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THETIS Class Patrol Frigate



NAVAL MATERIEL COMMAND
DENMARK

The North Atlantic fishery protection and inspection service of the Royal Danish Navy was established in 1587 by a Royal Decree and carried out by frigates and other men-of-war. With only minor interruptions, the service has operated ever since. After World War I, specially designed inspection ships were introduced, and from 1932 sea-planes based on the ships were used to extend the range of inspection. Helicopters replaced the sea-planes in 1962. Thus the design and construction of the new »Thetis« class patrol frigates rest on more than 400 years of experience in Faroe and Greenland waters, combined with 30 years of experience in the operation of ship-based helicopters in some of the roughest waters in the world.

In 1977, the Danish economic zone was expanded to 200 nautical miles from the coast of Greenland and the Faroe Islands. It became clear that the next generation of vessels for service in these waters had to be faster, more long-legged and better equipped than the ships in service at that time.

The design of the »Thetis« class patrol frigate is based on standardization with existing Danish naval equipment and software. The technological standards achieved ensure reliable, safe and economic operations. It has been possible to construct the vessels



of this class at a very low price. Operating costs have also been markedly reduced, due to the standardization achieved and the high degree of onboard automation.

The Danish Naval Materiel Command is proud to present the patrol frigates of the »Thetis« class and its contractors.

Rear Admiral S. Torp Petersen
Chief of Naval Materiel Command



General Requirements for the »Thetis« Class.

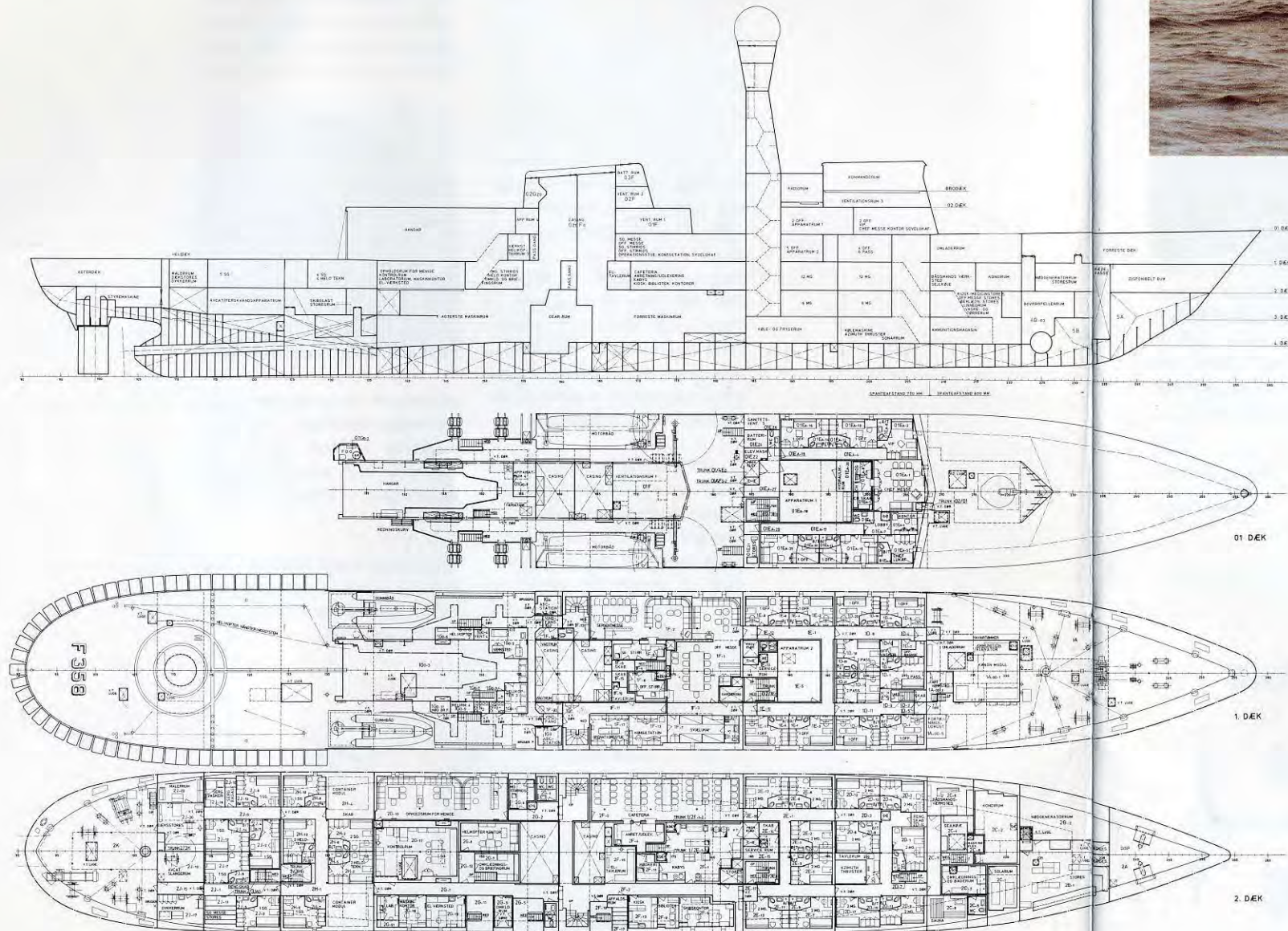
The new patrol frigates of the »Thetis« class have been designed to perform the following tasks:

- a. Fishery protection duties.
- b. Surveillance.
- c. Assertion of sovereignty
- d. Air-sea rescue.
- e. Assistance to local authorities and populations.
- f. Anti-pollution work.
- g. Ice reconnaissance.

