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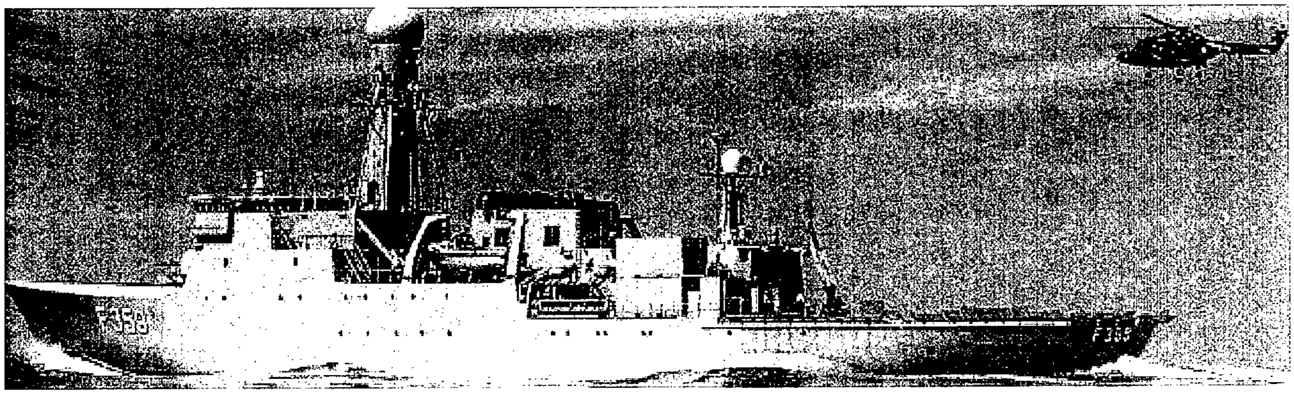
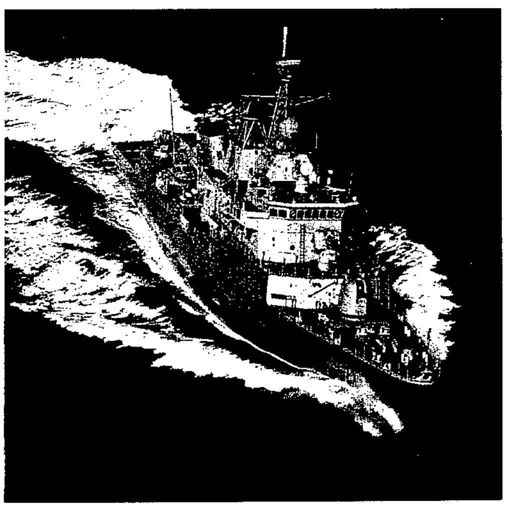
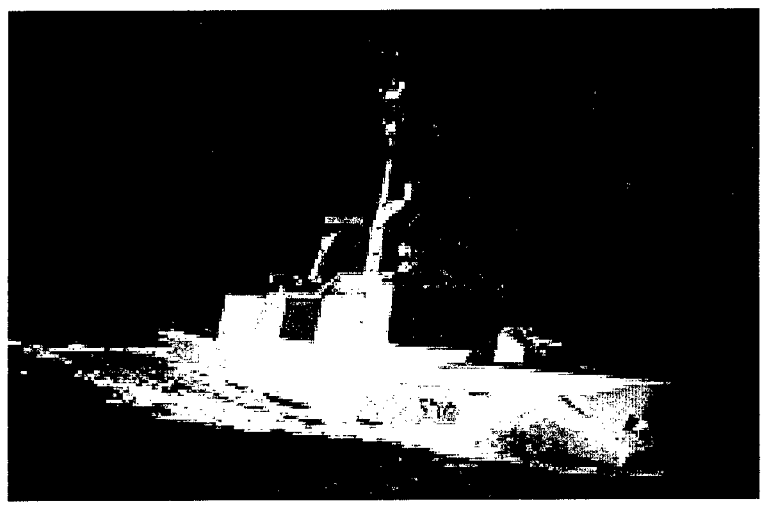


COMPARATIVE PRACTICES OF EUROPEAN FRIGATES AND OFFSHORE PATROL VESSELS





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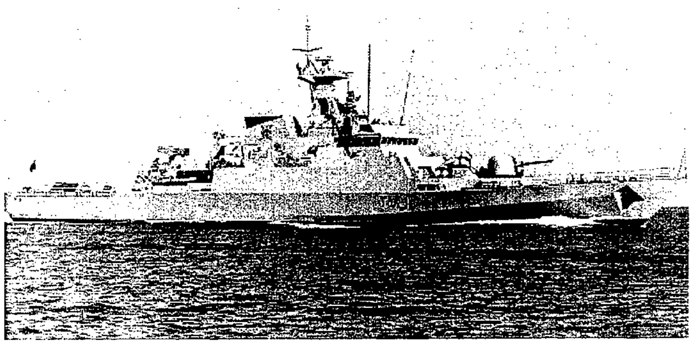

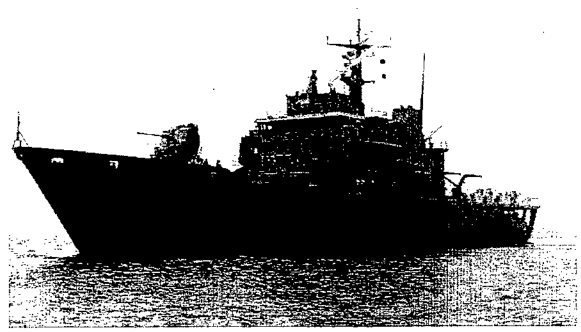

COMPARATIVE PRACTICES OF EUROPEAN FRIGATES AND OFFSHORE PATROL VESSELS

Participants:

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Mr. Rubin Sheinberg

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Deepwater Project Surface Matrix Product Team met with shipbuilding industry executives and Naval and Coast Guard leaders of Italy, Denmark, The Netherlands, France, England, Norway, Germany and Sweden to investigate seventeen multi-purpose frigates and offshore patrol vessels.

The objectives of this trip were to identify and compare design and operational practices and technologies which would assist the U.S. Coast Guard in performing their missions more effectively in the Deepwater environment. In addition methods for reducing life cycle cost through the use of current, non-developmental technologies were sought.

During the meetings the discussions focused on Mission Profiles of the Vessels, Crewing of the Vessels, Habitability, Maintenance Issues, Propulsion Systems, Design Criteria, Boat Launch and Recovery Systems, Aircraft Launch and Recovery Systems, and Damage Control Technology.

MISSION PROFILE OF VESSELS

The missions of the vessels visited included Law Enforcement, Maritime Safety, Defense Operations and Maritime Environmental Protection. Fisheries protection was the most important law enforcement mission for all of the vessels. Defense operations were generally important to all of the nations, and tended to have a significant impact on the characteristics of the vessels. Mine warfare missions were common to all of the vessels, and anti-submarine warfare was common to most.

While the missions were similar, vessels and services tended to be more focused on a single mission for each deployment. The ability to conduct fisheries, counternarcotics, migrant interdiction and defense operations in the same deployment was usually not required.

CREWING

Every nation realized the high cost of personnel on ships and all are investigating ways to reduce crew sizes. It was generally accepted that today's technology makes it possible to operate an Offshore Patrol Vessel or Frigate displacing up to 3600 tons with a crew of 75 or fewer. Many nations however continue to crew such ships with 100 to 200 people due to tradition, culture, training or employment objectives. Denmark and Norway have been successful in operating 3200 + ton ships in fisheries patrol missions with 62 people. Both countries have also begun using two crews on some of these vessels to increase the days deployed to 270 to 300 per year.

Almost every ship was designed for mixed gender crews in almost any ratio, though no crew was more than ten percent female and some vessels only had one female on board.

Officers on the vessels we visited generally spent more time at sea than officers in equivalent positions in the U.S. Coast Guard, and tended to stay longer on the vessels. However, a large portion of the junior enlisted force on these vessels tended to change every year.

HABITABILITY

Many European services consider themselves to be in competition with the commercial maritime industry for crew and therefore elected to provide accommodations equivalent to those found on commercial vessels. Many nations have adopted the Norwegian Maritime Directorate's standards for accommodations, which allows no more than two crew members per cabin. All vessels had

generous galleys, messing areas, lounge areas and fitness centers; some even had saunas and solariums.

MAINTENANCE

There was a general trend toward more contract maintenance in the countries we visited. However, those countries with the most experience using contract maintenance have found a balance between contract and crew accomplished maintenance most cost effective and efficient.

The Commanding Officers on both HVIDBJORNEN (3600 ton THETIS Class Patrol Frigate) and ANDENES (3200 ton NORDKAPP Class Patrol Frigate) stated that a crew of 62 was sufficient to accomplish the maintenance on these vessels. Both of these classes of vessels were assigned to collocated squadrons which make support and maintenance of the vessels easier.

Germany, Denmark and France used modular weapons systems, electronic suites and deck equipment on their vessels. Not only did these modular units reduce construction time and improve the quality of the systems they also allowed malfunctioning major components to be replaced quickly with spare units. The malfunctioning units are repaired and returned to a rotatable pool while the vessel remains operational.

Many countries used Fiber Reinforced Plastic (FRP) and composite materials for masts, deckhouse structures, rudders and fins in part because they reduce maintenance over the service life of the vessel.

Condition based maintenance was pursued by most nations to reduce the cost of extensive preventative maintenance programs. Preventative maintenance requirements were reduced and used only where supported by cost effectiveness and readiness issues.

PROPULSION

Propulsion and engineering plants in general were more automated. The services in Denmark, Norway and other countries are not asking whether the engine room should be manned but whether the Engineering Control Center needs to be monitored. New control systems, greater data transfer rates and open architecture standard shipboard displays are allowed nearly all engineering operating parameters to be displayed on the bridge. Similarly, nearly every routine operation and control function was performed on the bridge.

DESIGN CRITERIA

The services and shipyards visited used a mixture of commercial and military standards and practices in the construction of the frigates and off shore patrol vessels. Depending on mission requirements, own country naval, NATO, U.S. Naval or commercial standards were used. Generally, U.S. Naval standards were used for intact and damage stability requirements. All of the vessels were designed to withstand the flooding of any two adjacent main compartments, some were designed to withstand three compartment flooding. Commercial standards and practices were commonly used for hull structure, habitability requirements, and systems integration. Electronic equipment tended to be commercial-off-the-shelf (COTS) with tuned shock mountings where required.

Military standards were generally used for electrical generation and distribution systems, intact and damage stability, fire fighting and damage control systems.

Service life margins for new frigates and patrol vessels were comparable to the service life margins used for the U.S. Coast Guard's Sea Going Buoytender and HEALY acquisitions, adjusted for a 25 year service life, versus the Coast Guard's standard 30 year service life.

BOAT LAUNCH AND RECOVERY

The naval mission of many of the vessels did not require that small boats be launched and recovered in all weather conditions, consequently most nations did not place a lot of design emphasis on boat launch and recovery systems.

All small boats tended to be located amidships where pitch motions were least, to improve boat handling. All vessels carried at least one rigid hull inflatable boat (RHIB), many carried two. Most vessels launched the RHIBs with cranes fitted with constant tension winches.

AIRCRAFT LAUNCH AND RECOVERY CAPABILITY

All of the frigates and patrol vessels that had flight decks were able to launch and recover aircraft in seas up to sea state 5 or 6 (wave height 8 to 19 ft, wave period 7 to 17 sec). All of the vessels had a landing grid similar to Talon. All of the vessels had some type of traversing system, ranging from simple cable systems to full RAST systems.

Most of the vessels made use of two roll stabilization systems. Rudder roll stabilization systems in combination with fin stabilization systems were common. Roll stabilization tanks in combination with roll stabilization fins were also common.

Aircraft were typically Lynx or Superlynx helicopters in the 3 to 5 ton range, however many of the larger ships and newer designs could accommodate 10 to 13 ton aircraft.

DAMAGE CONTROL

Many of the services have conceded that 3000 to 3600 ton vessels can only withstand one weapon hit given today's threats. Having enough personnel and damage control equipment to successfully combat two weapons hits was deemed unrealistic and thus not provided.

The size of the Damage Control parties generally were smaller than those on equivalent sized U.S. Coast Guard cutters.

Heat, smoke and flooding sensors were extensively used on the vessels. Networked displayed damage and repair actions underway simultaneously at all operating stations (Repair Lockers, Engineering Control Center, Pilothouse). Firemain and HVAC systems were equipped with numerous remotely controlled and automatically controlled valves. Many of the vessels had sensors for access closures and critical piping valves such that the exact material condition was immediately known by the computerized damage control system.

1.0 INTRODUCTION

The Deepwater Project Surface Matrix Product Team met with shipbuilding industry executives and Naval and Coast Guard leaders of Italy, Denmark, The Netherlands, France, England, Norway, Germany and Sweden to investigate the following frigates and off shore patrol vessels:

ITALY - The MAESTRALE Class Frigate, the MINERVA Class Corvette and the CASSIOPEA Class Patrol Vessel

DENMARK - The THETIS Class Frigate and the STANDARD FLEX 300 multi-role ship

THE NETHERLANDS - The LCF Air Defense and Command Frigate

FRANCE - The LA FAYETTE and FLOREAL Class Frigates

GREAT BRITAIN - The HORIZON Anti-Air Warfare Frigate, the QAHIR Class Corvette, the SEA WRAITH Stealth Corvette and the 100 meter Trimaran Demonstrator Frigate

NORWAY - The SVALBARD Patrol Frigate, the Multi-Purpose Defense Frigate, and the NORDKAPP Class Frigate

GERMANY - The MEKO 200 Class Frigate

SWEDEN - The VISBY Class Corvette

The Deepwater Project Surface Matrix Product Team that participated in the survey of comparative practices of European frigates and offshore patrol vessels included:

Commander Jon M. Watson	Commander Scott D. Genovese
Mr. Rubin Sheinberg	Lieutenant Commander Paul W. Schulte
Lieutenant Commander Carl B. Frank	Lieutenant Commander Neil L. Nickerson
Mrs. Maria S. G. Cooke	Mr. Christopher Cleary

The vessels investigated are multi-mission platforms that conduct many of the same missions as the U.S. Coast Guard's High Endurance and Medium Endurance Cutters. These missions included Law Enforcement, Maritime Safety, Defense Operations and Maritime Environmental Protection. While each nation had its own priorities and some unique requirements, the following generalizations could be drawn. Within the Law Enforcement mission area, fisheries were most important and illegal migrants were a concern for some. However, no country or vessel appeared as active in the narcotics interdiction mission as the U.S. Coast Guard. Defense Operations were generally important considerations for most countries and had a significant influence on vessel size and configuration, though some countries; Norway for example, plan very little defense readiness into their Coast Guard operations during peace time. Mine warfare capability was prevalent throughout all the vessels investigated. Maritime Safety was largely an incidental effort carried out while deployed for other reasons. No country deployed ships strictly to standby and render assistance to vessels in distress. Maritime Environmental Protection appeared to be a growing concern, but one that gets little attention currently.

While the missions were similar, the vessels and services tended to be more focused on a single mission for each deployment. The capability to conduct fisheries, counternarcotics, migrant interdiction and joint or combined defense operations in the same deployment was usually not required. In fact in many cases, the vessels were specifically outfitted, crewed and trained for particular missions just prior to deployment. The most sparsely crewed vessels admitted to not being able to keep up with NATO or intense naval exercises for more than two weeks. Simply concentrating on fisheries law enforcement; the same vessels might conduct boardings nearly daily for more than two months.

A synopsis of each vessel's principal characteristics is contained in Appendix A.

2.0 DESIGN AND CONSTRUCTION STANDARDS

The government organizations and shipyards visited employ a variety of design criteria and construction practices. Depending on mission requirements, own country Naval, NATO STANAG, U.S. Navy or commercial standards are used. Generally, U.S. Naval standards (or very similar standards) are used for intact and damaged stability, though there is work ongoing in some countries to revise the stability criteria. National Navy or NATO standards were used for power distribution, ship signature reductions (noise, radar cross section (RCS) and thermal) and damage control systems (fire, flooding, ventilation). There is also a general move toward commercial design standards for structural and habitability requirements, operations and system integration. Shock standards are often met by using commercial-off-the-shelf (COTS) equipment with foundations built to withstand operational requirements. This greater use of COTS equipment has helped shipyards to cut the cost of most electronics systems by one half or more in some cases. Table 2.1 summarizes the design and construction standards used of the vessels investigated.

Ship Class	Structure	Electric	Machinery	Fire Fighting	Stability	Habitability	Service Life
MINERVA	M	M	M	M	M	M	25 yrs
CASSIOPEA	C	C	M	M	M	C	25 yrs
MAESTRALE	M	M	M	M	M	M	25 yrs
THETIS	C	C	C	M	C	C	25 yrs
STAN FLEX 300	C	M	M	M	C	C	25 yrs
ANDENES	C /M	C	C	M	M	C	25 yrs
FLOREAL	C	M	C	M	M	M	25 yrs
LA FAYETTE	M	M	M	M	M	M	25 yrs
MEKO 200	M	M	M	M	M	M	30 yrs
VISBY	C	M	M	M	C	C	25 yrs
83 M CORVETTE	M	M	M	M	M	M	25 yrs
100 M TRIMARAN	C	M	M	M	M	M	Demon-strator
HORIZON	M	M	M	M	M	M	25 yrs
LCF	C	M	M	M	M	M	20 yrs

M - Military C - Commercial

TABLE 2.1 Design and Construction Standards

2.1 STRUCTURAL DESIGN CRITERIA AND PRACTICES

Italy, Denmark, France, and Norway have built vessels using commercial structural design standards and practices. The Netherlands is planing to build their next frigate to commercial structural requirements and utilize COTS electronics to the greatest extent possible. With the exception of the LCF and HORIZON frigates, which are air defense and command frigates, these vessels are used primarily as Offshore Patrol Vessels. While all of the yards and government organizations visited, acknowledged that commercial structural design standards resulted in less costly structures to build than those designed to military standards , they also indicated that the resulting structures were typically 10 to 20 percent heavier than structures designed to military standards and were not suitable for military missions that exposed the ship to repeated shock loading. In addition the excess weight could result in stability problems if the vessels were required to carry a significant amount of topside weight (i.e., a large number of weapons). Most of the yards felt that the High Speed Craft Codes recently published by many Classification Societies were appropriate for the construction of an Offshore Patrol Vessel. The yards also indicated that just as important as the design code used was the material. Many stated the use of material other than ordinary strength steel will significantly increase the fabrication cost because of increased labor hours.

