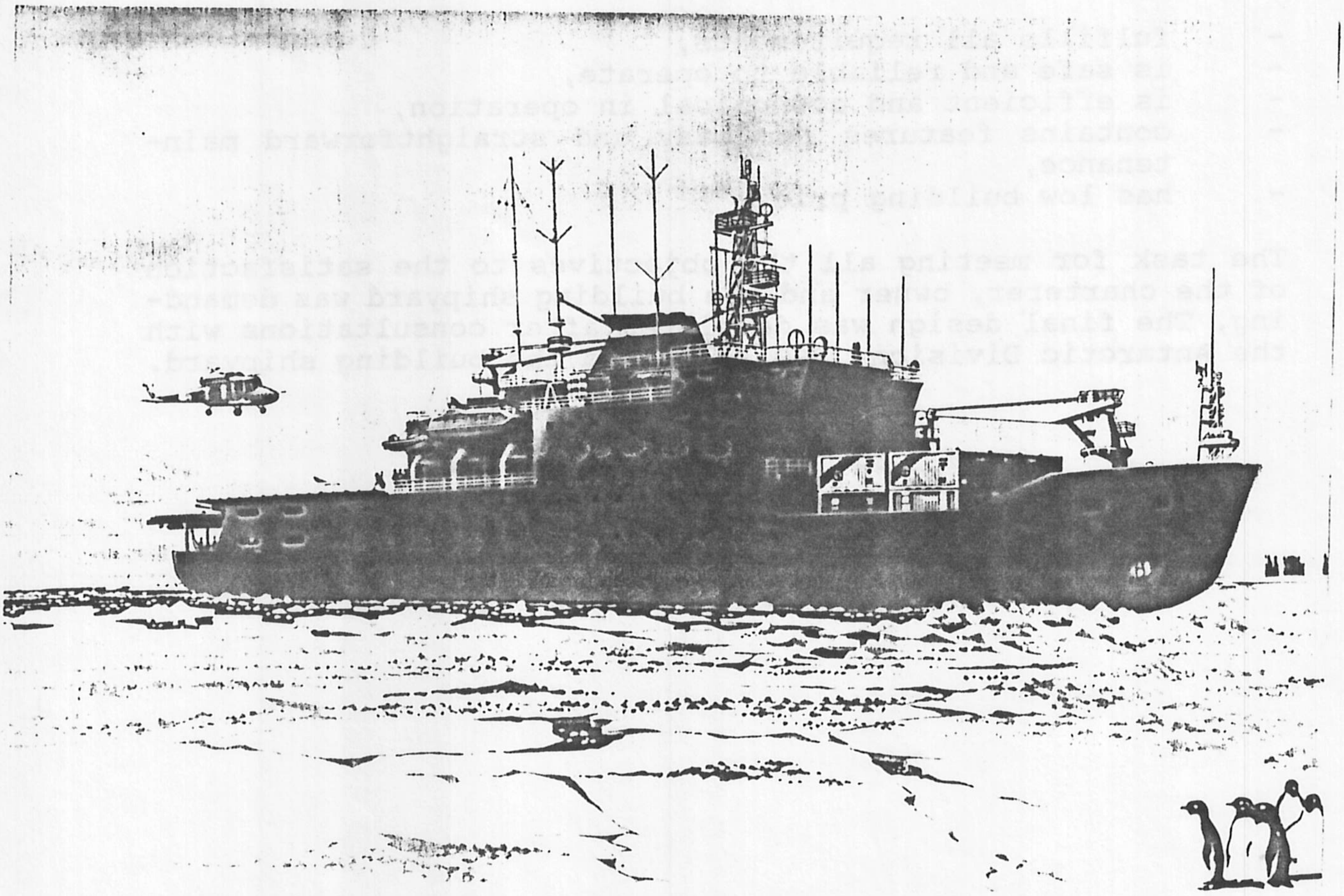
4.2.2 The Vessel

General characteristics:

- Length overall 94,8 meters
- Breadth 20,3 -"-
- Draft, max 7,85 -"-
- Deadweight 3600 tonnes
- Engine power 10.000 kw
- Speed, max 16.0 kn
- Complement and research personnel 133

Classification:

Lloyd's Register of Shipping with notation +100 A1, +LMC, UMS, Ice Class 1A Super, DP(CM), Special purpose ship with letter of compliance to Canadian Arctic Pollution Prevention Regulations Arctic Class 2 with Arctic Class 3 hull strength in bow and stern.



4.2.3 Machinery

The propulsion system consist of two medium speed Wärtsilä Vasa V32 diesel engines with total output of about 10.000 kw coupled to a Lohmann twin input single output reduction gearbox driving a Lips controllable pitch stainless steel propeller.

For station keeping the vessel is equipped with one 12-ton transverse thruster in the bow and two retractable azimuth thrusters in the aftship. The aft thrusters are used in slow steaming during research operations when low noise level is required. They can be used for trawling and they also serve as additional take-home units in case of failures in the main propulsion system.

Auxiliary power is generated by three Wärtsilä Vasa R32 diesel generator sets with total output of 3110 kVA.

The ship is single fuel ship with all machinery operating on intermediate grade fuel oil.

4.2.4 Resupply Systems

The vessel is designed for transporting 1700 cubic meters of general cargo below deck and an additional container capacity of 40 TEU. For supplying fuel oil the vessel has a tank capacity of 1000 cubic meters.

Cargo handling equipment consist of one 25-ton crane for loading and unloading in the bow and one 7-ton and one 2-ton crane in the aftship. Two forklift trucks will be used for stowage of cargo and transporting cargo to the helicopter deck for helicopter supply operations. The hangar can accommodate two Sea Hawk size helicopters.