Based on these tasks and past experience, the ships have been constructed with an endurance of 8300 nautical miles at varying speeds, consuming no more than 90% of the gas oil available. Provisions cover 4 months' operations, and the stocks of spare parts are sufficient for 6 months at sea without replenishment. Helicopter fuel suffices for 150 flying hours. The frigates are ice strengthened to DNV ICE 1A and are able to proceed through 80 cm of

solid ice. The hull has an ice-breaking bow and stern lines suitable for operations in ice with only one propeller.

Maximum continuous speed is 20 knots in 4 meter seas. The sea-keeping qualities allow the ships to stand up to wind gusts of 150 knots during light ice conditions and operate in all sea conditions at speeds of 4-5 knots. The capabilities for operating helicopters and rubber boats are optimized.



The armament corresponds to the task of asserting Danish sovereignty, and a growth potential has been included in the design.

General Characteristics

The Hull

The frigates have a double-skinned hull up to 2 meters above the water-line. It is subdivided by 10 bulkheads into watertight compartments of such a size that the vessels are able to sustain a hull damage up to 8 meters in length without dangerous stability impairment. For ship propulsion this means that one engine-room and the gear-room can be water-filled at the same time, and the frigates will still be able to proceed.

The basic hull shape corresponds to that of a high-speed trawler. The frames in the bow and stern are placed very close to each other. Amidships the thickness of the outer skin has been increased, based on the experiences gained

with old fishery protection ships. The controllable pitch propeller, the propeller shaft and the rudder are dimensioned in accordance with ICE 1A, and the propeller is protected against ice by a bulb in the stern.

The length of the hull is a compromise between 4 partly conflicting requirements:

- a. Demands for a relatively high speed.
- b. The necessity of giving the vessels a certain ice-breaking capability.
- c. Lack of maneuvering space in some harbours in Greenland.

d. The requirement to optimize conditions for helicopter and boat operations.

Requirements a. and d. support each other, as the desired profile results in slender hull lines and a rather long hull. A long hull will improve the conditions for helicopter operations, while requirements b. and c. tend to limit the length of the frigate.

Regarding helicopter operations, a study was made to determine the influence of the length of the vessel on the ability to fly off and recover helicopters, considering the length of the waves in Atlantic and Greenland waters.





Rating mess



Standard cabin

The study concluded that with a length p.p. of app. 100 m, the time during which helicopters cannot operate due to weather is reduced to 10%. A length of 100 m also serves the purpose of bringing the flight deck close to the pitch centre.

There are no bilge keels, but stabilization is achieved by a combination of fin stabilizers delivered by Blohm/Voss and a controlled passive tank system delivered by Interling.

The ships have been provided with many workshops and store rooms, and the crew quarters are probably the most luxurious in naval ships anywhere. All officers and petty officers have one-berth cabins; all other ranks have twin-berth cabins. Five twin-berth cabins are provided for passengers. All cabins have their own bath and toilet.

To minimize ice formation on the superstructure in cold weather, all winches, capstans, etc. are placed under deck. Efforts have been made to keep all surfaces smooth and clean. Furthermore, the fore-castle deck is »trawler shaped« and all open deck spaces and scuppers are heated. The allowed amount of icing is 375 tons.



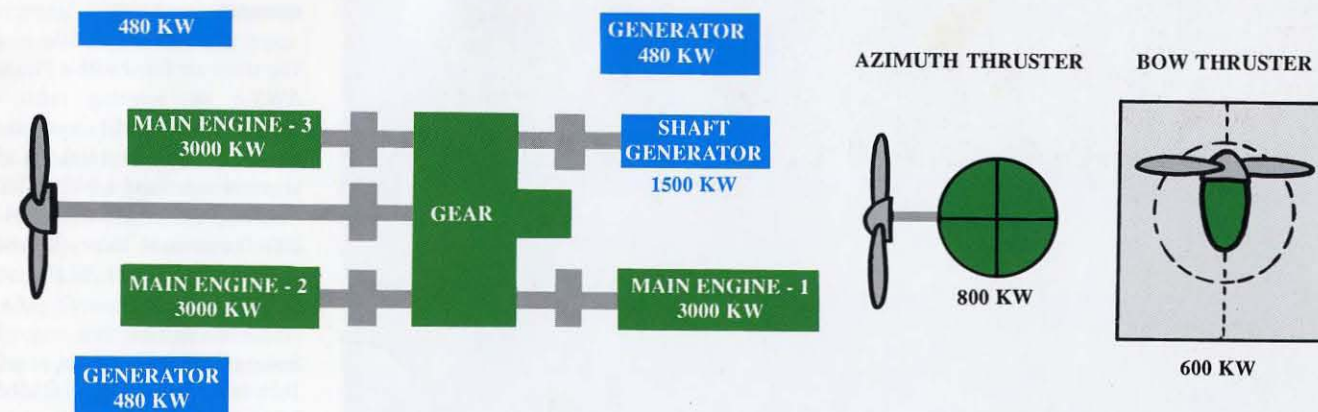
PROPULSION AND POWER LAYOUT

Configuration	Load (%) of max	Number of main engines	Speed Kn.
Max.	100	3	21.0
Max. Endurance	85	3	20.0
Displacement	76	2	17.0
Displacement	33	1	14.0
Azimuth Thruster	n.a.	n.a.	10.0

Machinery

The propulsion machinery consists of 3 MAN B&W V28/32 diesel engines with a total effect of app. 9000 KW, fitted in 2 separate watertight compartments on each side of a third compartment containing the gear. The reduction gear box is able to operate under water. The fitted bow thruster is able to hold the bow against an athwartship wind of 28 knots.

Furthermore, a retractable azimuth thruster has been installed. This thruster is able to propel the ship at about 10 knots, and can thus be considered as »get-you-home« machinery to be used in case of damage to the propeller or the gear, or total engine failure. The bow thruster and the azimuth thruster are both delivered by Brunvoll A/S.