2.2 STABILITY CRITERIA

All of the vessels which were designed to military stability criteria used the U.S. Navy stability criteria, defined by DDS-079-1, or slight variant. The Danish vessels, the Visby Corvette and the NORDKAPP vessels were designed to IMO criteria A167. All of the vessels were designed to withstand 100 knot beam winds in the intact condition. In addition all the vessels are capable of withstanding the flooding of any two adjacent main compartments, with the exception of the MAESTRALE and MEKO 200 Class frigates which are designed to survive the flooding of any three adjacent main compartments, and remain operational with any two adjacent compartments flooded.

2.3 HABITABILITY

The habitability standards of the vessels were generally comparable to commercial vessels. This was especially true in the services and ships that have taken crew size reduction the furthest. On all vessels there were large well appointed lounges for the petty officers and ratings. The wardrooms for the officers were also well appointed and spacious. They also have generous galleys, messing areas, lounge areas, fitness centers, saunas, solariums and passageways. Almost every ship is designed to allow for mixed gender crewing in almost any ratio, though no vessel had more than a ten percent female crew. The NORKAPP Class vessels and THETIS Class vessels provided two person cabins for the entire crew. Table 2.2 provides a summary of the number of crew sharing berthing areas. Figures 2.1 though 2.6 illustrate the accommodations found on ANDENES and HVIDBJORNEN.

	Officers in Stateroom	Petty Officers in Cabin	Ratings in Cabin
MINERVA	CO/1, All others/2	2 to 4	up to 12
MAESTRALE	CO/1, All others/1 or 2	2 to 4	up to 16
CASSIOPEA	CO/1, All others/1 or 2	2 to 4	up to 12
THETIS	All officers 1	2	2
STAN FLEX 300	CO/1, All others/2	2	2
FLOREAL	CO/1, All others/2	2 to 4	up to 10
LAFAYETTE	CO/1, All others/2	2 to 4	up to 10
83 M Corvette	CO/1, All others/2	2	up to 10
NORDKAPP	CO/1, All others/1	2	2
MEKO 200	CO/1, All others/1 or 2	2 to 4	up to 10
VISBY	CO/1, All others/1 or 2	2	4

Table 2.2 Crew Members Sharing Berthing Spaces

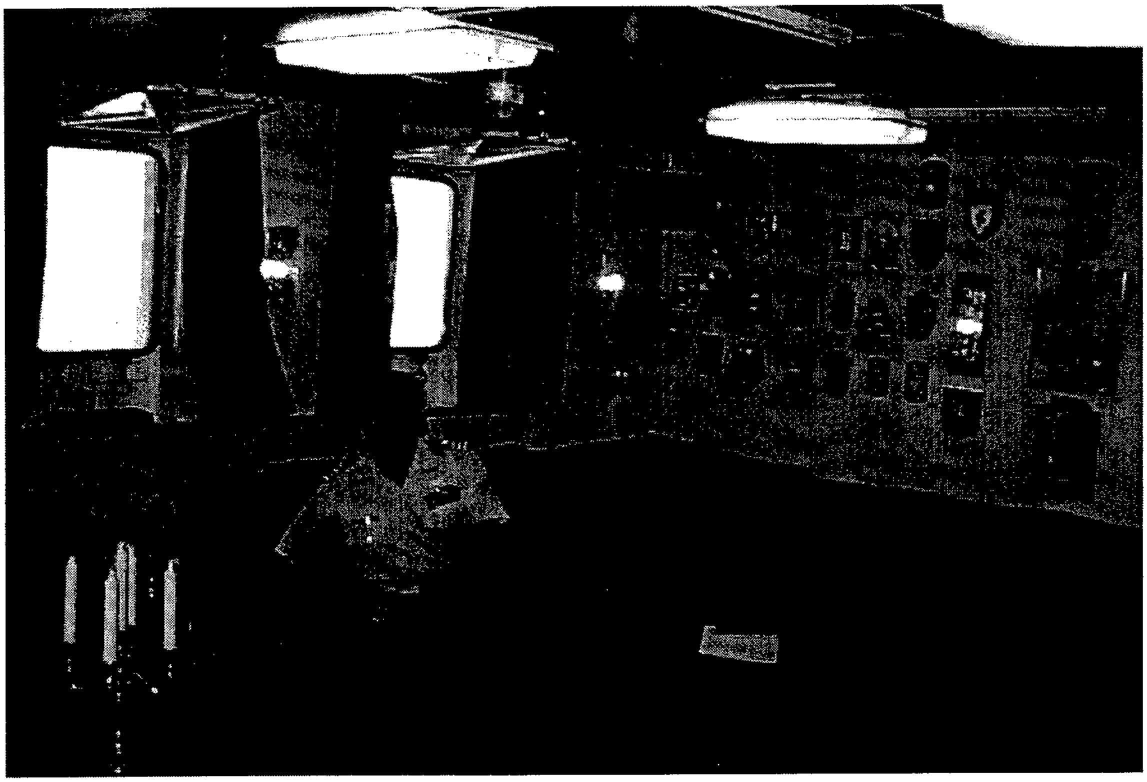


Figure 2.1 Wardroom on ANDENES

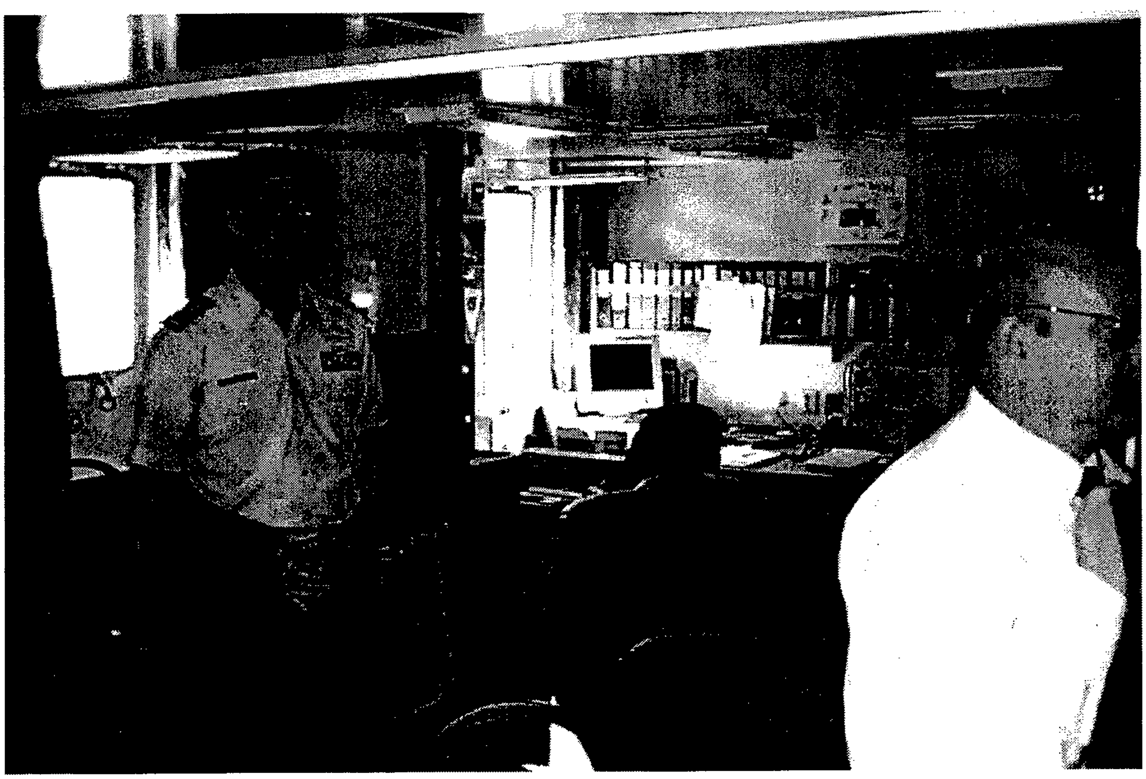


Figure 2.2 Commanding Officer's Cabin on ANDENES

Figure 2.3 Commanding Officer's Cabin on HVIDBJORNEN

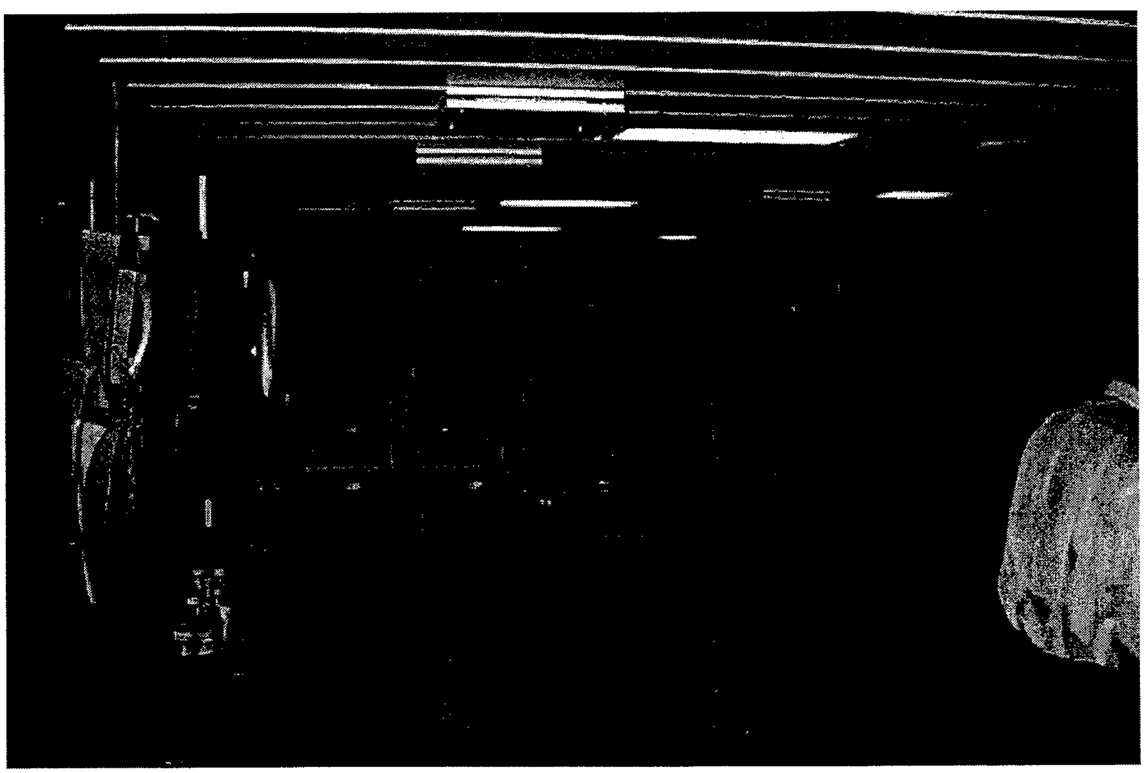


Figure 2.4 Crew's Mess on HVIDBJORNEN

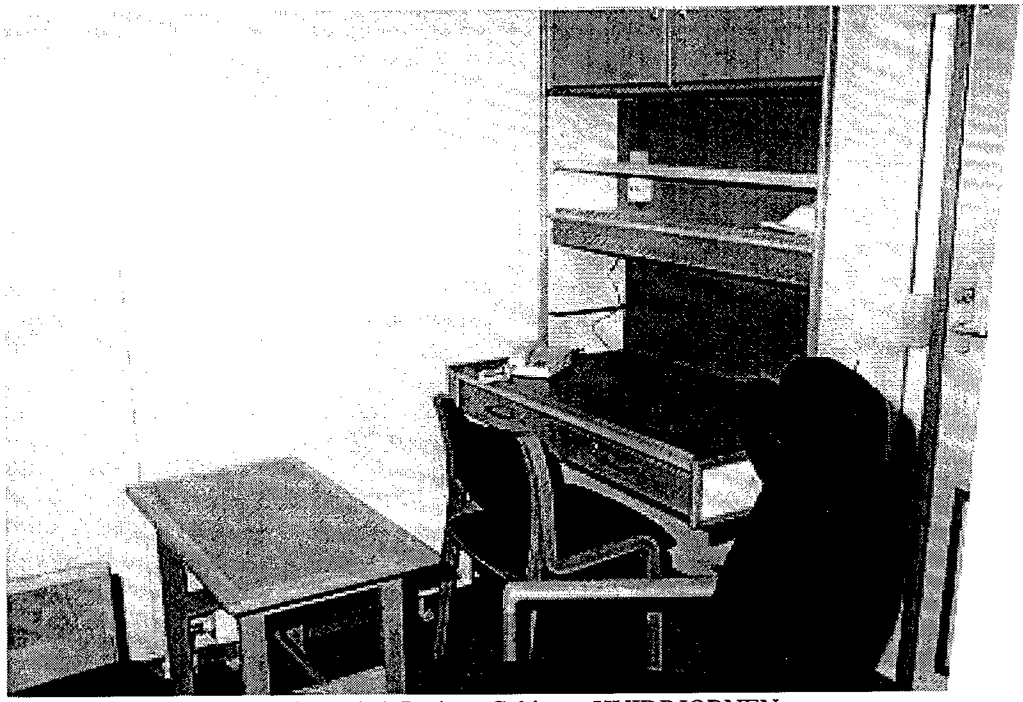


Figure 2.5 Ratings Cabin on HVIDBJORNEN

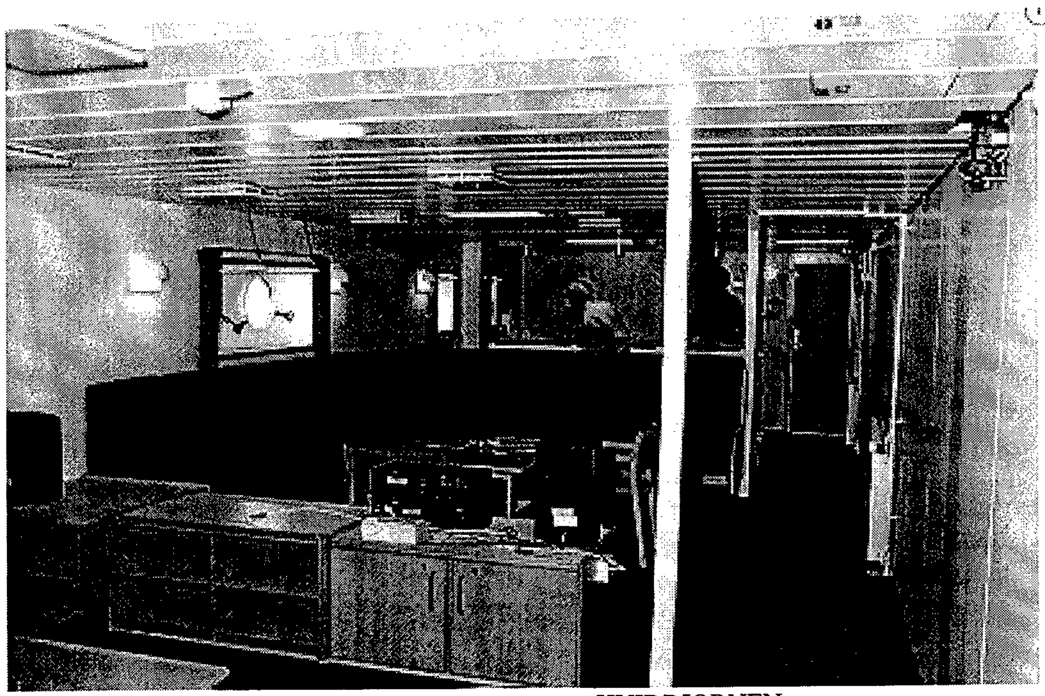


Figure 2.6 Crew's Lounge on HVIDBJORNEN

2.4 SERVICE LIFE AND DESIGN MARGINS

Service life weight and KG margins in general were comparable to those used by the U.S. Coast Guard. The Swedish Navy and the British Navy use a Service Life margin of ½ percent of Full Load Displacement per year of service life (12.5% Full Load Displacement), the Dutch use a Service Life margin of 5 percent of Full Load Displacement. In comparison, the U.S. Coast Guard's service life margin for the HEALY and Seagoing Buoytender Replacement is 10 percent of Light Ship Displacement. Design and Construction margins were generally less than those used recently by the Coast Guard, however this is a direct reflection of the acquisition process used and how well the shipbuilder understands the customer's requirements. Most of the Navies and Coast Guards we talked with paid the shipyards to do contract level designs and had conducted detailed technical discussions (between technical personnel) prior to award of the construction contact. The level of design and review accomplished prior to award of the construction contract is significantly greater than the Coast Guard has experienced prior to the award of either the HEALY or the Seagoing and Coastal Buoytender construction contracts. This additional development that normally is not present in U.S. Coast Guard acquisitions allowed the shipbuilders to lower design margins. In addition most contracts had weight penalties that are enforced if the margins the contractor is responsible for are exceeded.

Design life for most vessels was 25 years. The general conclusion was that anything beyond 30 years was too long. Not only does a long service life increase the acquisition and life cycle costs of the vessel, it also makes it impossible to keep up with technological advancements using the same platform for more than 30 years.

2.5 DESIGN CRITERIA FOR TRIMARANS

Vosper Thornycroft under contract to the United Kingdom's Ministry of Defense has begun developing guidance for the design and construction of trimarans. Vosper Thornycroft is currently developing design loads and response criteria for the structural design, developing parametric analysis tools, and developing an overall design methodology. In addition they have reviewed seakeeping, stability, maneuvering and resistance and propulsion codes for applicability to trimarans.

3.0 PROPULSION SYSTEMS AND POWER DISTRIBUTION SYSTEMS

3.1 PROPULSION SYSTEM ARRANGEMENTS

Combined diesel or gas turbine (CODOG), combined diesel and gas turbine (CODAG), combined diesel electric and gas turbine (CODLAG) and combined diesel and diesel (CODAD) plants are all being looked at and are frequently offered as options by the shipyards subject to the customer's needs. The combination plants provide for efficient operations in the 12 to 18 knot range and sustained speeds of 25 to 30 knots or more. Gas turbine efficiency has increased significantly over the years and turbines still offer the greatest power to space and power to weight ratios. However, improved diesel power density makes CODAD plants a economical option for frigates or patrol vessels requiring a top speed of 25 knots. Those that have selected CODAD plants over CODOG plants have stated that fuel efficiency and the ability to burn slightly dirtier fuel than is required for gas turbines are the primary reasons for the choice. Other advances such as sequential turbocharging systems are making diesels more efficient throughout the operating speed range. Figure 3.1 and 3.2 are typical CODAD and CODOG machinery arrangements.