4.2.5 Performance

The service speed will be 13 knots and maximum speed 16 knots. The objectives in developing the lines of the hull were efficient ice-breaking, good seakeeping capabilities and high fuel economy. For achieving these, often controversial characteristics, extensive tank testing was carried out. Test included ice model tank tests, open water seakeeping tests, towing tank tests and propeller cavitation tests.

The vessel will be able to operate independently in heavy ice-conditions equivalent to breaking 1,23 meters of first year level ice at a continuous speed of 2,5 knots. The intering stabilizing system onboard can also be used as an active heeling system during icebreaking operations.

4.2.5 Scientific Operations

In accordance with the requirements of thee charterer, the vessel has been designed to carry out a diverse range of research, including oceanographic, hydrographic and acoustic biomass studies. For these purposes the vessel is equipped with laboratories, workshops, extensive instrumentation and a centralized computer system.

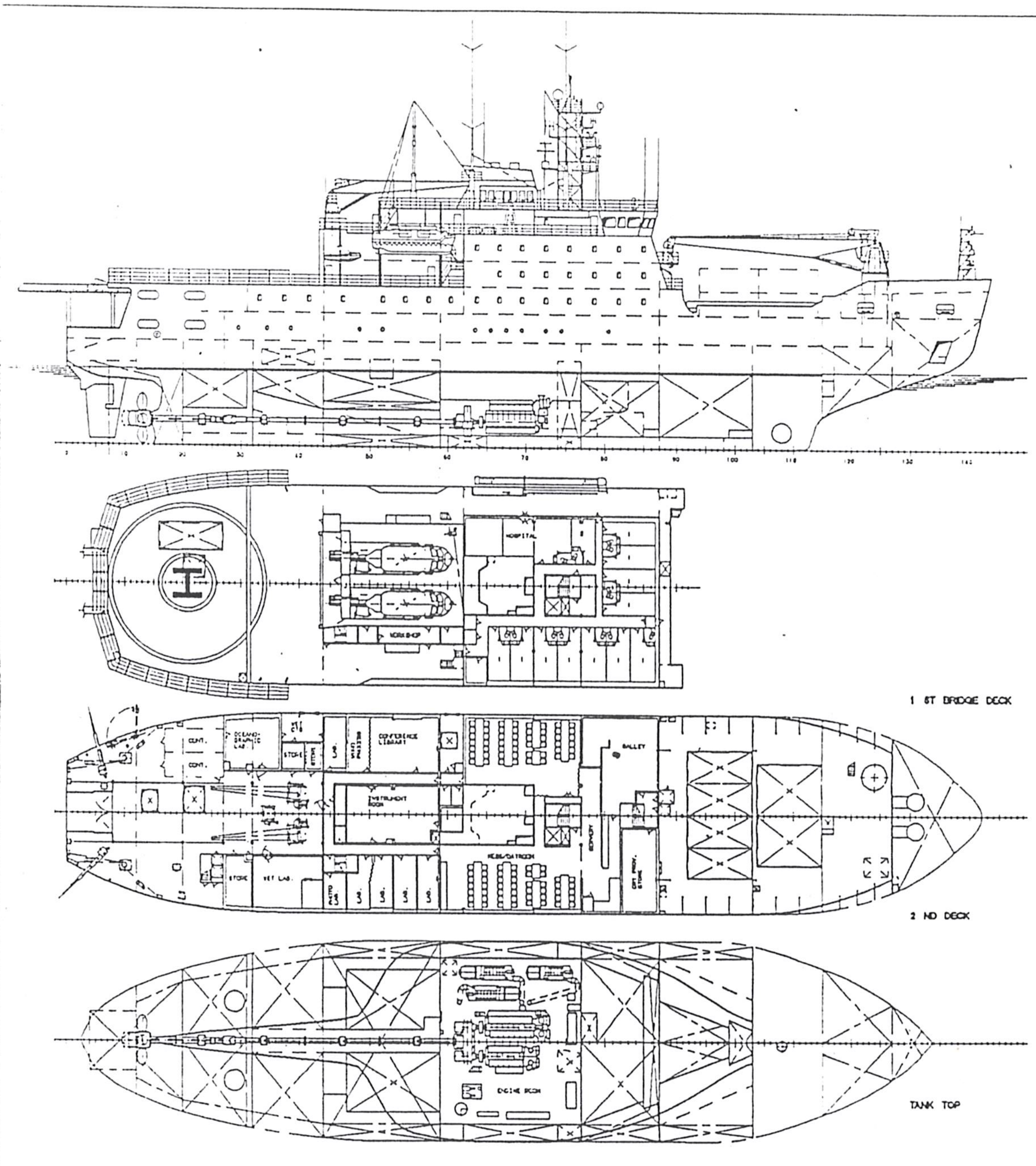
The hydroacoustic system consists of

- hydrographic sounders
- trawl surveillance sonar
- scanning sonar
- echo sounders for the estimation of fish biomass and krill
- split beam tranducers to allow target strength analysis.

The output of the different systems, oceanographic, meteorological and hydroacoustic instruments will be logged on a central data logging system. A second computer system with terminals throughout the ship will allow onboard data processing.

In addition to the eight permanent laboratories, the vessel has further eight laboratories housed in movable containers. These are hooked to the ship's electrical, water and cooling/heating systems while in operation.

An important role of the vessel is its ability to study fishing methods by using its own commercial scale trawling gear.



MAIN PARTICULARS

LENGTH OA.	~94,80 M
LENGTH DWL	88,40 M
BREADTH MOULDED	20,30 M
DRAUGHT	7,65 M
HEIGHT TO UPPER DECK	13,25 M

WÄRTSILÄ MARINE