Propulsion and power layout



Combined bridge and operation room

A shaft generator of 1500 KW, delivered by Vølund Motorteknik A/S, is located in the forward engine room, and there are 3 GM-Detroit diesel motors with Vølund Teknik generators, each with an output of 480 KW, installed with one in the forward and two in the aft engine room. Moreover, a 127 KW emergency diesel generating set is fitted in a

special compartment under the forecandle deck. The machinery is, where necessary, modified to fulfil the requirements of the Royal Danish Navy for shock resistance. It is mounted on resilient mountings.

The ships are provided with two fresh water generating plants by Esmil, each with a capacity of

15m³/24 hours. All garbage can be incinerated onboard in Team-Tec incinerators, and a purification plant of Blohm/Voss design for waste water is installed. The frigates are also provided with 2 remote controlled foam guns.

The machinery is controlled by a highly advanced and comprehensive integrated ship control

and surveillance system (SCSS) of Søren T. Lyngsø design. This system allows the vessels to sail with unmanned engine rooms, the entire installation being controlled, and technically and visually supervised, from the bridge and, if needed or desired, from other locations in the ships.

Finally, the frigates have been fitted with a computerized stability calculation system.

Electronic Equipment and Armament.

The ships are fitted with a Plessey AWS-6 air warning radar, a Terma Scantec Mil navigation radar, a Furuno FR-1505 DA navigation radar and a Nobel Tech (formerly Bofors Electronic) 9LV 200 fire control radar. Thermal Imaging Equipment (FLIR) will be installed in 1992.

Sonar equipment consists of a C-Tech hull-mounted type CTS 36 RDN, the beam of which can be turned 360° and tilted from hori-



VDS sonar

zontal to vertical, and a variable depth sonar (VDS), type Thomson Sintra TMS 2640 »Salmon«. The latter is installed and operated from under deck. An underwater telephone system has also been installed.

The ESM system is of type Racal »Mermaid« with antennas fitted in the mast and covering 360°. The system is connected to an advanced data handling system and can, with information drawn from a comprehensive »library« of electronic emissions, identify practically all known radar types.

Two gyro systems are installed. The main system is a Litton type LSN 505; the back-up system a Sperry Mk37/Anschütz type 210. The ships are also fitted with Decca, Loran and Global Positioning Systems for navigational purposes, with satellite communication systems and radio direction finder equipment.

The conventional communication equipment in the frigates consists of an extensive range of HF, VHF and UHF sets. These are controlled by an INFOCOM automated communication control system. All communication takes place from the combined bridge and operations room, where all signals are received on, or transmitted from, normal standard consoles, from which all internal communications also can be controlled. Signals will not have to be printed unless a hard copy of a special communication is needed. All signals are stored electronically.

The armament consists of one OTO Melara 76 mm Super Rapid Firing Gun with associated radar and optronic fire control, and depth charge throwers. The fire control system is of type Nobel Tech (formerly Bofors Electronic) 9LV 200 Mk 3.

All onboard weapon and equipment systems are connected through the C³ system via a Local Area Network (LAN) or Data Bus of Royal Danish Navy standard type. The main contractor for the C³ system is the Danish company, Terma.

Helicopter installations and handling equipment

Helicopter support arrangements comply with the NATO STANAGs in force for such systems. They consist of a glide path indicator (GPI), a horizon boom of 10 m length, fitted with 15 lights, visually secure white floodlights





(6 lights), 4 lights in the deck (one in each corner of the flight deck), a stop/go signal light, a transfer and restraining system and a flight refuelling system. The rails around the flight deck can be folded down and out to a horizontal position, and there are no installations over deck level aft of the danger line. The hangar is permanent and dimensioned to a »Lynx« helicopter without having to fold its tail. It can be closed by a door the full width of the hangar to provide a warm and sheltered space for helicopter maintenance.

Experience with commissioned ships

The experience gained so far with the patrol frigates of the »Thetis« class that have been commis-

sioned demonstrate that all specifications have been met or surpassed. One of the ships in Greenland waters has encountered a gale with wind gusts up to 126 knots and the sea coming in at 90°. The vessel had an almost constant heel of no more than 15° and the deck was very dry. The ships have also been able to proceed at 12 knots through 60-80 cm of solid ice with a clear wake, and they were easily maneuvered.

Possible developments

Patrol frigates of the »Thetis« class have been designed to meet special requirements formulated by the Royal Danish Navy. It is, of course, possible to meet other requirements within the existing vessel dimensions if desired.

Length small	369 feet
Breadth	47 feet
Draught	20 feet
Displacement full	3500 tons
Speed max. cont.	20 knots
Endurance	8300 n. miles
Helicopter	1 Lynx
Armament	Gun and depthcharges
Complement	60 persons
Passengers	11 persons
Provisions	4 months



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TERMA Elektronik AS



Svendborg Shipyard Ltd. is a non-subsidized Danish shipyard with over 65 years' experience in shipbuilding and ship repair. The company has comprehensive facilities for meeting the needs of navies and merchant fleets worldwide.

Based on the island of Funen, near the Kiel Canal across from Northern Germany, Svendborg Shipyard Ltd. employs about 700 people. The small but efficient shipyard is known in Scandinavia for its meticulous workmanship.

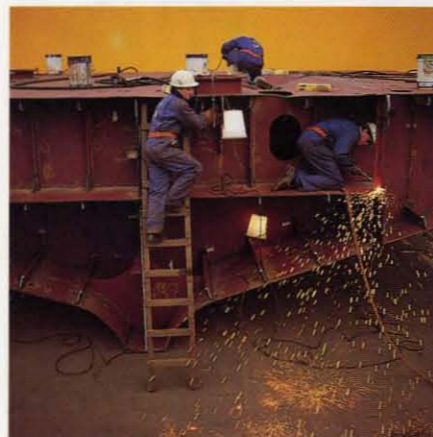
Over the past 30 years, the yard has built 22 naval vessels for the Royal Danish Navy, including most recently four Thetis-class patrol frigates.