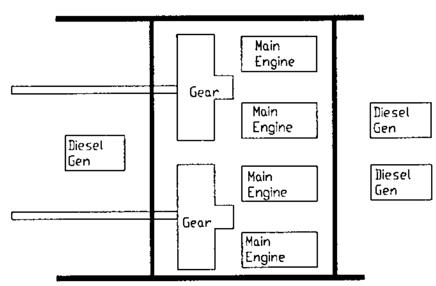


Figure 3.1 FLOREAL Class CODAD Machinery Arrangement

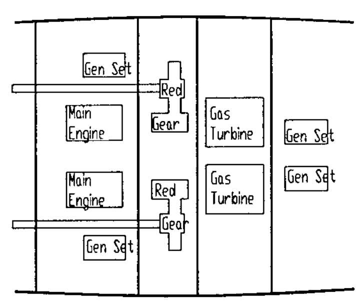


Figure 3.2 MAESTRALE Class CODOG Machinery Arrangement

The machinery arrangements on the vessels investigated were developed to prevent loss of ship mobility and maneuverability from fire or flooding in one main machinery space. The most unconventional arrangement, but still one developed with survivability in mind was that on the THETIS CLASS vessels, see Figure 3.3. This arrangement consists of two diesel engines in an after machinery compartment and one diesel engine in a forward machinery compartment. The forward and aft machinery compartments are separated by a third watertight compartment which contains a reduction gear (capable of operating underwater in the event the compartment is flooded). The three diesel engines were connected to the reduction gear which drove a single propeller shaft. A single shaft was chosen because it was less expensive than a twin shaft arrangement and it is more efficient to operate when patrolling at low speeds (not dragging an unused propeller, shaft and rudder through the water). Because the THETIS CLASS has only one shaft, a retractable azimuth thruster capable of propelling the ship at up to 10 knots is provided in case the propeller shaft, gear or propeller is damaged.

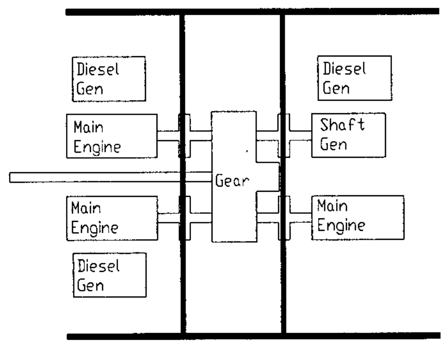


Figure 3.3 THETIS Class Machinery Arrangements

The top speed required will determine whether a combined plant or single engine per shaft is required. It is possible to provide a 20 + knot sustained speed from two diesel engines located in a single engine room. However, if a 25 to 30 knot sustained speed is required, then a combined plant (CODAD or CODOG) would be necessary. Two additional diesel engines or two additional gas turbines in an additional machinery space will add significantly to the acquisition cost as well as the life cycle cost of the vessel.

Mechanical components for the most part are COTS, with foundations and isolation mounts designed specifically for the ship and its intended missions (ASW, mine hunting, etc.).

3.2 PROPLUSOR SYSTEMS

All of the vessels, with the exception of the VISBY Corvette made use of controllable pitch propellers. Many of the vessels were designed for an anti-submarine warfare mission, where minimizing noise from the propeller was essential. Therefore the propellers tended to rotate slower (150 to 160 RPM) than is common on U.S. Coast Guard vessels (200 to 250 RPM), and because they rotated slower, the propeller diameters were significantly larger, with the propellers extending well below the baseline on most of the vessels. With the exception of the THETIS Class and Standard Flex 300 vessels, all of the vessels had two shafts.

Italy, Germany and France were all making use of feathering controllable pitch propellers to improve fuel economy when operating on a single shaft.

The Swedish Navy has decided that all new vessels they build will be fitted with water jets rather than propellers and rudders. Because water jets significantly reduce appendage drag, compared to conventional propeller/rudder arrangements, the Swedish Navy concluded water jets will reduce operating (fuel) cost. Karlskrona Varvet also stated that water jets radiated less underwater noise than propellers and were therefore better for ASW work. Vosper Thornycroft was considering a combination of propellers and water jets for their trimaran design. Cruising speeds would be accomplished by propellers, while sprint speed would be achieved with water jets and propellers. Vosper Thornycroft sited lower appendage drag as the reason for selecting water jets over propellers.

3.3 CONTROL SYSTEMS

Propulsion and engineering plants in general are becoming more and more automated. The Danes, Norwegians and others are not asking whether the engine room needs to be manned but whether the Engineering Control Center (ECC) needs to be monitored. New control systems, greater data transfer rates and open architecture standard shipboard displays are allowing nearly all engineering operating parameters to be displayed on the bridge. Similarly, nearly every routine operation and control function can be performed on the bridge.

The control systems all shared four characteristics; they provided centralized management either in ECC or on the bridge, they used standardized monitors with graphic color displays, there was a large degree of redundancy built into the system, and the systems were programmed to perform a wide range of actions ranging from calculations for fin or rudder roll stabilization, to adjustment of controllable pitch propellers, to main engine warm up, to diesel generator start, to management of fire mains, to management of NBC hazards.

The control systems were all based on distributed and redundant architecture, usually with the same terminals located in the ECC and on the bridge. All of the vessels had dual data-bus networks, so that if part of the network was damaged or became overloaded, the information was still able to be transferred at the rate needed for the system to maintain control.

3.4 POWER GENERATION AND DISTRIBUTION SYSTEMS

All of the power distribution systems were fully redundant and arranged in compliance with NATO standards. Beyond this there was very little in common from country to country. The Italians and Germans provided four ship service generator sets on naval vessels (without emergency or harbor generator), while the French provided three generator sets on their frigates. The THETIS Class vessel is provided with three diesel generator sets in addition to a 1400 kW alternator which is driven off the reduction gear. The machinery control systems also manage the command and control of the generators, converters and mains. Table 3.1 summarizes the installed generating capacity of the vessels.

VESSEL	**Installed kW**	**Number of Gen Sets**
LAFAYETTE	2250 kW	3 - 750 kW DG sets
FLOREAL	1770 kW	3- 590 kW DG sets
THETIS	2840 kW	1-1400 kW shaft alternator, 3-480 kW DG sets, 1- 127 kW emergency set
MEKO 200	3100 kW	4 - 775 kW DG sets
MAESTRALE	3120 kW	4 - 780 kW DG sets
MINERVA	2600 kW	4 - 650 kW DG sets
CASSIOPEA	1500 kW	3- 500 kW DG sets, 1- 120 kW emergency set
VISBY	810 kW	3 -270 kW DG sets

Table 3.1 Installed Generating Capacities

The MEKO Class frigates utilize a vertical power distribution system feeding individual load centers with each main subdivision having independent operation of the power distribution system to increase survivability. The vertical power distribution system of a MEKO 200 is illustrated in Figure 3.4. Blohm and Voss felt that this distribution architecture increased survivability for the following reasons:

a. Power is distributed by load centers via main and subsystems.
b. The load centers are equipped with a changeover for selectable feeding by one of the two main switch boards. A main distribution group, a weapons group, a lighting group, an emergency back-up power group and chargers for external batteries are incorporated into each load center.

c. The two main switchboards are directly fed from the generators and are connected to each other by a cable laid amidships. One switchboard is located in the forward damage control area and the other in the aft damage control area.

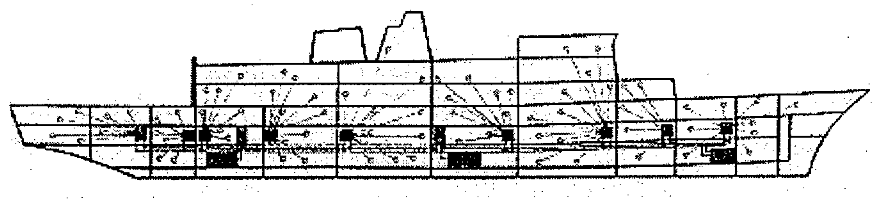


Figure 3.4 MEKO Vertical Power Distribution

4.0 VESSEL MANNING

Every nation was investigating ways to reduce crewing in hopes of reducing life cycle costs. Most have come to the conclusion that today's technology allows crewing of an Offshore Patrol Vessel, Corvette or Frigate of up to 3600 tons displacement with 75 or even fewer people. Denmark and Norway have been successful in operating 3200+ ton ships in fisheries patrol missions with 62 or fewer people. France's FLOREAL Class frigates are designed to be operated and maintained by a crew as small as 55; however, due to the areas of the world were these vessels operate, tradition, culture training, and employment objectives the French Navy chooses to man them with many more than 55. Other nations continue to crew such ships with 100 to 200 people because there has been no real incentive to change the way things are done. However, in those countries where there is incentive to change (Norway and Denmark), significant reductions in the number of crew have successfully been achieved. At the same time both countries have been able to increase the number of days the ships deploy to 270 to 300 days by providing two crews or a crew and a half for the vessel.

Officers and Petty Officers generally stay aboard longer than they do on U.S. Coast Guard vessels; it is not unusual for an officer or petty office to stay on board for 5 years. However, a large portion of the junior enlisted crew (conscripts) usually leave after a year. Even the average conscript, though, is likely to have some fairly advanced trade training prior to entering the service through the normal public school system.

Crew members are generally given more individual responsibility, the chain of command appears much shorter and the organization chart flatter than aboard U.S. Coast Guard vessels. Each crew member also has several functions or areas of expertise

4.1 NORDKAPP MANNING

Currently the ANDENES has two crews assigned to the vessel. Each crew consists of 22 officers and petty officers, and 40 ratings. The actual number of crew on board at any one time fluctuates between 55 and 62. The officers serve three weeks on the vessel and then get three weeks off. The ratings serve six weeks on the vessel and than receive three weeks off. All training is accomplished during the three to six week period the crew is assigned to the vessel. The ship is manned 365 days a year following this crew rotation. The ship is underway 300 days a year, with three, ten day maintenance periods each year. One week each year each of the crews goes to a week of training together. Officers coming on board these vessels are usually licensed and have spent a good deal of time at sea. Ratings (typically 19 to 20 years old) usually are only on board for a year and then they leave. The training of ratings is a never ending process, as soon as they are trained they leave and a new trainee arrives.

A normal watch on the ANDENES consists of seven crew; an Officer of the Deck (OOD), a helmsman, a lookout, a roving watch, and one person on duty in the Operations Room, the Radio Room, and the Engineering Control Center. The Executive Officer normally stands a watch. The Commanding Officer (CO) usually will not stand watch; however, the CO does have a number of collateral duties. On ANDENES the CO was also the paymaster.

The vessel spends up to 80 percent of it's time doing fisheries patrols. There are normally three fisheries inspectors on board and the vessel will perform up to six vessel boardings a day. Each boarding lasts from three to four hours. Boardings are usually accomplished by a boarding team of three (one inspector, one crew, and one trainee). The RHIB is usually lower by a crew of two. There are two people in the boat crew, so for normal fisheries boardings no more than seven people are involved excluding the OOD.

A crew of six is used for flight operations. One flight control officer, one rescue man (in fire suit), and four for tie downs, fire fighting or manning and launching the ready boat. Trainees are usually one of the four tie down crew.

There are two damage control parties on ANDENES, six people in each party. The ship conducts damage control drills every week. A significant portion of this time is spent on computer training in ECC. The vessel trains to survive damage from mines and torpedoes in addition to normal fire and flooding. The Commanding Officer stated that he expects at least a 70 percent chance of survival from any possible event.

Maintenance is accomplished during the work day which lasts from 0800 to 1600. No maintenance is accomplished by personnel on watch. ANDENES and other vessels of the class perform daily cleaning of the vessels, to the extent possible; however, during port calls, professional cleaning crews perform a thorough cleaning of the vessel.

ANDENES and the other NORDKAPP vessels have mixed gender crews. ANDENES had one female assigned to the crew while we were on board. The female crew member berthed with, and shared a head and water closet with male crew members (two crew members share a cabin).

4.2 HVIDBJORNEN MANNING

HVIDBJORNEN currently has two crews of 60 assigned to the vessel. Each crew consists of twelve officers, eight petty officers and 40 ratings. Crews are normally assigned to the vessel for four to five years. There is a 10 to 20 percent turn over in the crew every year.

These vessels operate in the coastal waters of Greenland. Each patrol period starts with a month of training, where crew members are trained on ship's equipment, fire fighting and damage control. The vessel also conducts sea training in Danish waters. Following this training period the vessel then sails to Greenland or the Faeroes where it will spend approximately 8 months. The crews change every three months, while the ship is in the Faeroes or Greenland. The vessels are normally at sea for two weeks and then return to port for supplies and a short break.

A normal watch on the HVIDBJORNEN consists of seven crew; an Officer of the Deck, a helmsman, a Quartermaster, a lookout, and one person on duty in the Operations Room, the Radio Room, and the Engineering Control Center. The Executive Officer normally stands a watch. The Commanding Officer (CO) usually will not stand watch. The Commanding Officer is responsible for the ship's navigation, the ship's efficiency and for executing missions. The Executive Officer (XO) is responsible for the crew's conduct and training. However, the XO spends very little time compared to an XO on a U.S. Coast Guard vessel on crew conduct or interpersonal relationships and there are not as many inspections. In addition the XO is responsible for the ship's overall condition. The Technical Officer (or Engineer Officer) is responsible for the ship's maintenance and its ability to fight fires and other damage on board the ship and other ships needing assistance. The ship's force is broken down into three divisions. The Tactical Division which mans the bridge, radio room, radar and sonar, gun, depth charges and deck stations. The Technical Division which mans the engine control room, engine room, workshops, hospital and the damage control parties. The Administrative Division which mans the galley, messes, supply office and ship's office. In addition there is a Helicopter Group which is responsible for flying and maintaining the helicopter.

A crew of six is used for flight operations. One flight control officer, one rescue man (in fire suit), and four for tie downs, fire fighting or launching and manning the ready boat.

There are two damage control parties, six people in each party. The ship conducts damage control drills once a month that involve the entire crew.

Fishing vessel inspections usually involve nine of the crew. A boarding team of three (one inspector, one assistant, and one trainee), a boat crew of three, and three crew on the boat deck to launch and recover the boat.

4.3 GENERAL OBSERVATIONS

In general the ratings on both the ANDENES and HVIDBJORNEN are given more responsibility than a fireman or seaman on a U.S. Coast Guard cutter is given. Ratings also seemed to have more than one job and had more choice in choosing the work they did on the ship. For example the crew that worked in the galley did so because they wanted to, not because they were "volunteered" as is the case on many U.S. Coast Guard cutters.

Both crews relied upon automation to assist them in performing their jobs. Sensors and cameras were used to monitor the condition of spaces rather than having a roving watch check them. In addition equipment and sensors were trusted. The crew's valuable watch/work time was not spent watching a pump. One person monitored all equipment from the ECC, and the Commanding Officers were questioning whether it was necessary to have someone monitoring the equipment from ECC. They maintained that was what the control system was supposed to be doing, and if the pump or equipment was not working an alarm would sound notifying someone. The Danish Navy has become so trusting of sensors and the ability of people to respond correctly to them, that they do not even leave a duty section on the vessel when the vessel is at it's home base. Instead they mount a surveillance camera to monitor the ship's brow, connect the control plant to a shore side junction box, and the ship is monitored by the duty section on the base. If a fire or other casualty occurs the base duty section is expected to provide the first response and notify the Commanding Officer of the ship.

The officers of both the HVIDBJORNEN and the ANDENES seemed to spend a greater percentage of their careers at sea than officers in the U.S. Coast Guard. The commanding officers, executive officers and engineering officers we met had spent the majority of their careers at sea either in the Navy or as licensed merchant mariners. In addition the rating generally had attended technical high schools or apprenticeship programs which gave them a good foundation for the areas of specialization they were pursuing on the ships.

5.0 MAINTENANCE

There is a general trend toward more contract maintenance in the countries we visited; however, those countries with the most experience with contract maintenance are finding that a balance between contract and crew maintenance is the most cost effective and efficient way to accomplish maintenance. Norway and France expressed the opinion that much of the less complicated maintenance is less expensive when performed by ships force and have actually increased the crew's portion of the required maintenance. It is important to note however that the Commanding Officers of ANDENES, HVIDBJORNEN and LAXEN (the three minimally crewed vessels we visited) all stated that they did not need additional crew to maintain the vessels.

Not all services are moving quickly to remove the actual maintenance work from the crew. Some countries see the ships as important employers and training opportunities and are not anxious to remove people. Since the people are there, they may as well perform maintenance. These countries see less need for extensive contract maintenance. Some countries have also started using two crews per ship with 270 - 300 days underway per year. This increases the number of staff hours available per year for own ship maintenance.

Both Denmark and Norway maintain vessels of the same class in collocated squadrons to improve the efficiency and cost effectiveness of maintenance and other support services. Denmark currently keeps three of the THETIS Class cutters in service while the fourth cutter is undergoing maintenance or is in standby status. Norway is planning a similar maintenance philosophy for the new class of Navy frigates they are building. They plan to build six frigates. Every five years one of the frigates will be taken out of service for a major overhaul. The frigate that just finished her overhaul will replace the vessel beginning its overhaul.

Most new frigates in Europe today are being built for a 25 year service life, with a planned major availability every five years. These five year availability periods are planned to last from six months to one year. The vessels will usually be dry docked every 18 to 24 months, and have three to four short dockside maintenance periods every year.

The shipyards building vessels for the export market are more and more becoming involved contractually in the full life cycle of the ship, responsible for major repairs, modifications and configuration control long after the ship is delivered. This is because the countries that buy most of these vessels are ill equipped to maintain the sophisticated equipment themselves.

Modularity, particularly in the Danish Standard Flex vessels, allows major components such as a 76mm gun, boat launch and recovery system or missile and torpedo launchers to be removed and replaced in hours. Thus, spare modules are used to keep the ships operational while malfunctioning modules are repaired at a repair depot or manufacturer's facility.

Condition based maintenance is being pursued by most nations as a measure to reduce the cost of extensive preventative maintenance programs. Preventative maintenance requirements are being reduced and used only where economic and readiness issues support it.

Shipyards and vessel designers are using fiber reinforced plastic (FRP) and composite components to reduce life cycle maintenance and achieve other benefits as well. In France and England shipbuilders are fabricating rudders and roll stabilization fins out of FRP and high molecular weight plastic. Not only do these fins not rust, they do not need to be air tested or flow coated. In addition the shipbuilders say they are much less expensive to construct than steel fins. In France, Great Britain and Sweden shipbuilders are constructing FRP masts. Because FRP does not rust maintenance is significantly reduced, and because FRP structures are lighter than steel, the vessel's stability is improved as well.

The Swedish Navy has also recently made the decision to construct the hulls of all it's future naval vessels out of FRP. Realizing that it costs more to build vessels out of FRP, the Swedish Navy feels that over the service life of the vessel, the cost of a FRP vessel will be less than a steel vessel because the maintenance of an FRP hull costs much less than a steel hull. The Swedish Navy recently completed a survey of a 20 year old FRP mine sweeper. The hull was in such good condition they decided to re-engine the vessel, and are expecting to get another 20 years of service out of the vessel.

The LA FAYETTE Class frigates and the THETIS Class frigates both have weather decks covering their deck machinery with covered access holes for mooring lines and line handlers, see Figure 5.1. In the case of the LA FAYATTE frigates the (forward covering deck is constructed of FRP) the deck is used to reduce radar signature. The THETIS frigates use a heated covered deck to reduce topside icing. Both classes of vessels also found that not having deck equipment exposed sea water, rain, ice and snow significantly reduced the amount of maintenance that needs to be performed on this equipment. Figure 5.2 shows the enclosed deck machinery on HVIDBJORNEN.

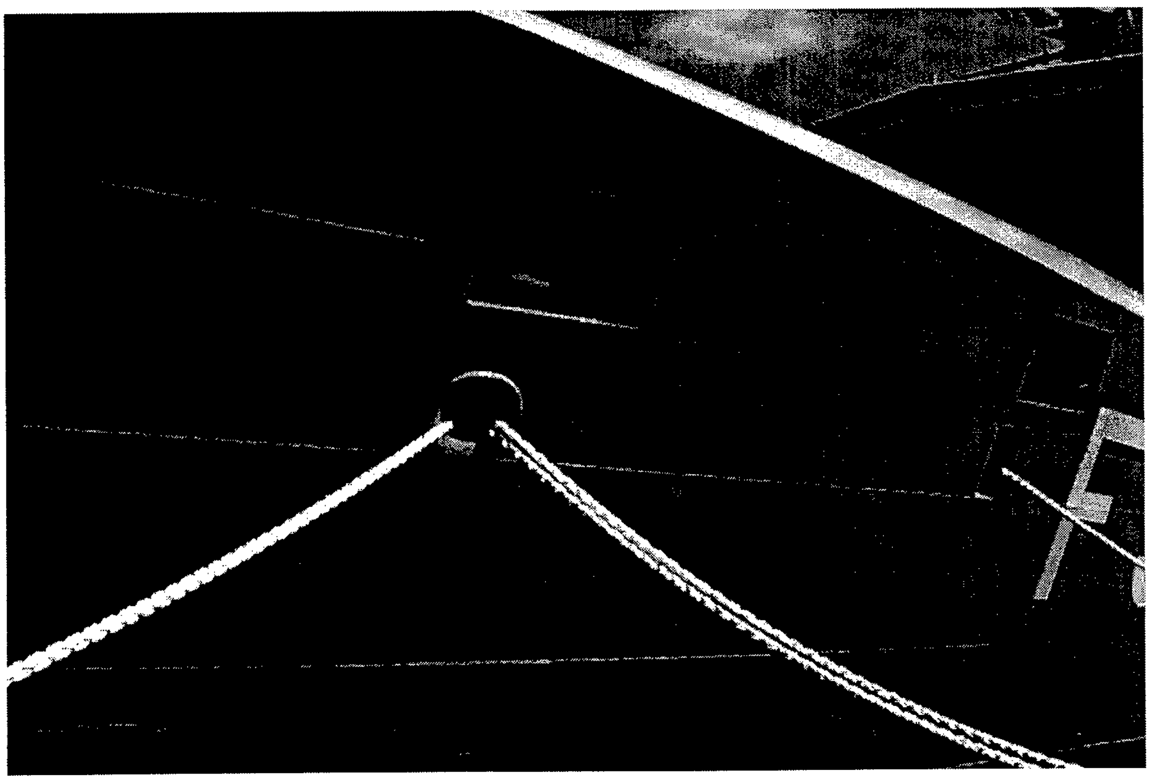


Figure 5.1 Access Opening for Lines and Line Handlers on HVIDBJORNEN

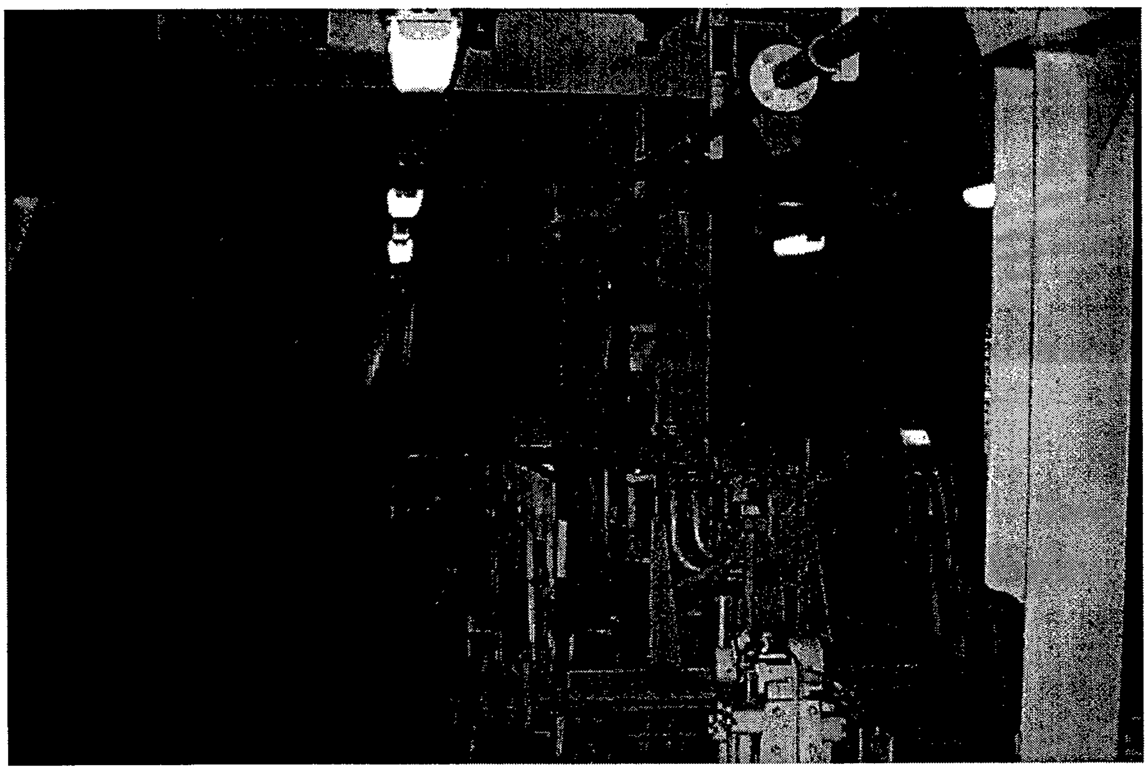


Figure 5.2 Enclosed Deck Machinery on HVIDBJORNEN

6.0 AIRCRAFT HANDLING

All of the helicopter capable ships had arrangements that complied with NATO STANAGs which required the vessels to have a glide path indicator, a 10 meter horizon boom, deck lighting, a stop/go landing light, a transfer and restraining system and a flight refueling system. Many of the vessels had dedicated radar for landing aircraft.

Aircraft are typically Lynx or Super Lynx helicopters in the 3-5 ton range, though many of the larger ships and newer designs could accommodate 10-13 ton aircraft in fixed hangers.

Landing grids were generally 2 meters in diameter and similar to Talon used on the U.S. Coast Guard's WHECs and WMECs. The traversing systems ranged from fairly simple cable systems capable of moving the helicopter in and out of the hangar while maintaining tension in the other direction and some degree of athwartship control to full RAST systems. Most were amazed to find the U.S. Coast Guard operates without any traversing system.

All of the vessels had roll stabilization systems that allowed the flight operations to continue in seas up to sea state five or six (wave height 8 to 19 ft, wave period 7 to 17 sec.). Most vessels used a combination of two systems to reduce roll. The LAFAYETTE frigates used fin stabilizers and a rudder roll stabilization system. The MEKO 200 frigates used active fin stabilizers and bilge keels. The THETIS Class frigates used active fin stabilizers and a roll stabilization tank. All vessels claimed these systems reduced roll amplitude by more than 60 percent.

All of the vessels had foam cannons mounted on the hanger as a first response to fire on the flight deck. Many of the ships said they had used these cannons to fight fires on other vessels as well. The ship designers said they were looking at water mist systems to fight fires on the flight deck; however, none of the vessels we visited had such systems installed. None of the vessels needed more than six people (including the flight deck officer) to land or launch a helicopter and the new vessels being designed (LCF and HORIZON) will only need three people to land helicopters.

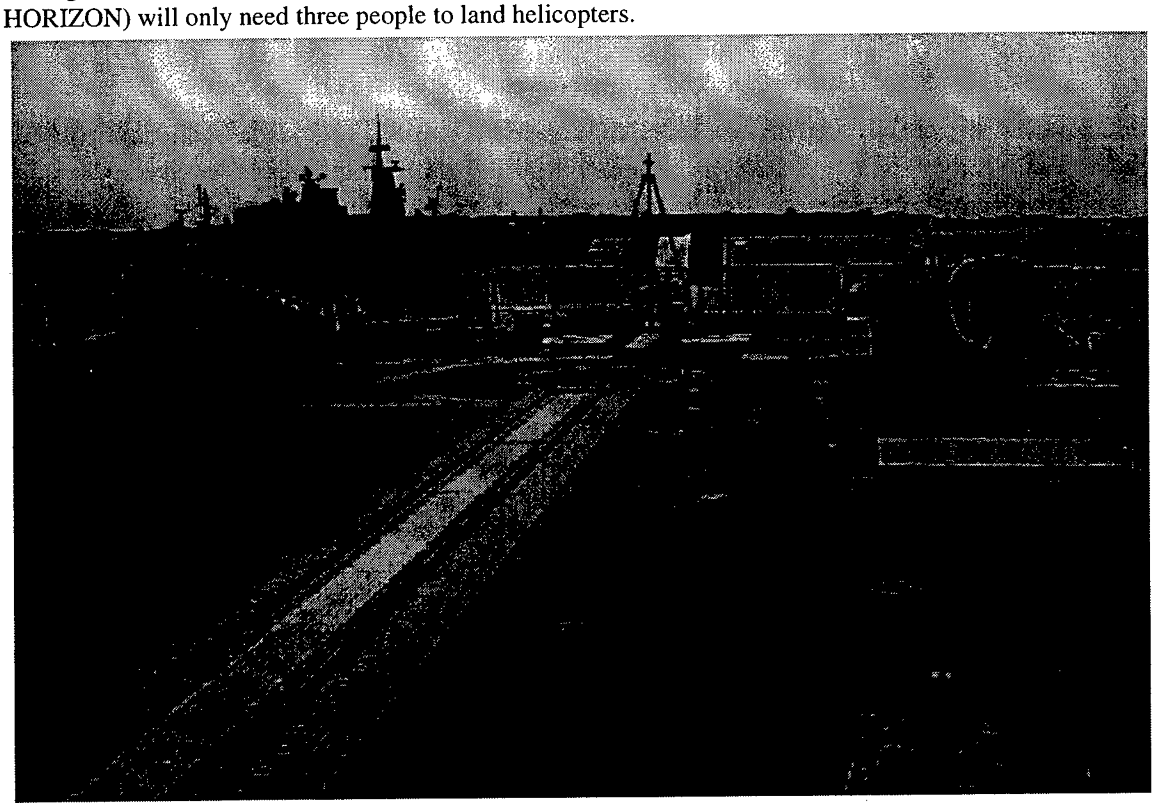


Figure 6.1 Aircraft landing grid and traversing system on FLOREAL

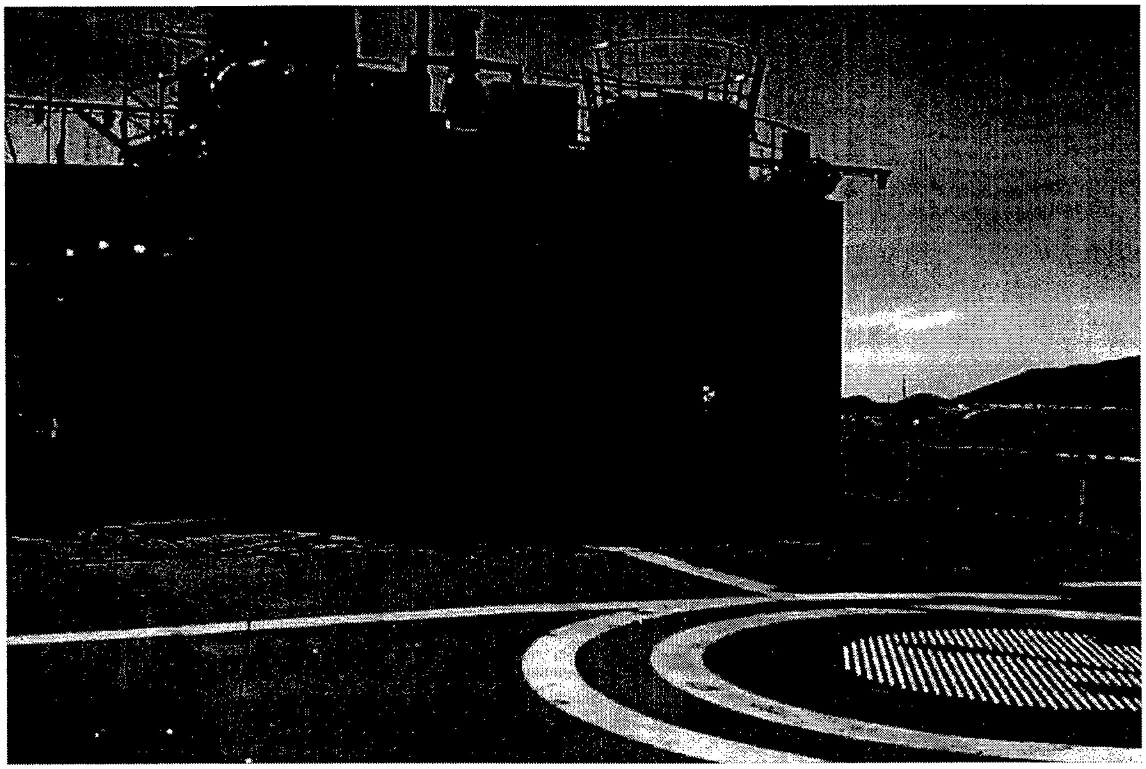


Figure 6.2 Landing grid, flight deck and hanger on ANDENES

7.0 BOAT LAUNCH & RECOVERY SYSTEMS

The shipyards and services visited, with the possible exception of the Norwegian Coast Guard, did not put much design emphasis or operational time into boat launch and recovery systems. The naval missions many of these vessels perform do not require such an emphasis and the law enforcement emphasis on fisheries does not require immediate boardings in all weather conditions.

All of the ships we visited and ship designs we reviewed had the primary boat stations located amidships, forward of the flight deck, where accelerations from pitching were lowest. All of the vessels had at least one rigid hull inflatable boat (RHIB) on board, most vessels had two. The RHIBs we saw were powered by outboard motors which are much smaller than the U.S. Coast Guard is accustom to. Most RHIBs were powered by two 40 hp motors. Smaller engines were used because of the high cost of fuel; however, the boat crews felt that these smaller engines were sufficient for the boats to perform their intended missions. Most vessels handled the RHIBs with cranes fitted with a constant tension winch.

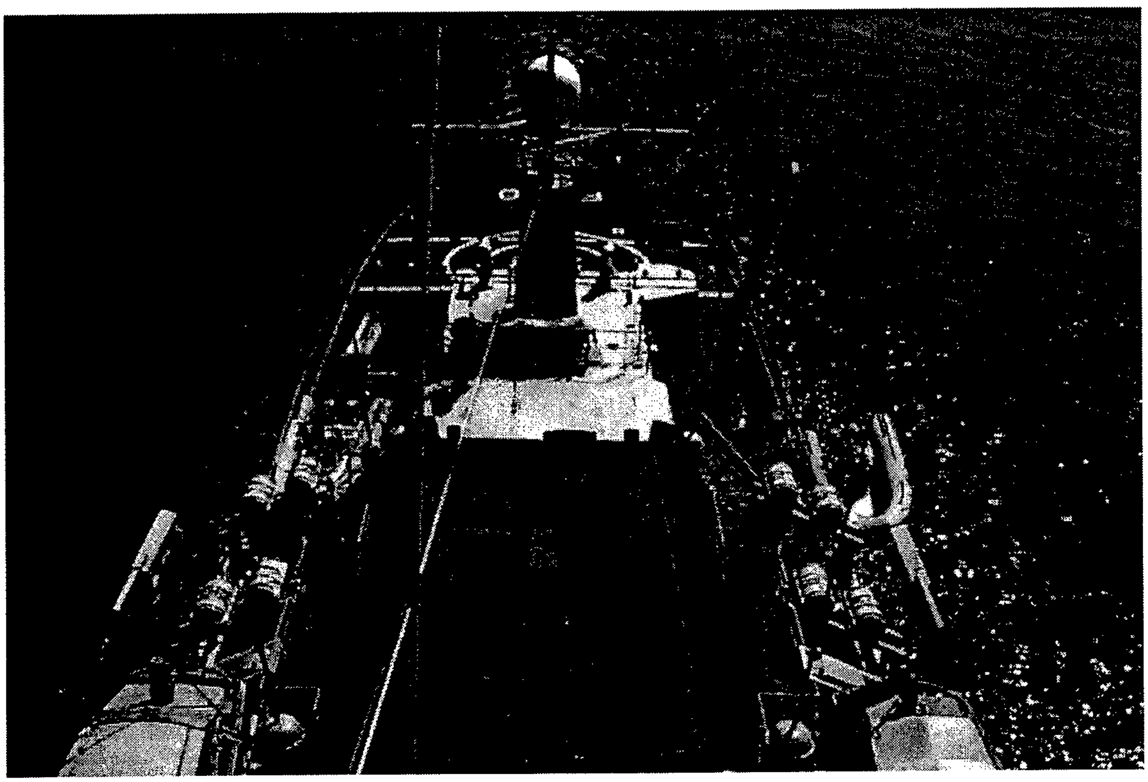


Figure 7.1 Boat handling arrangements on the THETIS Class Frigates

The NORDKAPP class vessels have recently been retrofitted with the VESTDAVIT system to improve their boat handling capability; however, they did not have any quantitative data as yet regarding its impact. Several other designs we saw include the VESTDAVIT in recognition of its superior boat control features.