These vessels were designed and constructed in close cooperation with the Danish Navy Materiel Command.

These multi-functional, long-range vessels are capable of operating in polar as well as tropical waters.



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The Flexible C³ System

TERMA has supplied the electronic core system that ties the ship's systems together

Techniques of the C³ system

The C³ system - also called the electronic system, the CCCI system, or the combat system - is the electronic backbone of naval ships. It is the tool by which all sub-systems on board are linked and made to interact for shipboard operations.

The system is built around two Ethernet (IEEE 802.3) data buses that operate redundantly, and a

series of intelligent nodes, which are the gateways for sub-systems to access the data-bus.

Each node contains one or more processor cards on an industry-standard VME bus. This architecture allows functional system intelligence to be distributed to the nodes, and provides an easy way of adding functions by adding extra boards and software to the node. It allows completely new functions (weapon-systems etc.)

to be added at any time by hooking new nodes to the data-bus.

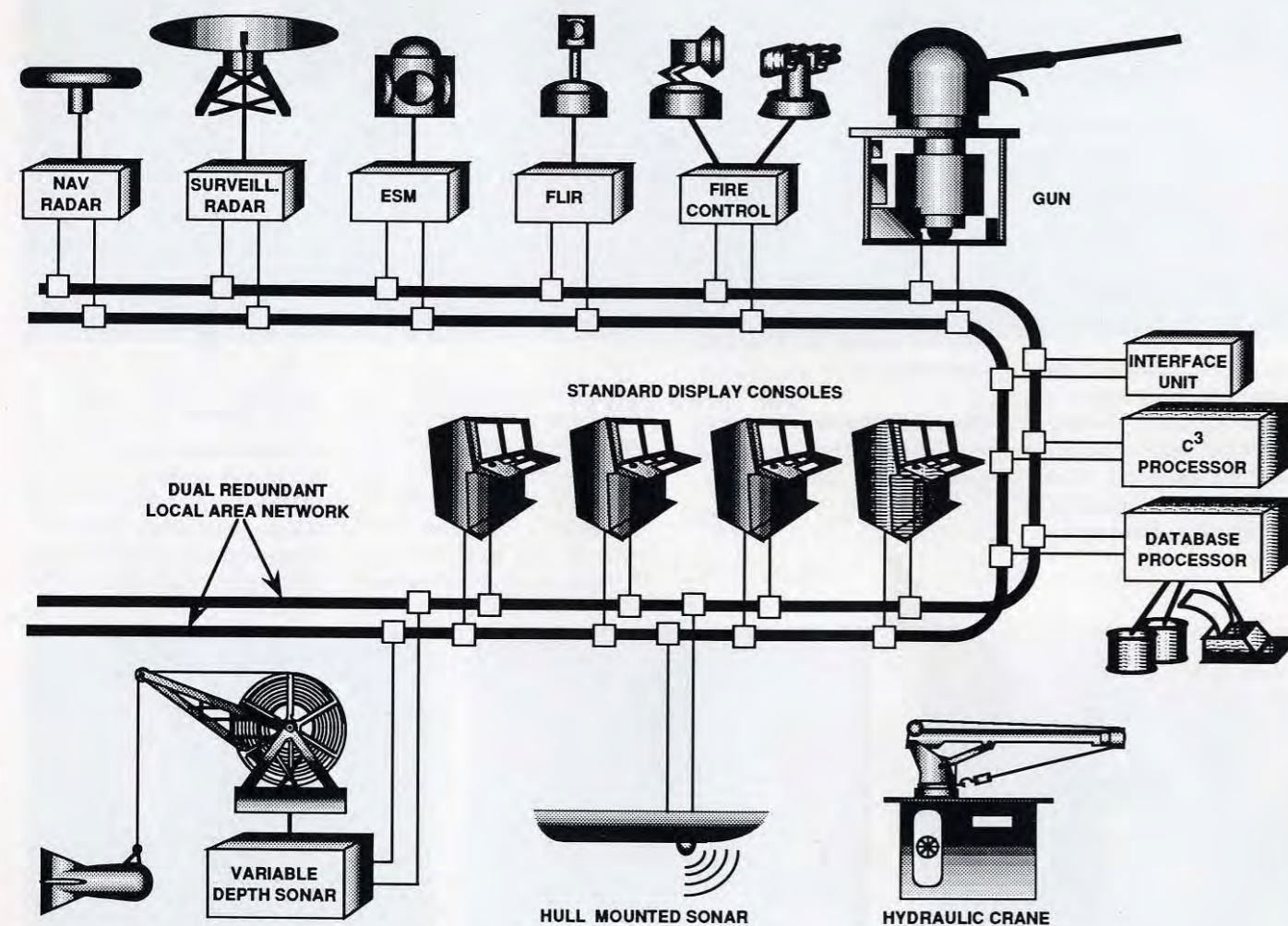
ADA Software

One of the main benefits of building a system from many processors is that it is easy to let the system have spare capacity, both in terms of processor load and memory size. This will allow the application software to reconfigure itself in case of loss of one or more nodes on the network.

TERMA is the Main Contractor of the C³ Systems, the Electronic Integration, and the X-band Radars for the THETIS-Class patrol frigates

The basis for this is the highly modular and distributed architecture of the Ada code: The applications are written with no assumptions about processor or node allocations.

All the software is written in Ada and operates in the base-system



A schematic presentation of the C³ system..

2000 developed by NobelTech of Sweden.

Standard Consoles

At the user end of the data-bus, TERMA's standard consoles provide the man-machine-interface (MMI). In general, all systems on board are operated from the standard consoles (see photo). This allows the Navy to standardize the education of operators, who no longer must be trained to use a long series of different equipment panels. The MMI for each sub-system, be it sensors, navigational aids, communications, or weapons, is embedded in the standard console.

Easily adaptable MMI

The MMI is created around a concept of "MMI-Objects" - an advanced mechanism that allows specification and implementation of applications without imposing any restrictions on how the MMI is configured. The tools for producing MMI-features allow changes without actually changing the basic Ada code. This provides a standard console that is easily adapted to existing practices and procedures, and which is easily amended after a period of experience with a new application.

The standard console has a double set of screens for presentation of radar/video, synthetic colour graphics, text-totes, RBG-sonar pictures, and TV/IR-video from cameras, and includes many possibilities of swapping the various types of display between the two screens.

Two touch-sensitive programmable keyboards provide the hierarchy of menus linked to the various systems that must be controlled. Rollerballs provide the cursor operations, and a QWERTY-keyboard allows text entries.

Each standard console can be configured to operate all existing features in the system - and can be reconfigured during operation. Operator passwords are used to



TERMA's standard console selected for the THETIS-class. The console is available in several housing configurations.

safeguard restricted functions or information.

The system is too vast to be described in this document, but an example can be given. Via the interface to the communication system, operators can control all

communications on board, channel switching, sub-station allocation, emission policies, and message handling. No paper messages need be circulated on board - every addressee may receive his message on the screen whenever he requires it!



TERMA ("Dansk Radio") has also supplied the antenna tuners (TU 4015), synthesizers (SE 4010) and the HF-receivers (RX 4010) (shown above) for the THETIS-Class.

Company Profile

TERMA Elektronik AS is fully owned by the Thomas B. Thrige Foundation.

TERMA's main businesses are radars, display systems, C³ systems, system integration, radar and EW-avionics, ballistic instrumentation, HF radio equipment, electronic modernization programmes, and logistic support.

The company has high technological standards and carries out development and production in compliance with MIL Standards and AQAP-regulations.

The company facilities include well-equipped electronic laboratories and antenna test range, a test firing range for small arms, and frequency shielded software laboratories for classified production plants.

TERMA has a highly qualified staff of 450 and sales of about DKK 400 million per year.

The main facilities are in Lystrup near Aarhus. A development and sales facility is located in Tåstrup near Copenhagen, and a sales subsidiary (TERMA Inc.) has an office in Washington DC, USA.

TERMA creates electronic solutions for professional customers. We have a strong programme management tradition, and the three services of the Danish Armed Forces have been among our main customers for many years.

We provide solutions !

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INFOCOM ELECTRONICS

The THETIS-class patrol frigate continues the new era in automation and integration of shipborne systems for navigation, maneuvering, surveillance, information, and communication.

The concept, design, and highly technological communication system are substantial contributions to "the revolution of the sea". The project is a source of inspiration for new concepts in the accelerating development of naval technology.

The INFOCOM group developed, produced, and installed the THETIS-class integrated information system, which is based on a digital fiberoptic switch with digital multipurpose subscriber stations. This system handles all internal and external communications including data link and message handling for the ship's C³ system.

INFOCOM's unique design of the system's digital switch, which uses the newly developed PDM (Parallel Digital Multiplexing) principle, makes it possible for up



to 512 channels to be connected at random. The mechanical dimensions of the switch are about one fifth of a conventional analogue switching system.

Since the communication system is an integrated part of the ship's C³ system, it is possible to control it from the ship's standard weapon consoles. It may also be used as a stand-alone system, if necessary.

INFOCOM's communication processor, which is also part of the THETIS-Class inventory, is designed to meet TEMPEST requirements. It contains the programs for the communication system, the application software, and all functions related to a modern message handling system, including message generation, and radio channel and crypto management.

The software for the communication processor was developed with CASE tools and coded in Ada. The total software package has more than 170,000 lines of Ada-code.

Apart from the modules described above, INFOCOM developed a complete public address system, rules of the road generator, different crypto interfaces, automatic antenna switches, and a dual 16 x 16 audio/data/morse switch for the THETIS-class communication system.

INFOCOM ELECTRONICS

Since its start in 1982, INFOCOM ELECTRONICS A/S has earned a reputation as a company that solves complicated problems of development and production of electronic systems for communication, for presenting information and for interfacing subsystems that must operate as an integrated system.

Following design and development, INFOCOM's production consists primarily of assembly and final testing, as its policy is to have parts and modules supplied by subcontractors. To meet the high level of quality and performance required, INFOCOM subjects all subcontractor deliveries to rigorous quality control prior to use.

Achievements

From the beginning, INFOCOM has been engaged in both the domestic and export markets. The first products developed and delivered by INFOCOM were for civil use. They included mobile telephones and information systems based on light emitting diodes, liquid crystal displays and light bulbs, in both standard and custom-made displays. Later, there followed integrated information and communication systems and electronic processing systems for industry.

However, INFOCOM had not existed for long before it entered the field of electronic defence equipment.



Tasks carried out for the land forces have so far ranged from communication recording and processing systems to electronic control systems for multiple target arrangements used at combat firing ranges.

INFOCOM's qualifications have probably best been displayed by its naval contracts. In 1981 the Royal Danish Navy ordered from Thomson CSF of France as prime contractor a C³I-system to link shore based headquarters and ships. For this system, designated FOD CCIS (Flag Officer Denmark Command, Control and Information System), INFOCOM was awarded a contract for the communication part, and later also a contract for automatic data transmission between the headquarters and a number of coastal radar stations.

In 1986, on completion of the contracts, INFOCOM, in collaboration with another Danish company, received a software life-cycle support contract for the entire FOD CCIS.