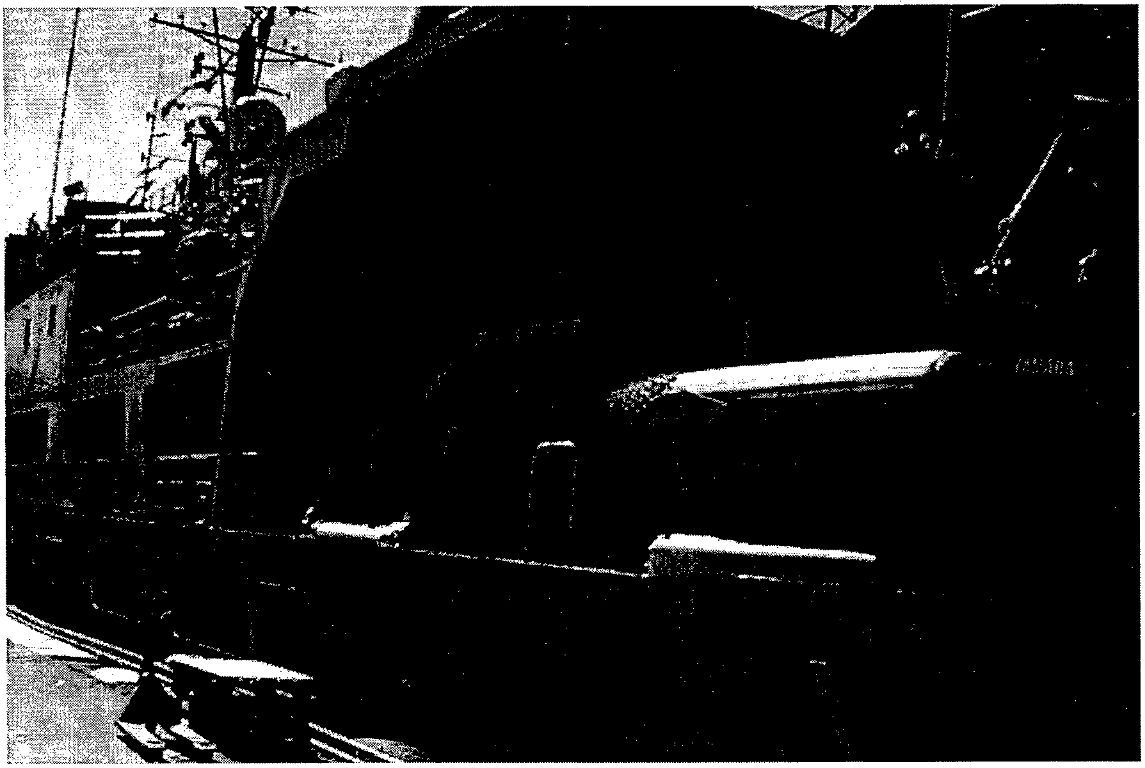


Figure 7.2 VESTDAVIT on NORDKAPP Vessels

Stern ramp systems have not been incorporated into any of the designs we reviewed on this trip. However, such systems have been used on vessels up to 64 meters in length.

Many of the vessels had passive stabilization tanks to reduce the roll motion of the ships. These tanks are superior to fin stabilization systems, or rudder roll stabilization systems for boat operations because they are most effective at the low speed ranges (0 to 6 knots) where boat evolutions are usually conducted.

The crew of the Danish vessel HVIDBJORNEN demonstrated their boat launch and recovery operations with a constant tension single point davit. The conditions were nearly ideal but using only two people on deck (three are normally used to launch the boat), their proficiency was impressive nonetheless. In rough weather they use a hard ship turn to create a lee and flattened sea area, precise timing and quickness to get the boat in and out of the water. The boat crew is in the boat. The crane operator is on the phone with the OOD and one person tended the sea painter and frapping lines. No additional line handlers, supervisors or safety observers were used.

8.0 DAMAGE CONTROL

8.1 DAMAGE CONTROL PHILOSOPHY

Many services have conceded that frigates are one hit ships given today's threats. Having enough personnel and DC equipment to successfully combat two weapons hits and simultaneously "fight" the ship is unrealistic and thus not provided for.

Most of the services have come to the conclusion that there are functions that can better be accomplished by equipment and systems rather than crew. This has led to a reduction in the number of personnel in the damage control parties. The ships we visited relied on sensors to determine the location and nature of fire or flooding. On these ships the first people on scene were prepared to deal with the incident, rather than investigate and determine what is needed to respond. On the HVIDBJORNEN and ANDENES, the damage control parties are skeleton crewed with only 6 people in each of two parties. If more people are required, they are taken off operations stations and the degradation of capability is accepted. If more people are required the ship gives up the "fight" capability in the Fight, Move, Float hierarchy.

All of the minimally manned ships (THETIS Class, STANDARD FLEX 300, and NORDKAPP Class) had back-up halon flooding systems in each main subdivision in case the fire became to much for the damage control party to handle. However, both a THETIS Class vessel and a NORDKAPP Class vessel had experienced a major fire and the crews had been able to extinguish them without having to use the halon system.

8.2 DAMAGE CONTROL TECHNOLOGY

Heat, smoke and flooding sensors are used extensively with alarms clearly indicating the compartments affected. The newer ships employed a greater degree of automatic systems. Some had sensors for all access closures and critical piping valves, such that the exact material condition of the entire ship was immediately known by the computerized damage control system. Further, many of these closures and valves could be remotely operated. Firemain systems are equipped with numerous remote controlled and in some cases automatically controlled valves.

Few ships had hydraulically operated watertight doors and those that did could not operate them remotely. All services had concluded that hydraulically operated doors had to be operated locally, because the danger of trapping someone in the space was too great if the doors could be closed from the ECC or the bridge.

All of the Navies and Coast Guards have moved beyond having phone talkers as part of the Damage Control Party. Networked computers are used to display damage and repair actions underway simultaneously at all operating stations (Repair lockers, DC central, Engineering Control Center and pilothouse at a minimum). Damage Control Central (DCC) is frequently collocated with Engineering Control Central. In some cases, an Integrated Platform Management System (IPMS) is employed, and thus nearly any ship's terminal can serve as DCC. Repair lockers were less defined on some ships with DC gear spread throughout the ship and several remote access points for laptop computers provided.

Most countries are using CO_2 as the flooding agent for the main machinery space; however, no one is satisfied with it and everyone is searching for an alternative. Most countries are investigating water mist systems, however no one felt they were developed sufficiently today. Denmark and Norway are still using halon flooding systems. Engine rooms, magazines, flammable stores and many other spaces are equipped with remotely controlled fire extinguishing systems (halon, CO2, watermist, AFFF etc.). Hangers are protected by fixed water spraying systems. Flight decks are equipped with remotely controlled AFFF monitors.

Ventilation, electrical and firemain systems, on some ships are highly segregated into vertical zones. Penetrations of watertight bulkheads are minimized. This prevents the lengthwise travel of smoke, fire and water through the ship.

9.0 VESSEL ACQUISITION

9.1 ACQUISITION STRATEGY

All of the countries visited used a different acquisition strategy than the U.S. Coast Guard has chosen for the Deepwater Capabilities Replacement Project. All of the services visited follow the traditional four phase ship design process of feasibility design, conceptual and preliminary design, contract design, and detailed design. It was typical for the navies and coast guards to perform feasibility and conceptual designs and then hire the shipyard (most yards specializing in naval vessels were either partially owned or subsidized by the government) to perform preliminary and contract designs. Only after the contact design had been completed, and the service and shipyard had mutually established a detailed physical and performance definition of the vessel, was a construction contract awarded. All of the shipyards stated that this acquisition strategy allowed them to provide the least cost solution to the governments needs, because after completing design work and detailed technical meetings, the shipyards fully understood the mission, performance and design requirements of the vessel, which translated into less risk for the shipyard, and lower cost for the client.

Many of the Material Commands we met with also stated that it was important for the feasibility and conceptual design work to be completed by the government because this was the best opportunity to influence the overall cost of the program. The objectives of feasibility and conceptual design is to establish detailed operational requirements, ship and performance characteristics.

All of the recently built or new frigates being designed in Europe, except for the MEKO 200, will have a service life of 25 years. This is being done to reduce acquisition costs (because weight, KG and electrical system margins are smaller) and also because life cycle support for a ship intended to last 25 years is less costly than for a ship intended to last 30 or 40 years.

9.2 ACQUISTION COST DRIVERS

All shipyards we spoke with were unanimous concerning which systems had the greatest impact on the cost of the vessel. Weapons systems and electronics represent 50 percent or more of the acquisition cost and probably a greater percentage of the total life cycle cost, followed by propulsion and auxiliary systems, electrical generation and distribution systems, hull and deckhouse structures, and finally accommodations. Figure 9.1 is a typical cost breakdown of a frigate, provided by one shipyard. However, it is representative of what other yards stated as well.

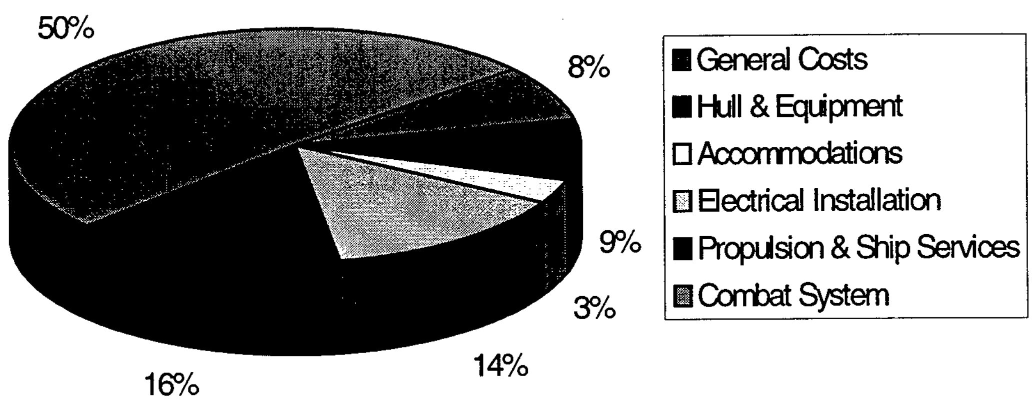


Figure 9.1 Cost Breakdown of Frigate

Many yards building frigates in Europe today are using pre-outfitted/tested, turn-key weapons, electronics and machinery modules as a way to lower construction cost and delivery time and improve product quality. Items that are being provided in modules or on cradles include weapons, deck machinery, electronic suites, main engines, generator sets, fresh water production units, and heating, air conditioning and ventilation units. Product quality is improved and delivery time is reduced because the manufacturer of the modularized equipment assembles and tests the equipment in their own facility, while work is progressing on the ship. When the shipyard is ready for the equipment to be installed, the module needs only to be lifted into place, secured and power, piping etc. connected. One disadvantage of modular construction is that it requires more hull volume than would be required of a traditional component/piece installation. Ship yards maintain that this additional volume does not cost the customer very much because the labor hours saved on the equipment installation offset the additional steel and labor costs required to provide the additional volume. However, this additional volume is often useless except in terms of facilitating the module installation. The volume adds to the life cycle cost of the vessel by increasing fuel costs and reducing stability. However, modularity does make weapon systems and some auxiliary machinery upgrades easier and less expensive to accomplish.

All shipyards indicated that weapon systems and electronic systems will be the highest cost items on a frigate. Suggested ways of reducing these costs were to carefully examine what the mission requirements of the vessels are in order to minimize the number of weapon and sensor systems, use COTS electronics where ever possible, and mount them on foundations to suit mission requirements (shock, noise, etc.).

The next most costly part of constructing a frigate and an area where great cost saving could be realized is by not reducing the vessel's acoustic, thermal and radar signatures. Reducing acoustic signatures involves isolating main engines and diesel generator sets with special foundations and in some cases enclosing them and using double foundations, locating generator sets above the waterline, using slow turning, low cavitation propellers and air masking systems. If anti-submarine warfare is not part of the vessel's mission acoustic signature reduction is not necessary.

Most yards and navies were placing a lot of emphasis on trying to reduce the radar cross section (RCS) of frigates today. There was a wide variation in opinion as to how much was necessary and what the cost associated with RCS reduction was. Engineers in Great Britain and Sweden appeared to have done the most work in this area (or were most willing to talk about the work they had done) and were of the opinion that reducing RCS was expensive. Other countries felt it was not very expensive. The cost of reducing RCS depends on the extent to which the signature is intended to be reduced. Everyone agreed that shaping the superstructure and adding bulwarks was the first step to reduce RCS and was inexpensive. Some countries did not do anymore than reshape the superstructure while others took the additional and much more costly steps of enclosing radar and antenna in radar reflective masts, covering all decks that had deck machinery, enclosing all boats and davits and redesigning all exterior doors and hatches so they were flush with the surrounding structure. These additional steps are what tended to make RCS reductions expensive and were details not all countries felt were necessary.

The final area of signature reduction is thermal signature reduction. Most countries were trying to achieve this by adding additional insulation to uptakes and stacks, adding water mist to exhaust gases to cool them or using wet exhausts rather than stacks. Some countries were experimenting with enveloping ships in a cloud of water mist. All of these techniques were somewhat effective at reducing thermal signatures; however, none were so effective that they eliminated the threat of heat seeking missiles. Most shipbuilders felt efforts to reduce infrared signatures were not cost effective.

Ship survivability features also tended to add to the acquisition and life cycle cost of the frigates. All of the frigates utilized the "citadel" concept to provide nuclear, biological and chemical (NBC) protection to the interior of the vessels. Shipyards indicated that providing NBC protection added 20 percent to the cost of the ventilation system plus the additional cost of decontamination stations and additional doors and vestibules.

Some of the frigates were provided with protection against shell fragments and small-caliber shells by armored steel plating. The LAFAYETTE Class frigates had lateral galleries on the main deck to provide similar protection. All of the vessels were designed to a two compartment damage stability standard, with the exception of the MAESTRALE frigates which are three compartment ships. No one identified this as a cost driver.

Other cost drivers might include vertical distribution concepts for fire main, electrical and ventilation systems, and redundant power generation and distribution systems.

10.0 CONCLUSIONS

The frigates and offshore patrol vessels investigated all performed missions very similar to the U.S. Coast Guard's traditional missions. By taking advantage of technological advances and cultural changes, many of these European services have been able to reduce the cost of performing their missions without compromising the standards to which those missions are performed. While all of the services maintained that replacing people with equipment on ships will result in a net cost savings, many of the services are still struggling to find the most cost effective way to maintain their vessels.

Most nations are of the opinion that there are more cost effective ways to provide adequate maintenance than traditional preventative maintenance programs. It is not apparent from the organizations we visited that there is a universally accepted method for reducing the life cycle maintenance cost of these vessels. Some services have tried to implement contract maintenance programs and have found their effectiveness to be limited.

Technology is available today that makes it possible for a crew of 75 or fewer to safely perform the U.S. Coast Guard's primary missions of law enforcement and search and rescue on a vessel equivalent in size to a 378-ft WHEC. However, it is apparent from all of the organizations we spoke with that it is not possible to operate with such crew sizes without making use of state-of-the art hull, mechanical, electrical and electronics technology.

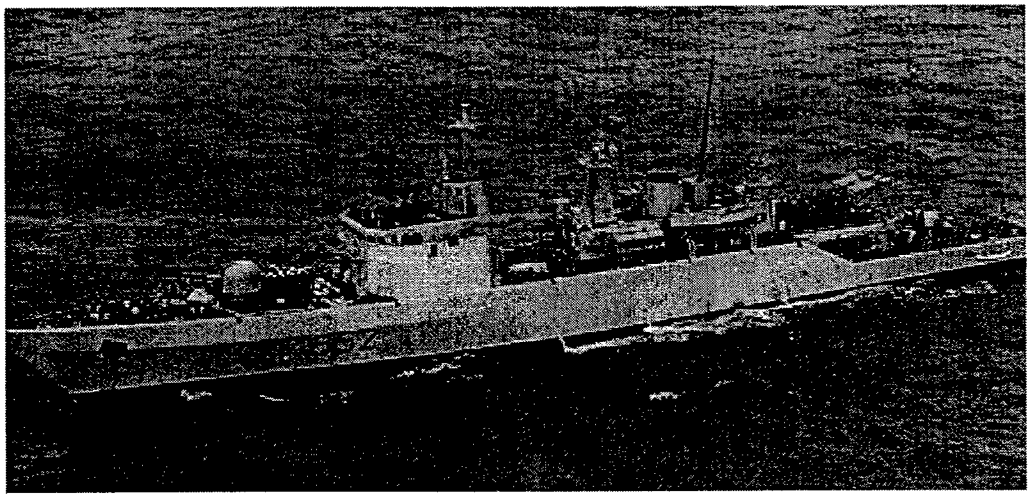
The services visited have also demonstrated that many of the ship board evolutions the U.S. Coast Guard finds to be man power intensive can be safely performed with far fewer personnel. Currently European Navies and Coast Guards:

- Operate their vessels with unmanned engine rooms, and some services are contemplating operation their vessels with unmanned engineering control spaces.
- Land helicopters with a party of six assisted be a landing traversing system. The British, Dutch, French and Italian Navies are planning to use no more than three people to land helicopters on their next class of frigates.
- Commonly have damage control parties of no more than six and accept that their vessels will not withstand more than one weapons hit.
- Launch and recover small boats with as few as three people on deck.

Reductions in crew size result in better accommodations for all of the crew members. The Danes and Norwegians have shown it is possible to provide two person cabins for the entire crew, and they have found it generally has a positive effect on crew morale and retention.