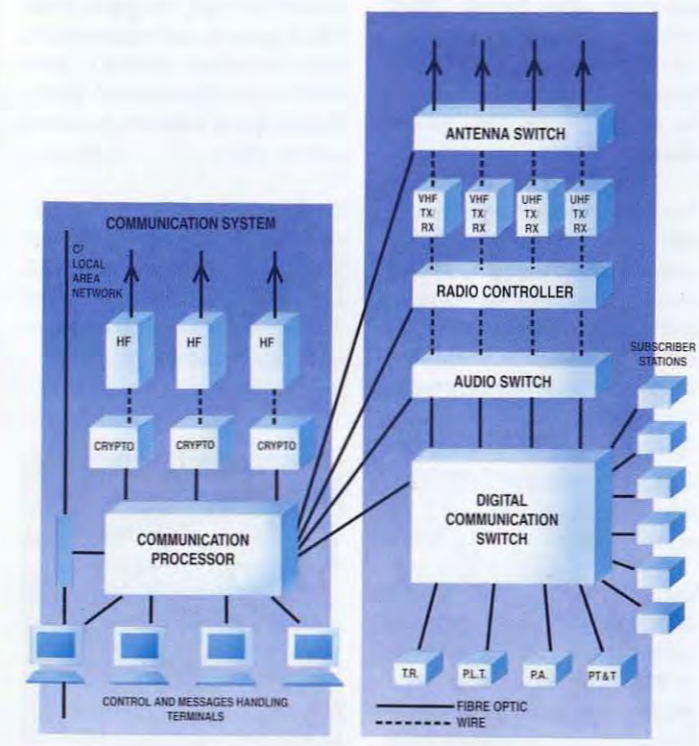
Commitments and prospects

The contract to develop and supply the communication system for



the THETIS-class patrol frigate is INFOCOM's latest major naval contract.

The communication sub-bus is based on fibre optics, operates fully digitally and comprises all external and internal communications, including a data link for the C³-system, with which it is integrated.



ADA is the main programming language, and an HP 9000 structural software analysing case tool has been acquired. Additional supporting facilities for proper



software engineering are being installed.

With such means added to INFOCOM's other advanced facilities, such as CAD/CAM, the staff, the company's most important asset, look confidently forward to new demanding tasks from the Danish and other friendly armed forces. Along with communication and information systems, INFOCOM's product range includes simulators and interface units, which allow customers to make cost-effective "mix and match" and still obtain integrated systems.

INFOCOM ascribes much of its success to its practice of decentralised management. Each member of the staff is motivated by having full responsibility and the necessary authority for solving his or her tasks.

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Ship Control and Supervisory System

Operating the complex propulsion plant of the Thetis class would be complicated if done in the traditional way. And it would require unacceptably high manning.

Instead, the Naval Materiel Command and Lyngsø-VALMET Marine cooperated closely to create a comprehensive, fully electronic control and supervisory system, based on decentralized processors and heavy reliance on software.

All propulsion elements and auxiliary machinery are operated from a bridge console, eliminating the need for permanent engine room manning.

A duplicate console in the machinery control room is used mainly for servicing, but also provides redundancy. Both consoles are driven by two independent, synchronized display processors. A dual Ethernet network connects them to outstations. The system is independent of, yet integrated with, the main bus-system that connects sensors, C³-installations and weapon systems.

Each outstation is a self-contained unit with up to eight independent STELLA processors. The two display processors have configuration control, and perform automatic down-line load of new code into an outstation processor if necessary. The system has been designed for easy updating and introduction of changes, and for graceful degradation.

The number of modes of operation is limited to those sufficient to serve basic purposes. Control from the various positions is exercised through standard command signals.



Consoles for the Machinery and Propulsion Plant Control and Alarm System

The various machinery items are placed in groups such as:

- propulsion machinery on-line,
- propulsion machinery off-line,
- power generation,
- fluid treatment and transfer,
- ventilation,
- damage control etc.

This grouping keeps more than one person from simultaneously commanding a part of the system, yet allows different crew members to control different independent parts of the system simultaneously.

A special procedure ensures safe and unambiguous transfer of control. Machinery is controlled, through hardwired connections to on-plant inputs or servo setpoints,



STELLA[®] computer outstation in the engine room

from a separate control panel in the control room and from back-up systems on the bridge.

The ship is handled from the main ship's handling panel at the front of the closed bridge/ops-room, from wing panels on either side, or from the crew's nest. When the system is in cruise mode, the autopilot will normally be connected. Course is changed either by using a course pre-setting instrument at the main panel or by activating the turning knob mounted on all four panels.

Each wing panel also has levers for azimuth - and bow thruster control.

The navigator uses a joystick to indicate a vector force that the system transforms to rudder, bow- and azimuth thruster and engine commands. Thus the navigator is relieved of calculating how he can make the best use of

three propellers and the rudder under various conditions.

Ship Intercom System

The ships are equipped with the Amplidan PA System (model 6700). This system has proven safe and efficient under the most severe conditions, and meets the requirements of the Royal Danish Navy's shock test. The modular rack system, with a built-in microphone, has 5 control boxes located around the ship from which general messages can be issued. An alarm module is built in. For crew entertainment, the PA System has a radio receiver and cassette player.

Two-way communication between certain locations aboard are carried out through the Amplidan Talkback System (model 1500 MkI). This system also meets shock test requirements.



Amplidan command and talkback control station for internal communication

Company Profile

Lyngsø-VALMET Marine, part of the Søren T. Lyngsø Group, was formed in 1991 by merging Lyngsø Marine, Valmet Automation and Amplidan. Lyngsø-VALMET Marine has offices in Norway and Denmark, where the expertise of these marine suppliers is available to customers worldwide.

SØREN T. LYNGSØ A/S began in 1952 as a one-man operation, and has grown steadily. The company has a strong worldwide reputation as a designer, developer, and producer of computer-based systems for controlling complex processes.

Lyngsø-VALMET Marine headquarters, near Copenhagen, house the R&D, administration, sales and marketing functions, and extensive training facilities.

Production takes place at a modern, 25,000 sq.m. factory in Aars, Denmark. The annual output of more than 125,000 computer boards goes mainly into the company's versatile STELLA process computer – a key part of the systems produced by the firm.

Manufacturing, development, and systems engineering meet the requirements of the company's ISO 9001 Quality Assurance Programs, which have been certified by the International Standards Organisation.

Søren T. Lyngsø Group has over 500 employees in Denmark. Lyngsø has sales and service agents in more than 45 other countries.

The company is engaged both on land and at sea.

On land

Lyngsø systems in power plants control not only output and distribution, but also production economics and environmental behaviour.



View from the Bridge with Consoles to the left containing workstations for the Ship Control and Supervisory System and to the right for controlling the Propulsion and Maneuvring System

Bridge Wing Control Station

Lyngsø also produces systems for remote control and monitoring of other networks, such as those that distribute district heating, water and gas, and those that collect, purify, and dispose of waste water.

And, Lyngsø has in recent years delivered over 100 systems that control sorting plants in post offices, department stores and airports.

All Lyngsø systems use high-resolution colour graphic displays whenever applicable. Lyngsø systems are user-friendly, flexible, and reliable. Data exchange between system units is possible via power lines, telephone and data lines, or fibre-optic cables, as appropriate.

At sea

For over twenty years, Lyngsø has cooperated with shipyards, shipowners, engine manufacturers, marine consultants, and research institutions to be in the



Over 5,200 ships worldwide use Lyngsø-VALMET Marine automation or surveillance systems.

AMPLIDAN products operate worldwide within Amplidan's traditional field of high-quality electronic communication equipment. The range includes talk back, public address, fog bell and gong, and aerial systems for maritime and off-shore applications. Amplidan also produces radio beacons, for maritime and aeronautical navigation systems, that meet international standards.

AMPLIDAN's portable, mobile and stationary electro-acoustic alarm systems have a variety of features. The systems have proven themselves in military and civil applications where demanding physical and acoustic conditions prevail.

Advice and technical services are available from

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front line of marine automation development.

Lyngsø-VALMET Marine Automation Systems include bridge maneuvering systems, governor systems, and equipment for analysing diesel engine performance. Alarm and supervisory systems, integrated control systems, power management systems and complete bridge and engine control room consoles are also part of the product range.

Equipment for standard automation, and systems for integrated ship control, use either the LYNGSØ STELLA or the VALMET datamatic computer concept. These systems have been type approved by all major classification societies for the harsh marine environment, and will continue to be available to the demanding shipowner.

The marine systems are designed with an Open Automation Architecture so that they can interface readily with other onboard systems.

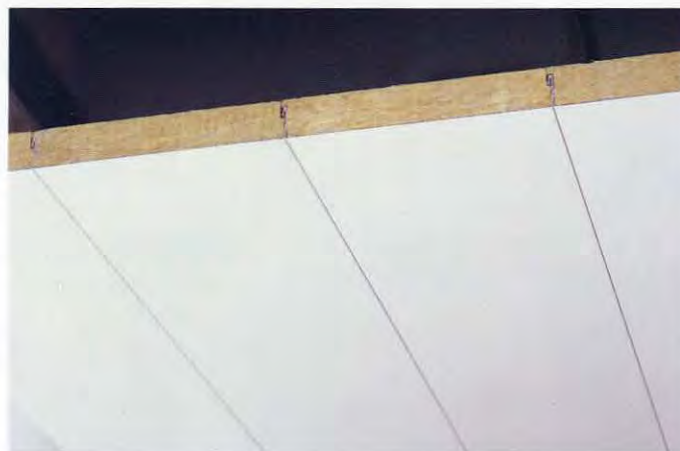
During the past 20 years, TNF Marine Products have been widely acclaimed and installed on more than 2000 civilian vessels, including cruise liners, merchant vessels of all types and sizes, work boats, and offshore platform accommodation and production modules.

Navy ships have also been fitted with TNF accommodation during this period, ranging from frigates, inspection vessels and mine-hunters of the Royal Danish Navy, to torpedo test crafts, oceanographic research ships, surveillance ships, and sealift/prepositioning ships of the U.S. Navy.

Rockment A/S is a member of the ROCKWOOL Group, operates 14 factories in Europe and North America, and employs more than 5000 people. We have an experienced staff of naval architects and engineers to offer assistance with product application, design, layout, and methods of installation.

The technical services department can help architects and engineers by creating design proposals of their actual projects using a 3D CAD system. The drawings are used by the contractor to ensure correct installation.

Rockment and its subsidiary are represented worldwide to offer assistance to owners, consultants, and shipyards.



Ceiling

TNF Marine Products

TNF's assortment of prefabricated panels includes

- TNF Bulkhead Systems
- TNF Ceiling Systems
- TNF Floating Floor System

The assortment ensures low maintenance for accommodation quarters on ships, and is continu-



Cabin



Wet room

- Application of low noise sources
- Design of low noise cabins

High sound reduction is where the Rockment products excel. When correctly installed, TNF low noise cabin designs offer maximum quiet and comfort, and reduce unwanted structural and airborne sound to a lower level than any other product can achieve.

Appearance

TNF accommodation surface finishes have been developed and tested as much for durability and appearance as for insular and fire-proof properties.

ously being improved by new technical processes.

TNF

TNF means:

- Thermal Insulation
- Noise Reduction
- Fire Protection

TNF Panel Systems are designed for conventional or completely modular arrangements, and meet all requirements for low weight, easy and quick installation, and pleasing appearance.

Fire Protection

TNF Panel Systems are approved by the world's major authorities and classification societies, meet the latest safety regulations of B15 and A60 standards, have been shock-tested by Varo in Dallas, Texas, and approved by the U.S. Navy.

Noise Reduction

TNF Panel Systems give greater comfort, because the core of mineral wool produces higher thermal benefits and superior noise reductions up to 44 dB, all within a single 50 mm thick wall construction.