APPENDIX A - VESSEL CHARACTERISTICS

A.1 MINERVA CLASS CORVETTE



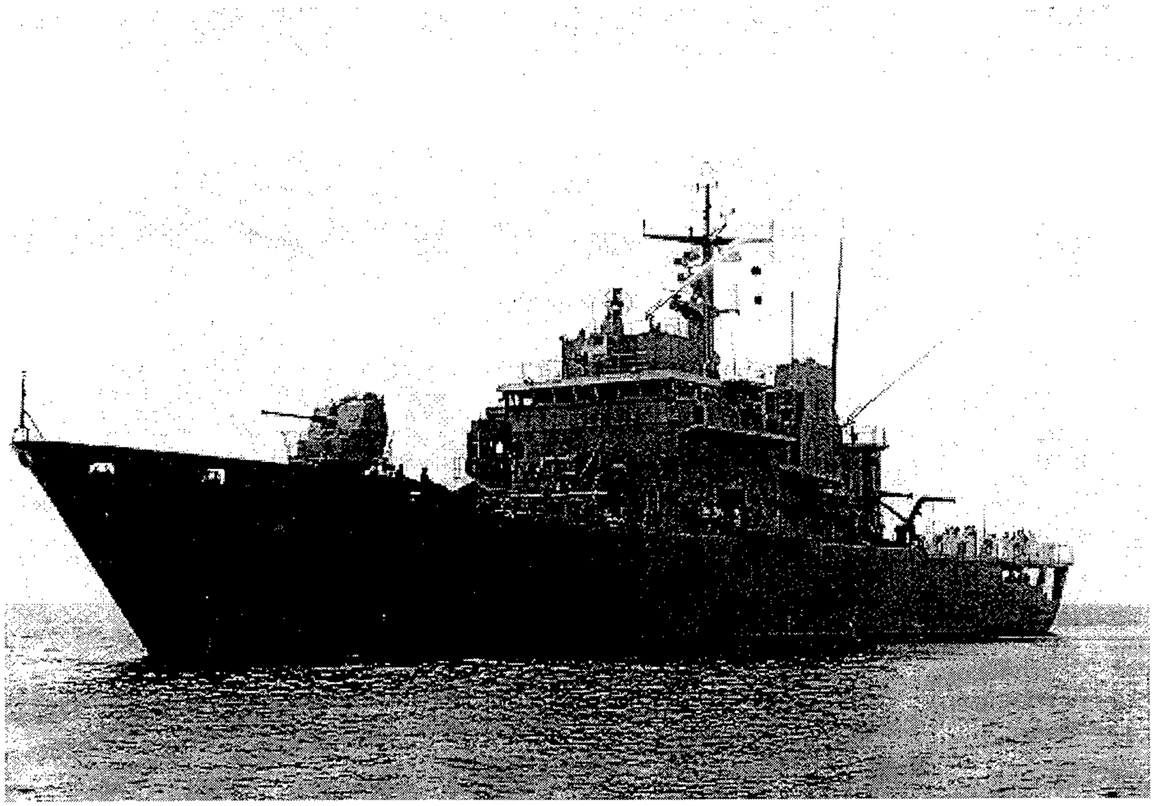
Length Over All	286 ft
Length Between Perpendiculars	263 ft
Beam	34 ft
Draft	12.3 ft
Depth	18 ft
Displacement Full Load	1300 tons
Displacement Light Ship	1030 tons
Main Machinery	2 x 5500 hp Fincantieri GMT 230.20 DVM Diesel Engines, 4 x 650 KVA Fincantieri-Isotta Fraschini ID 36 SS 12V, two CP propeller
Maximum Continuous Speed	24 kts
Range	3,500 nm at 18 kts
Endurance	21 days
Complement	121
Stability	Intact - Italian Navy Criteria, Similar to DDS-079-1 Damage - 2 compartment, vessel still operational
Helicopter	Currently no helo handling capability, however Fincantieri has developed a helo capable version for the export market
Boats	2 -Motor Surf Boats. Boats are not used very often by the Italian Navy
Armament	One 76/62 C gun OTO BREDA, One ALBATROS SAM AOSM, One B515M Torpedo-Launching System (Two Launchers), Two Decoy Launchers
Fire Control	One Elsag Dardo E System, Selenia/Elsag NA 18L Pegaso optronic director, Elmer TLC system
Communication	HF, VHF, and UHF
Radars	One RAN 10S 2D Radar AESN One MM/SPQ 748 2D Radar SMA
EMS	RQN-3M intercept

Sonar	One Raytheon /Elsag DE 1167 hull mounted, active search and attack
Navigation	SMA SPN 728 I Band

Eight vessels of the MINERVA Class were built between 1982 and 1991 by Fincantieri for the Italian Navy.

This class of vessels is intended to perform multiple missions, including EEZ patrols, fisheries protection, and anti-submarine warfare. In addition these vessels are used as training ships for perspective Commanding Officers of line vessels.

A.2 CASSIOPEA CLASS OFFSHORE PATROL VESSEL



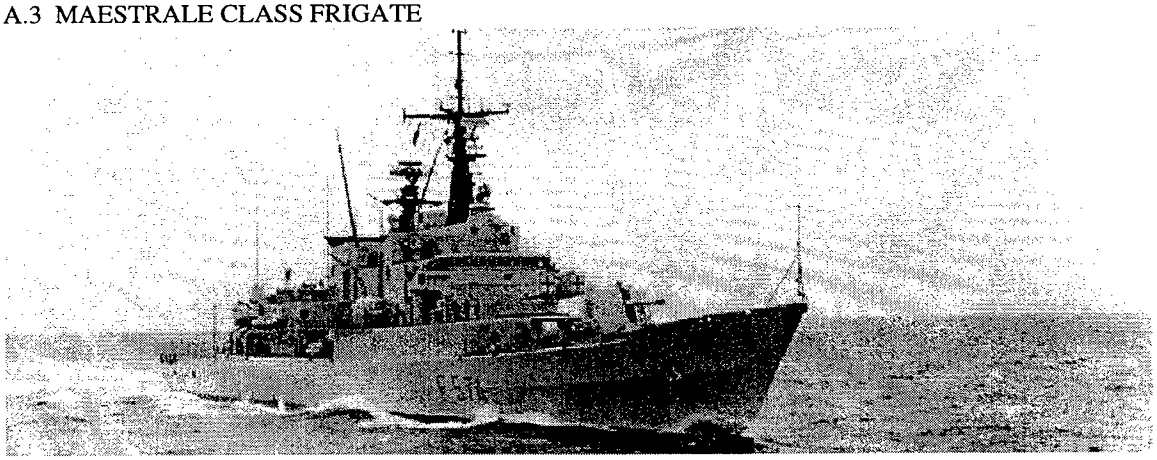
Length Over All	262 ft
Length Between Perpendiculars	235 ft
Beam	38.7 ft
Draft	11.5 ft
Depth	27.0 ft
Displacement Full Load	1475 tons
Displacement Light Ship	1000 tons
Main Machinery	2 x 4400 hp GMT BL 230/16 Diesel Engines, 3 x 500 KVA Fincantieri-Isotta Fraschini, one 120 KVA emergency diesel generator, two CP propeller
Maximum Continuous Speed	20 kts
Range	3,300 nm at 17 kts
Endurance	21 days
Complement	8 Officers, 40 Petty Officers, 30 Ratings
Stability	Intact - Italian Navy Criteria, Similar to DDS-079-1 Damage - 2 compartment, vessel still operational
Helicopter	One - AB 212ASW
Boats	2 -Motor Surf Boats
Armament	One 76/62 C gun OTO BREDA, Two 12.7 mm Machine Guns
Fire Control	One Argo NA 10, ELMER-MAC Integrated TLC System
Communication	HF, VHF, and UHF

Radar	One Surface Search, SMA 3RM 7-250; I Ban
Sonar	One Raytheon /Elsag DE 1167 hull mounted, active search and attack
Navigation	SMA SPN 728 I Band

Four vessels of the CASSIOPEA Class were built between 1987 and 1990 by Fincantieri for the Italian Ministry of the Merchant Marine.

This class of vessels was built to commercial standards to reduce cost and is intended to perform multiple missions, including EEZ patrols, fisheries protection, fire fighting, oil delimitation, oil recovery and oil dispersion. Class reusing legacy weapon systems.

A.3 MAESTRALE CLASS FRIGATE



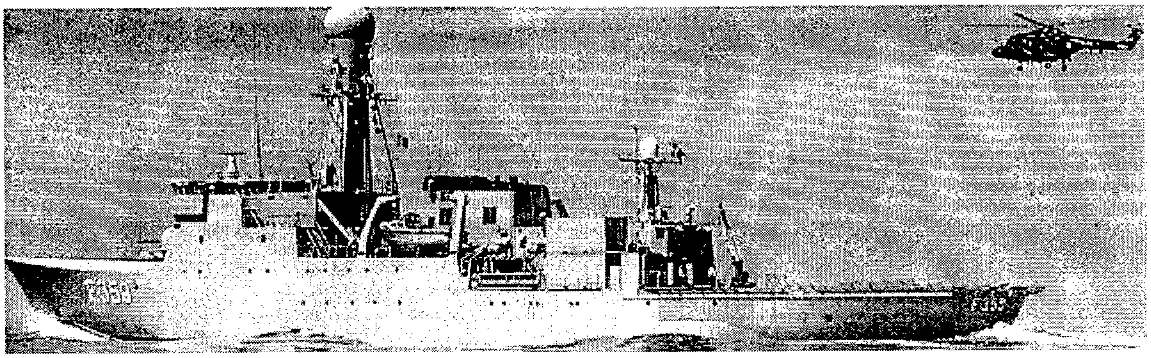
Length Over All	405 ft
Length Between Perpendiculars	374 ft
Beam	42.5 ft
Draft	15.1 ft
Depth	27.5 ft
Displacement Full Load	3200 tons
Displacement Light Ship	2500 tons
Main Machinery	CODOG 2 - Fiat/GE LM 2500 Gas Turbines (50,000 hp sustained) 2 GMT BL 230 20 DVM diesels, 12,600 hp sustained, 2 shafts with cp props
Maximum Continuous Speed	33 kts gas turbines, 21 kts diesels
Range	6,000 nm at 16 kts
Endurance	21 days
Complement	232 (24 officers)
Stability	Intact - Italian Navy Criteria, Similar to DDS-079-1 Damage - 3 compartment (survival) 2 compartment (operable)
Helicopter	Two - AB 212ASW or One SH 3D
Boats	2 -Motor Surf Boats
Armament	One 127/54 mm OTO BREDA, Two 40/70 mm OTO BREDA twin guns, One 8 S/A missiles AESN Albatros launcher, One OTO OTOMAT S/S missile system with 4 launchers, Two ILAS 3 triple torpedo launchers, Two A 184 torpedo launchers,
Fire Control	One AESN NA 30 missile and gun integrated fire control system, Two AESN Dardo fire control systems
Countermeasures	Decoys: Two 105 mm OTO BREDA SCLAR rocket launchers, Two Dagaie chaff launchers, SLQ 25 towed torpedo decoy, Prairie Masker noise suppression system
Radar	One AESN RAN 10 S main search radar, One 702 SMA secondary search radar, SMA SPN 703 nav radar
Sonar	One Raytheon DE 1164 hull mounted, VDS active/passive search and attack

Navigation	SMA SPN 728 I Band

Eight MAESTRALE class frigates were built by Fincantieri between 1977 and 1984 for the Italian Navy.

The MAESTRALE class frigate was deigned primarily for anti-submarine warfare. Theses vessels are built in accordance with Italian and NATO Navies standards for anti-shock, anti-vibration, and anti-noise protection, with special care devoted to underwater radiated noise.

A.4 THETIS CLASS OFFSHORE PATROL VESSEL



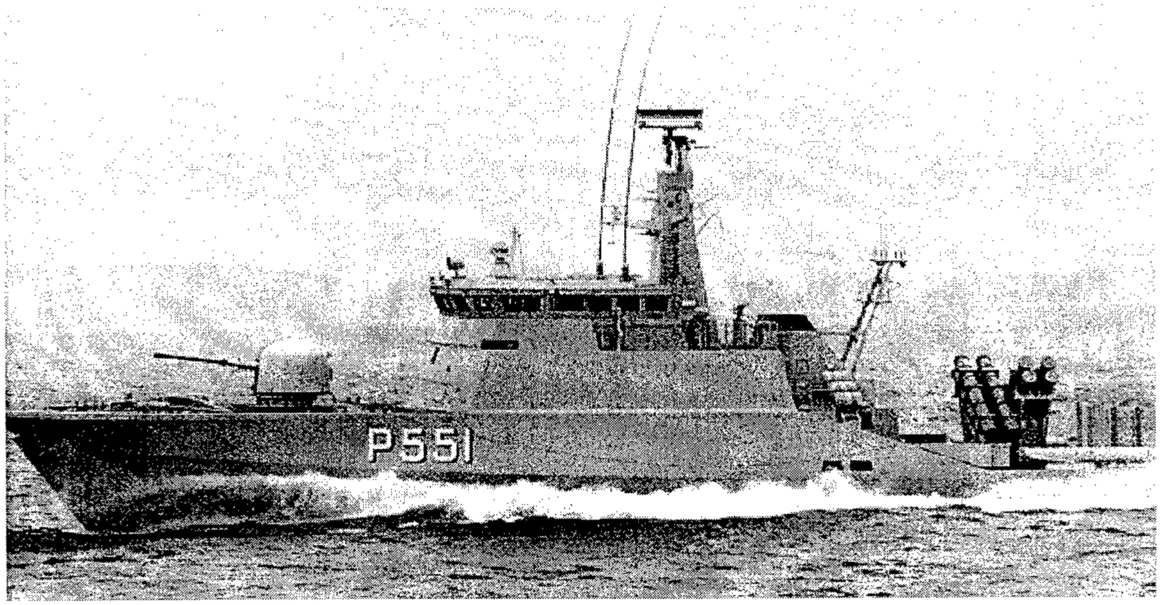
Length Over All	369 ft
Length Between Perpendiculars	328 ft
Beam	47 ft
Draft	20 ft
Displacement Full Load	3500 tons
Displacement Light Ship	2600 tons
Main Machinery	3 MAN/Burnmeister & Wain Alpha 12V 28/32A diesels, with a total effective application of 12,000 hp, single shaft, KaMeWa CP Propeller, electric bow thruster (800 hp), azimuthing thruster (1100 hp)
Machinery Control	Lyngso automatic ship control and supervisory system
Trial Speed	21 kts (8 kts on azimuthing thruster) Capable of breaking 1 m thick ice at 8 kts.
Range	8,500 nm at 15.5 kts
Endurance	90 days
Complement	60 (plus accommodation for 11 passengers)
Stability	Intact - IMO Criteria A167 (100 kts beam winds) Damage - 2 compartment w/ 300 tons of ice
Helicopter	Complete facilities for 1 Westland Lynx
Boats	2 -7 M RHIBs serviced by containerized hydraulic cranes
Armament	One containerized 76 mm OTO Melara Super Rapid dual-purpose gun, and depth charge throwers
Electronic Equipment	Modular TERMA C3 - system with integrated Celsiustech fire control system with radar and optronic trackers
Communication	Satellite, HF, VHF, and UHF controlled by an INFOCON automated system
Radars	Plessey AWS-6, TERMA Scanter Mil, Furuno navigation
EMS	Racal Mermaid
Sonars	C-tech CTS 36 hull mounted, Thomson Sintra TMS 2640 VDS
Navigation	Sperry/Anschutz gyro systems, Decca, Loran, and

	GPS

Four vessels of the THETIS Class were built between 1988 and 1992 by the Danish Svendborg Shipyard Ltd, based on the Royal Danish Navy's requirements and a design developed in consultation with Yard Ltd. of the United Kingdom.

The ships of this class are built for Offshore Patrol duties in the North Atlantic in the 200 nm Exclusive Economic Zone surrounding Danish Greenland and the Faeroe Islands. The vessel's missions include fishery protection and inspection, surveillance, assertion of sovereignty, air-sea rescue, assistance to local authorities and populations, anti-pollution tasks, and ice reconnaissance

A.5 STANDARD FLEX 300



Length Over All	177 ft
Length Between Perpendiculars	164 ft
Beam	30 ft
Draft	8.5 ft
Displacement Full Load	450 tons
Displacement Light Ship	320 tons
Main Machinery	1 Gas Turbine 6000 hp 2 Diesel Engines 2600 hp (each) 1 Diesel Engine Hydraulic 540 hp 3 shafts, gas turbine is connected to centerline shaft, diesel engines connected to outboard shafts, hydraulic propulsion is for slow speed , low noise operations
Machinery Control	Lyngso automatic ship control and supervisory system
Trial Speed	30 kts gas turbine and diesels 20 kts diesels 6 kts hydraulic propulsion
Range	2400 nm at 18 kts
Endurance	10 days
Complement	19 to 29 depending on vessel mission
Stability	Intact - IMO Criteria A167 (100 kts beam winds) Damage - 2 compartment
Boats	1 -7 M RHIB serviced by containerized hydraulic crane
Armament	Containerized (4 container positions), with combat system functions implemented in resident C3 system:

	• Gun 76mm OTO MELARE Super Rapid • HARPOON surface to surface missiles • SEA SPARROW surface to air missiles • TP613 Anti Surface Torpedoes • Mine rails for 60 bottom mines • Depth Charge Launchers • MCM, Side Scan Sonar, T-CSF/Sintra, mounted in towed "fish" • Surface Auxiliary Vessels (data link control) • Mine Disposal Vehicles (sonar/TV) (cable)
Electronic Equipment	Modular TERMA C3 - system with integrated Celsiustech fire control system with radar and optronic trackers
Communication	HF, VHF, and UHF controlled by INFOCOM automated control system (SATCOM for special tasks)
Radars	Plessey AWS-6, TERMA Scanter Mil, Furuno navigation
EMS	Racal Mermaid
Sonars	C-tech CTS 36 hull mounted, Thomson Sintra TMS 2640 VDS
Navigation	Decca and GPS, Sperry/Anschutz gyro system

Fourteen vessels of the Standard Flex 300 Class were built between 1987 and 1995 by the Danish shipyard DANYARD A/S for the Royal Danish Navy. When built these were the largest Glass Reinforced Plastic vessels ever built.

The Standard Flex 300 vessels replaced a series of vessels which were each dedicated to specific tasks, including mine counter measures, surveillance, mine laying and fast surface attack. The containerized weapon system allows the SF300 to change roles rapidly and perform duties as surface combat units, anti-submarine warfare units, MCM/Mine hunters and mine layers. In addition there are modules that allow the vessel to perform search and rescue work, pollution control work, surveillance and law enforcement missions. The operations area for these vessels are primarily the Danish Straits, their approaches and the Baltic Sea.

A.6 NORDKAPP CLASS OFFSHORE PATROL VESSEL

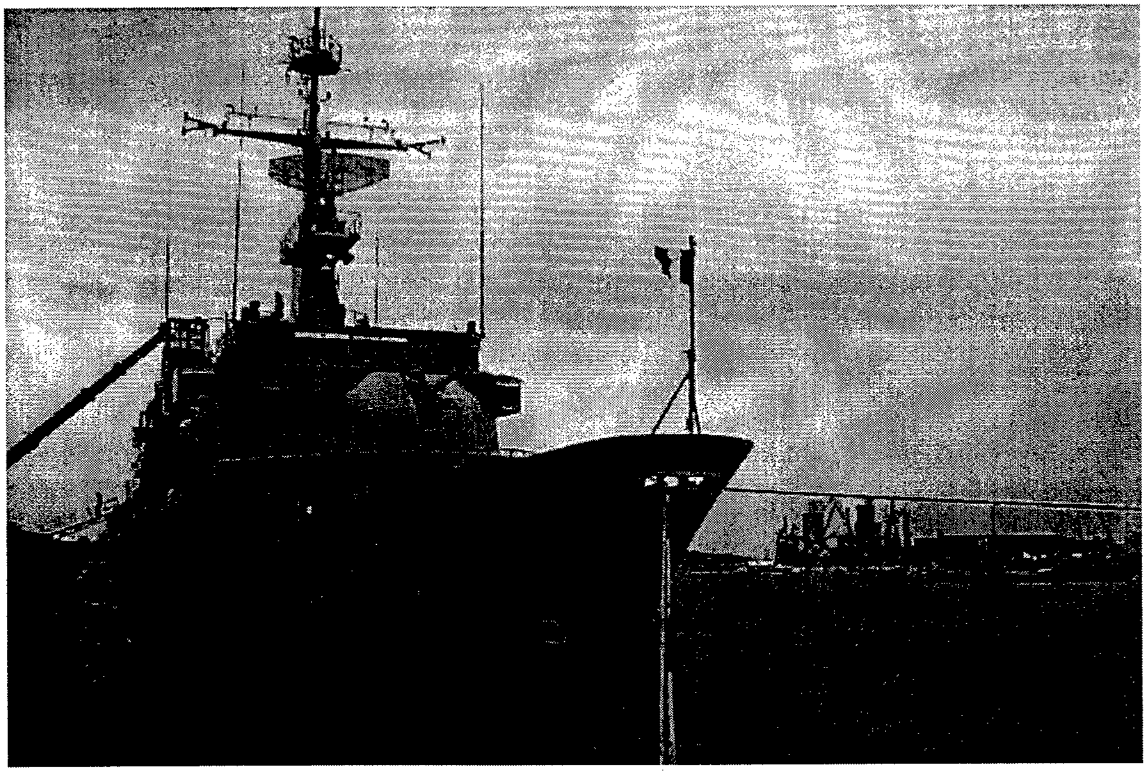
Length Over All	346 ft
Length Between Perpendiculars	328 ft
Beam	48 ft
Draft	16 ft
Displacement Full Load	3240 tons
Main Machinery	4 Wichmann 9 AXAG diesels, with a total effective application of 16,200 hp, two shafts
Trial Speed	23 kts open water, Capable of breaking 1 meter of ice at 8 kts.
Range	7,500 nm at 15 kts
Endurance	90 days
Complement	62 (including air crew of 6), increases to 76 in time of war
Stability	Intact - IMO Criteria A167 (100 kts beam winds) Damage - 2 compartment
Helicopter	Complete facilities for 1 Westland Lynx Mk 86
Boats	2 Motor Cutters and One RHIB. All boats launched with Vesta davit
Armament	One Bofors 57 mm/70, Four Rheinmetall 20 mm guns, fitted for 6 Kongsberg Penguin II missiles but not embarked, fitted for 6 - 324 mm/20 US Mk 32 (2 triple) tubes, not embarked
Fire Control	Philips 9LV 218 Mk 2
Communication	Satellite, HF, VHF, and UHF controlled by an

	INFOCON automated system
Radars	Plessey AWS-5
Sonars	Simrad SS 105 hull mounted
Navigation	Two Racal Decca 1226

Three vessels of the NORDKAPP Class were built between 1978 and 1981.

The ships of this class are built for Offshore Patrol duties in the North Atlantic in the 200 nm Exclusive Economic Zone surrounding Norway and the fishery zones around Svalbard and Jan Mayen. The vessel's missions include fishery protection and inspection, surveillance, assertion of sovereignty, air-sea rescue, assistance to local authorities and populations, anti-pollution tasks, ice reconnaissance and research assignments.

A.7 FLOREAL CLASS PATROL FRIGATES



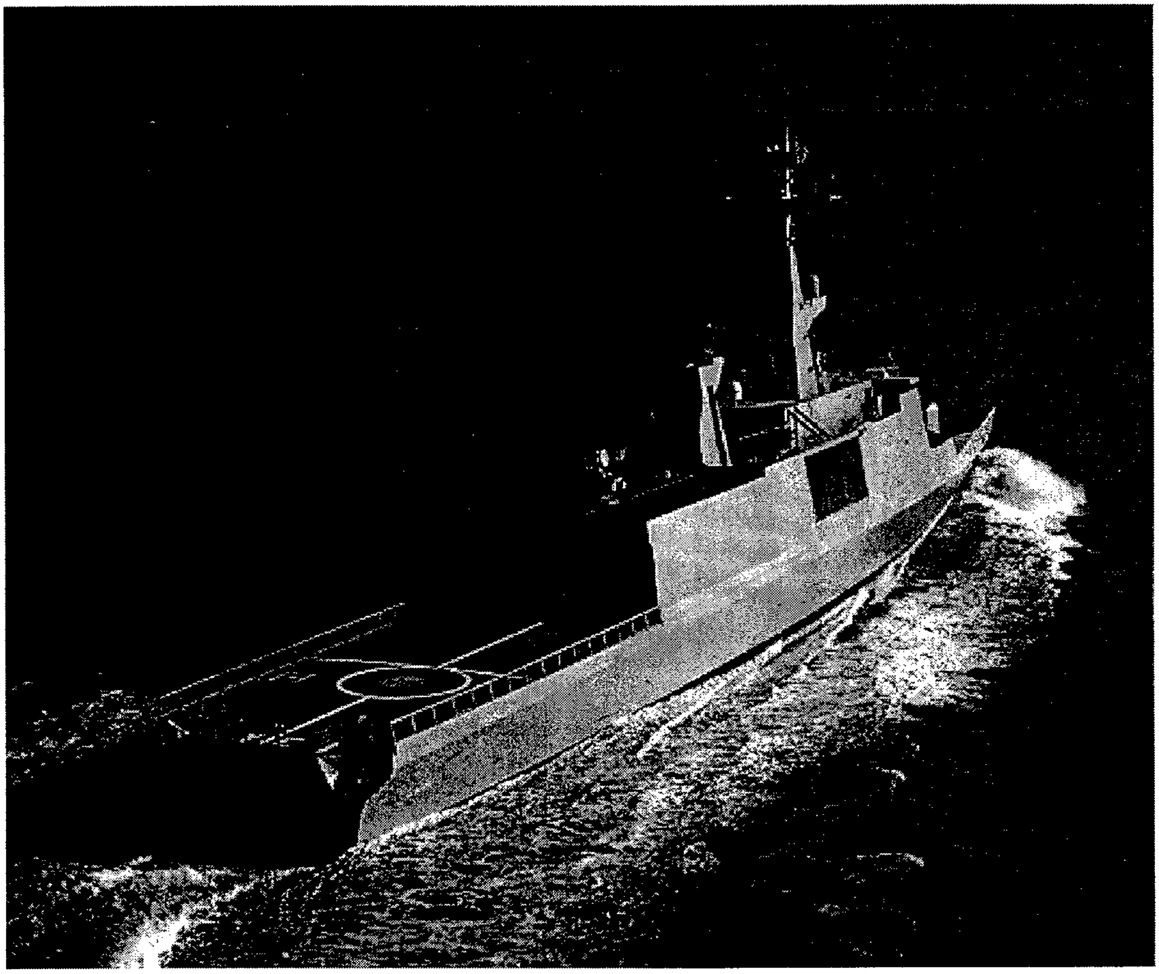
Length Over All	308 ft
Length Between Perpendiculars	289 ft
Beam	46 ft
Draft	14.5 ft
Displacement Full Load	2950 tons
Displacement , Standard	2600 tons
Main Machinery	2 shaftlines with cp propellers 4 x 2200 bhp Diesel Engines, Pielstick 6PA6 3 x 590 kW diesel generators
Maximum Speed	20 kts
Range	9,000 nm at 15 kts
Endurance	50 days
Complement	Standard Crew - 55 (8 Officers, 6 CPOs, 23 Pos, 18 Enlisted) Optional Crew - 44 Marines - 24 TOTAL 123
Stability	Intact - IMO Criteria A167 (100 kts beam winds) Damage - 2 compartment
Helicopter	Complete facilities to handle a Super Puma
Boats	2 RHIBs, 1 Cutter Boat
Armament	1 DCN 100 mm "CADAM", Two 20 mm canon, Four Aerospatiale MM 40 Exocet, Two Matra Sinbad twin launchers
Fire Control	CSEE Najir optronic director, Syracuse Satcom
Countermeasures	Decoys: 2 CSEE Dagaie; 10 barreled trainable

	launchers; Chaff and IR flares
Radar	Air/Surface search: Thomson-CSF Sea Tiger (DRBV 15)
Navigation	Two Racal Decca 1226

Six FLOREAL Class vessels were built for the French Navy by Chantiers de L'Atlantique from 1990 to 1993.

The ships of this class are built for Offshore Patrol duties in the Indian, Pacific and Atlantic Oceans. Primary missions of the vessels are enforcement of laws and treaties, surveillance, search and rescue, and training. During times of war the vessels are intended to perform surveillance work, provide naval and amphibious support, conduct commando operations, and engage in surface combat.

A.8 LA FAYETTE CLASS FRIGATE



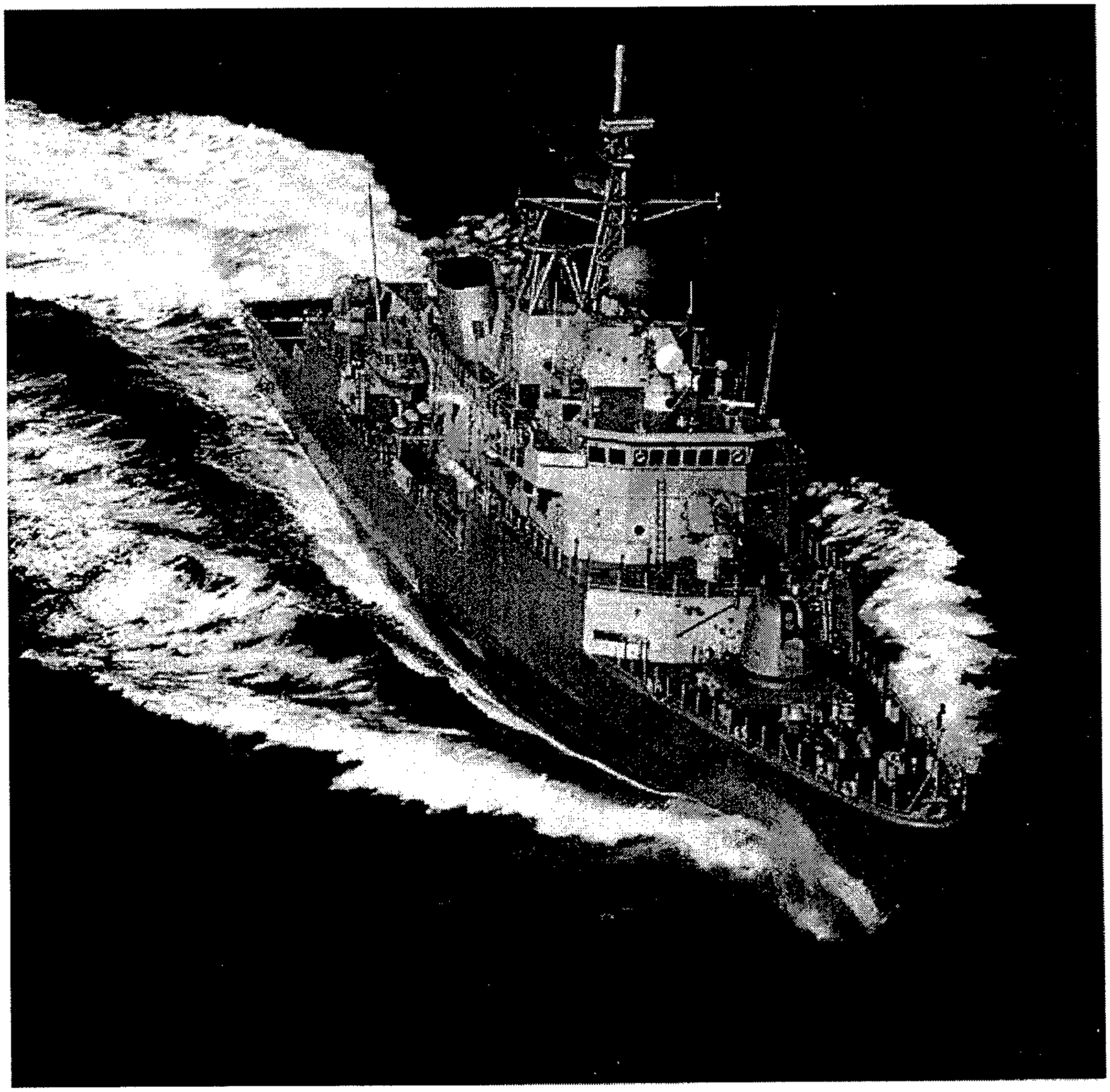
Length Over All	407 ft
Length Between Perpendiculars	377 ft
Beam	44.6 ft
Draft	13.5 ft
Displacement Full Load	3600 tons
Main Machinery	CODAD; 4 SEMT-Pielstick 12 PA6 V 280 STC Diesels (21107 hp sustained) 2 shafts cp props, bow thruster
Maximum Speed	25 kts
Range	9,000 nm at 12 kts, 7,000 nm at 15 kts
Endurance	50 days
Complement	141 (Includes 15 Officers, 12 aircrew and 13 passengers)
Stability	Intact - IMO Criteria A167 (100 kts beam winds) Damage - 2 compartment
Helicopter	Complete facilities to handle a Aerospatiale AS 565 MA Panther
Boats	1 RHIB stern overhead launch, 2 Cutter Boats

	amidships
Armament	1 DCN 100 mm "CADAM", Two 20 mm canon, Eight Aerospatiale MM 40 Exocet, Fifteen 24 VT1 Crotale Missiles
Fire Control	Thomson-CSF Castor II, Crotale J band for SAM
Countermeasures	Decoys; Two Dagaie Mk2 launchers
Radar	Air/Surface search: Thomson-CSF Sea Tiger (DRBV 15)
Navigation	Two Racal Decca 1226

Six LA FAYETTE Class frigates were planned to be built, five have been funded. The fourth vessel ACONIT will be delivered in early 1998.

The ships of this class are built for Offshore Patrol duties in the Indian, Pacific and Atlantic Oceans. Primary missions of the vessels are enforcement of laws and treaties, surveillance, intelligence gathering , and search and rescue. During times of war the vessels are intended to perform surveillance work, provide naval and amphibious support, conduct commando operations, and engage in surface combat, anti-submarine warfare and surface to air warfare.

A.9 MEKO 200 MULTI-PURPOSE FRIGATE



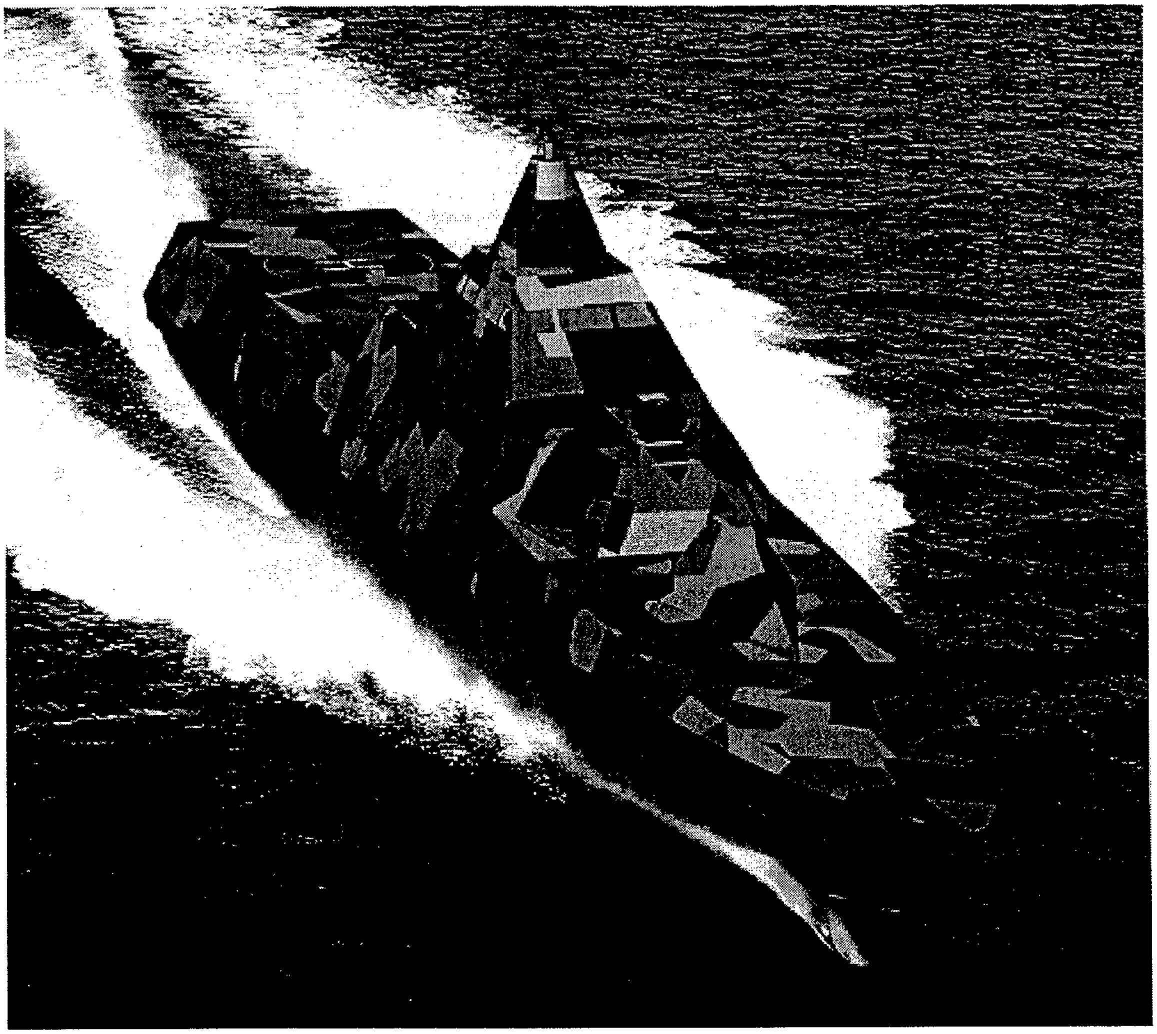
Length Over All	387 ft
Length Between Perpendiculars	358 ft
Beam	48.6 ft
Draft	14.3 ft
Displacement Full Load	3600 tons
Main Machinery	CODOG; 2 GE LM 2500 gas-turbines 31,700 hp each (sustained), 2 MTU Diesels 5800 hp each, 2 KaMeWA controllable pitch, featuring blade props
Maximum Speed	32 kts
Range	6,000 nm at 18 kts
Endurance	50 days
Complement	Up to 200

Stability	German Navy Criteria, similar to DDS-079-1, ship designed to survive two missile hits, remain operational after one missile hit
Helicopter	Complete facilities to handle a Bell Augusta 212 ASW
Boats	2 Ship's boats amidships, 1 RHIB launched from SPD
Armament	1 - FMC 127 mm Mk45 Mod 2A multi-purpose gun, 3 Contraves Sea Zenith 25 mm quad guns, 8 Harpoon Missiles, 8 Sea Sparrow missiles, 2 MK32 triple torpedo tubes, SRBOC MK36 chaff decoy system
Command and Control	Signaal STACOS Battle Management, B&V TAICOS, B&V MICE/DAIL
Radar	Siemens/Plessey AWS-9 (TN) 996 3D search and target indication radar, Contraves Dolphin Search Radar for Seaguard CIWS, Signaal STIR Tracking and illumination radar, Contraves TMX Tracking and illumination module for Seaguard, Contraves TMKu Tracking radar for Seaguard - CIWS, RACAL Cutlass B1/Scorpion Integrated ESM/ECM system
Communication and Navigation	Hagenuk Integrated Communication System, Anschutz Integrated navigation system
Sonar	Raytheon AN/SQS56

Blohm and Voss has delivered 15 MEKO 200 Class ships to Turkey, Portugal and Greece, in addition Australia and New Zealand have a licensing agreement to build 10 more of these ships in Australia.

MEKO is a family of modular warship designs with variable payloads for weapons and electronics, with standardized interfaces and equipment.

A.10 VISBY CLASS CORVETTE



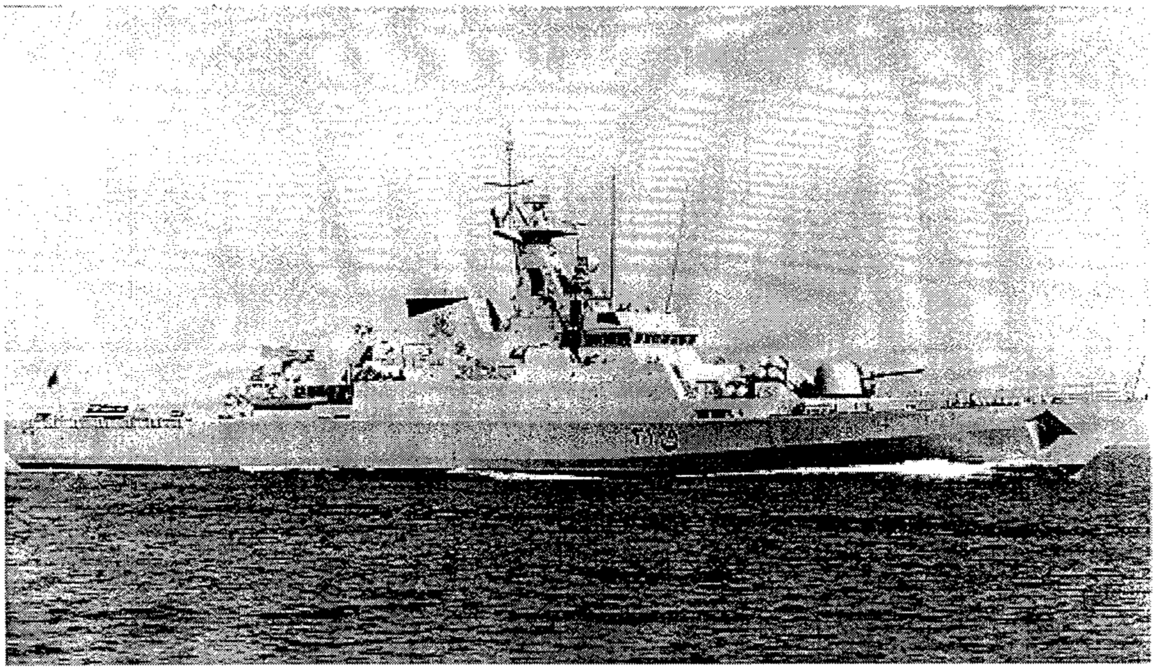
Length Over All	236 ft
Length Between Perpendiculars	202 ft
Beam	34 ft
Draft	8 ft
Displacement Full Load	600 tons
Main Machinery	CODOG; 4 Allied Signal TF50A gas turbines (21500 hp total) 2 DDC/MTU 16V2000 TE92 diesels (3500 hp total), 2 camera 125 SII water jets, 3 diesel generators (810 kW total)
Maximum Speed	40 + kits on gas turbines, 15 kits on diesels
Range	6,000 NM at 18 kits
Endurance	20 days
Complement	43 (27 officers, 16 conscripts)
Stability	IMO
Helicopter	Flight deck provided for handling a 3 ton helicopter which is stowed below deck via an elevator
Boats	1 RHIB stowed amidships, launched via overhead

	railway
Armament	1 - Bofors 57 mm MK 3 gun, 4 torpedo tubes, 2 sets of grenade launchers, ECM chaff launchers, ROVs for mine hunting and mine destruction
Command and Control	Signaal STACOS Battle Management, B&V TAICOS, B&V MICE/DAIL
Radar	ESM/radar warner, surveillance radar, navigational radar
Sonar	Hull mounted and variable depth sonar

The first of four of these ships is scheduled to be delivered to the Swedish Navy in 1999, with three more hulls under contract for delivery in 2004 to 2005.

These vessels are the largest ever to be built of carbon reinforced plastic. These vessels are configured for mine counter measure missions and anti-submarine warfare. In addition the vessels are designed for surveillance, patrol and escort missions.

A.11 QAHIR CLASS CORVETTE



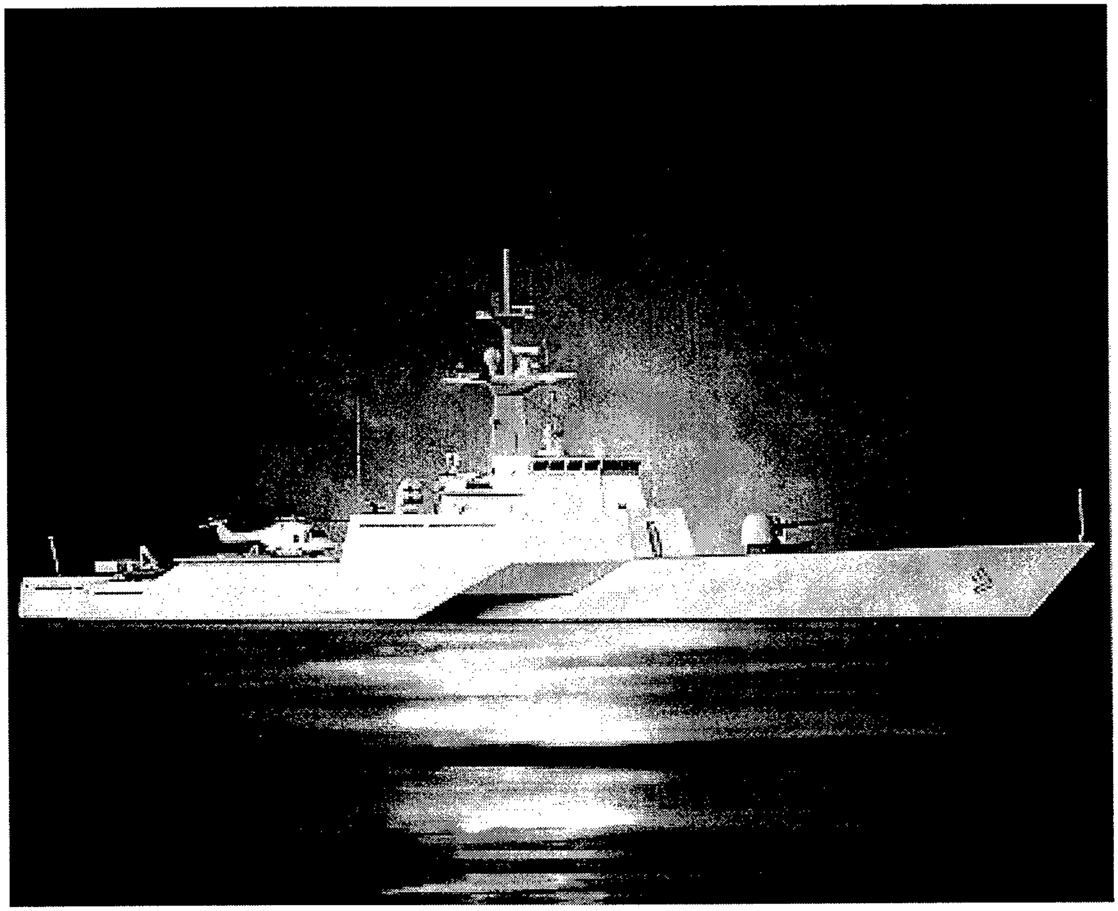
Length Over All	275 ft
Length Between Perpendiculars	249 ft
Beam	38 ft
Draft	11.8 ft
Depth	23.6 ft
Displacement Full Load	1450 tons
Main Machinery	Engine Options 4 x MTU 20v 1163TB83 4 x MTU 20v 1163TB93 4 x Ruston 16 RK 270 4 x Crossley Pielstick 16 PA 6v 280STC
Maximum Speed	In excess of 30 kts depending on choice of engines
Range	2100 nm at 20 kts 4000 nm at 10 kts
Endurance	21 days
Complement	76 (14 Officers)
Stability	UK MoD Standards
Helicopter	Flight deck provided for handling a Super Puma helo. Hanger can be either fixed or telescopic.
Boats	2 RHIBs stowed forward of hangar.
Countermeasures	Decoys: 2 Barricade 12 barreled chaff launchers ESM/ECM: Thomson CSF DR 3000; intercept jammer
Armament	1 - OTO Melara 76mm/62 Super Rapid, 8 - Aerospatiale MM 40 Exocet, 1 - VT1 Thomson-CSF Crotale NG octuple launcher
Combat Data Systems	Signaal/Thomson CSF TACTICOS; Link Y; SATCOM

Radar	Air/Surface Search: Signaal MW08; G Band Fire Control : Signaal STING; I/J Band, Thomson CSF DRBV 51C J Band Navigation: Kelvin Hughes 1007; I band
Sonar	Thomson Sintra/Bae Sema ATAS; towed array active search

Developed by Vosper Thornycroft from the well proven Mk9 Corvette. Two of these vessels have been sold to the Oman Navy and are currently in use.

These vessels are designed to carry out Economic Exclusion Zone Patrols, fishery protection, surveillance, anti-smuggling, search and rescue, disaster relief and anti-pollution activities.

A.12 100 Meter TRIMARAN CORVETTE



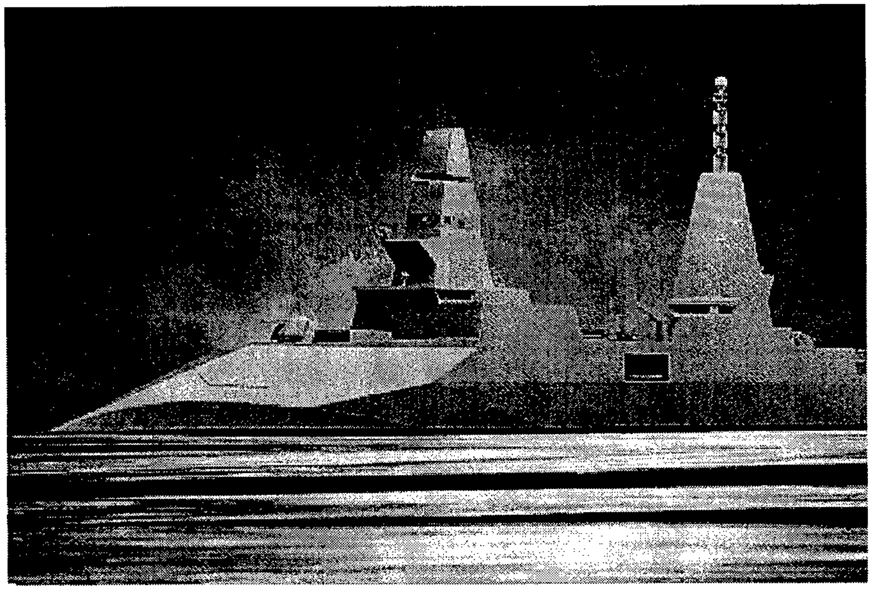
Length Over All	335 ft
Length Between Perpendiculars	312 ft
Beam	56 ft
Draft	12.2 ft
Depth	23.6 ft
Displacement Full Load	1250 tons
Main Machinery	Four Marine diesel engines each rated at 4,000 hp. Propulsion is provide by two water jets for cruising each driven by a single engine. One central water jet provides boost power driven by two diesel engines via a twin input single output gearbox.
Maximum Speed	In excess of 30 kts, 40 kts can be achieved with installation of larger engines.
Range	1500 nm at 20 kts
Endurance	21 days
Complement	81 (14 Officers)
Stability	UK MoD Standards
Helicopter	Flight deck provided for handling a Super Puma

	helo. Hanger can be either fixed or telescopic.
Boats	2 RHIBs stowed aft of the flight deck, launched via Vesta Davits
Countermeasures	Decoys: 2 Barricade 12 barreled chaff launchers ESM/ECM: Thomson CSF DR 3000; intercept jammer
Armament	1 - OTO Melara 76mm/62 Super Rapid, 8 - Aerospatiale MM 40 Exocet, 1 - VT1 Thomson-CSF Crotale NG octuple launcher
Combat Data Systems	Signaal/Thomson CSF TACTICOS; Link Y; SATCOM
Radar	Air/Surface Search: Signaal MW08; G Band Fire Control : Signaal STING; I/J Band, Thomson CSF DRBV 51C J Band Navigation: Kelvin Hughes 1007; I band
Sonar	Thomson Sintra/Bae Sema ATAS; towed array active search

Developed by Vosper Thornycroft to satisfy the same requirements as the 83 meter corvette, this vessel or one very similar to it will most likely be built by the UK MoD as a demonstrator.

This vessel is intended to carry out deterrent patrols and control of the sea, provide support attack craft operation, provide naval gunfire support and provide area command and control. In addition this vessel can conduct anti-smuggling patrols, fisheries protection, search and rescue, disaster relief, research and anti-pollution work and maritime traffic control.

A.13 SEA WRAITH STEALTH CORVETTE



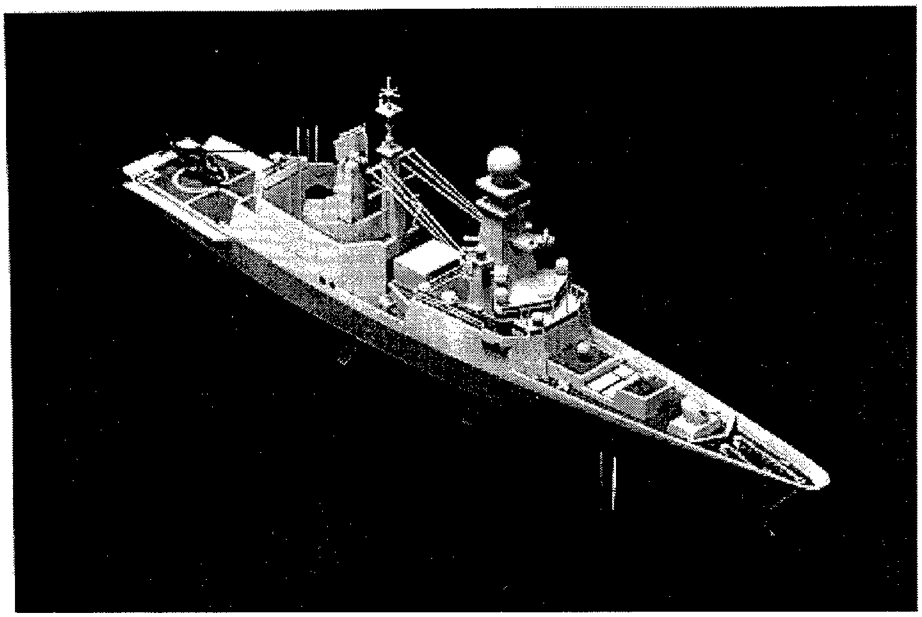
Length Over All	377 ft
Length Between Perpendiculars	361 ft
Beam	51 ft
Draft	14.75 ft
Displacement Full Load	2500 tons
Main Machinery	For high speed operation a single WR21 1CR gas turbine is used to drive two controllable pitch propellers via a split gear box. The turbine is rated at 31,500 hp. For cruising and stealth propulsion, each propeller is directly driven by a 2.1 MW electric motor.
Maximum Speed	28 kts
Range	2500 nm at 15 kts
Endurance	21 days
Complement	105 crew plus 18 trainees
Stability	UK MoD Standards
Helicopter	Flight deck and hanger provided for handling a five ton helo.
Boats	2 RHIBs
Countermeasures	One EMS system integrated with static four faced ECM system, One above water chaff and IR decoy system, One water fog system
Armament	two medium caliber guns, two small caliber guns, surface to surface missile, surface to air missiles, artillery rocket weapon system, helicopter launched torpedoes and depth charges
Radar	one phased array surveillance radar, one FMCW surface search radar, one navigation radar with helicopter transponder receiver, two light weight radar fire control directors, one data link, one unmanned aerial vehicle system with 4 aircraft, one

	XBT system
Sonar	Towed array search sonar, option for hull mounted sonar

Developed by Vosper Thornycroft to investigate technologies for reducing ship signatures. Vosper Thornycroft is currently seeking a customer to build this vessel for.

Vosper Thornycroft contends this would make an excellent offshore patrol vessel, however it looks more like a warship.

A.14 HORIZON FRIGATE



Length Over All	488 ft
Length Between Perpendiculars	459 ft
Beam	65 ft (59 ft at waterline)
Draft	16.4 ft
Displacement Full Load	6000 tons
Main Machinery	Undecided. Will be either one 21.5 MW gas turbine per shaft or 4 MW diesel engines per shaft. Vessel will have two shafts. Ship services will be provided by four 1.3 MW diesel generators. Propellers will be feathering controllable pitch propellers to reduce fuel consumption.
Maximum Speed	30 kts
Range	7,000 nm at 18 kts, 3,500 nm at 25 kts
Endurance	45 days
Complement	235
Stability	DDS 079-1
Helicopter	Flight deck and hanger provided for handling the following helos: Merlin, EH101, NH90, SH3D, AB212, Lynx or Panther.
Boats	2 RHIBs
Countermeasures	Not Available
Armament	Not Available
Radar	Not Available
Sonar	Not Available

The Horizon frigate is an anti-air frigate being developed jointly by the British, French and Italian navies. Current plans are for the UK to build 12 ships, Italy to build 6 ships and France to build 4 ships.

The vessel will have anti-air warfare defense capabilities, command and control capabilities, anti-submarine warfare capabilities and anti-surface warfare capabilities. Enabling the vessel be part of a task force or carrier group, support a force of lightly or unarmed vessels or operate alone either in combat or non-combat situations.