Three parameters determine the noise reduction:

- Ship layout



Rockment has conducted years of research in new surface material for accommodation. The aim has been to develop surface finish material that, in case of fire, *does not damage electronic equipment* or emit hazardous fumes, and that at the same time is sufficiently resistant for normal shipboard use. *TNF PACIFIC has all the qualities to set a new safety standard at sea.*

Rockment®

Marine Division

Rockment A/S
 Hovedgaden 483
 DK-2640 Hedehusene
 Denmark
 Telephone + 45 42 16 37 00
 Telefax + 45 42 16 04 66
 Telex 43107 rocm dk

Alpha Complete Propulsion systems – proven reliability.

The works

MAN B&W's Frederikshavn works, known as ALPHA, are a modern factory with a total floorage of 32.000 m² for production, design, development and administration.

The products

Our aim is to produce complete propulsion systems for all types of ships. ALPHA key words are high quality, reliability and durability.

Our product range includes propulsion systems from 850 to 5.330 bhp, based on MAN B&W's 4-stroke medium-speed engines of the 23/30A and 28/32A series.

The reduction gear programme consists of gearboxes with reductions from 3:1 to 7:1 each with a built-in servo for the CP propeller, and ALPHATRONIC remote control system.

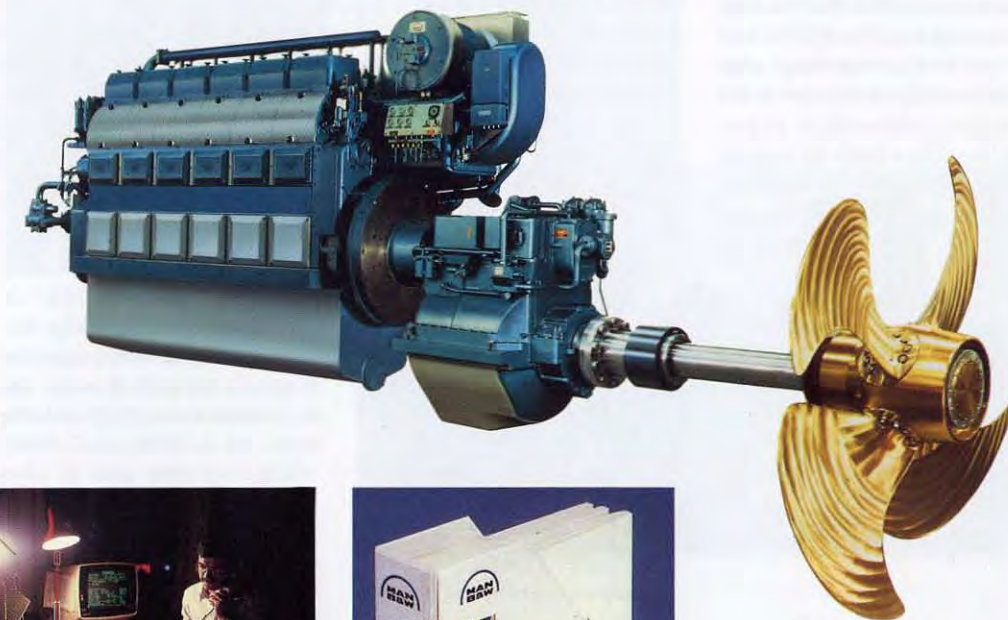
We also make larger VB/VSA and VBS-type CP propellers and the associated remote control system ALPHATRONIC IIA. We offer these as separate products in the range of 3.000-27.900 bhp.

World-wide after sales service

ALPHA's service organization in Frederikshavn, and MAN B&W Diesel's world-wide service network, are available 24 hours a day, 365 days a year.

In addition, ALPHA has a large team of well-trained service engineers who travel world-wide.

Further, ALPHA offers tailored training programmes in maintenance and repair.



MAN B&W Diesel A/S
 Alpha Diesel
 Niels Juels Vej 15
 DK-9900 Frederikshavn
 Telephone +45 98 42 10 00
 Telefax +45 98 42 32 00





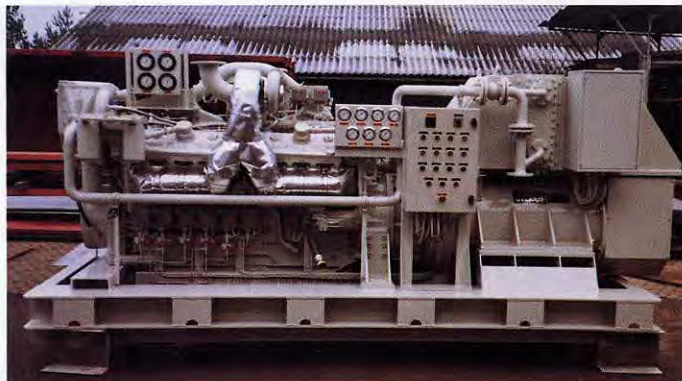
Since 1972 we have supplied a large number of specially constructed diesel generating units and main propulsion systems for many Royal Danish Navy vessels. One series is the new Thetis class patrol frigate.

Vølund Motorteknik's experience in the development of auxiliary systems for various classes of ships qualified it for collaboration with Svendborg Shipyard Ltd. for delivery of the main and emergency generating sets for the Thetis class.

THE DELIVERY for each ship includes three main generating sets, each 480 KW, and one emergency unit, 127 KW. The main generating sets TS-16V71T, with A. van Kaick watercooled alternators, supply the vessel with 450

volts power. The units are equipped with all necessary control and alarm systems for remote operation from the central control rooms. The main units can be operated either by the automatic load sharing synchronizing system, or manually, depending on the ship's power demand or mode of operation. In special situations the ship can be propelled by use of the azimuth thruster system, powered only from the main generating sets. During normal operation the 1400 KW shaft alternator will be driven via power take-off on the main propulsion engine gearbox.

EMERGENCY UNIT TS-671N at 127 KW is connected only for emergency supply and starts automatically in case of mains failure. The unit, including the emer-



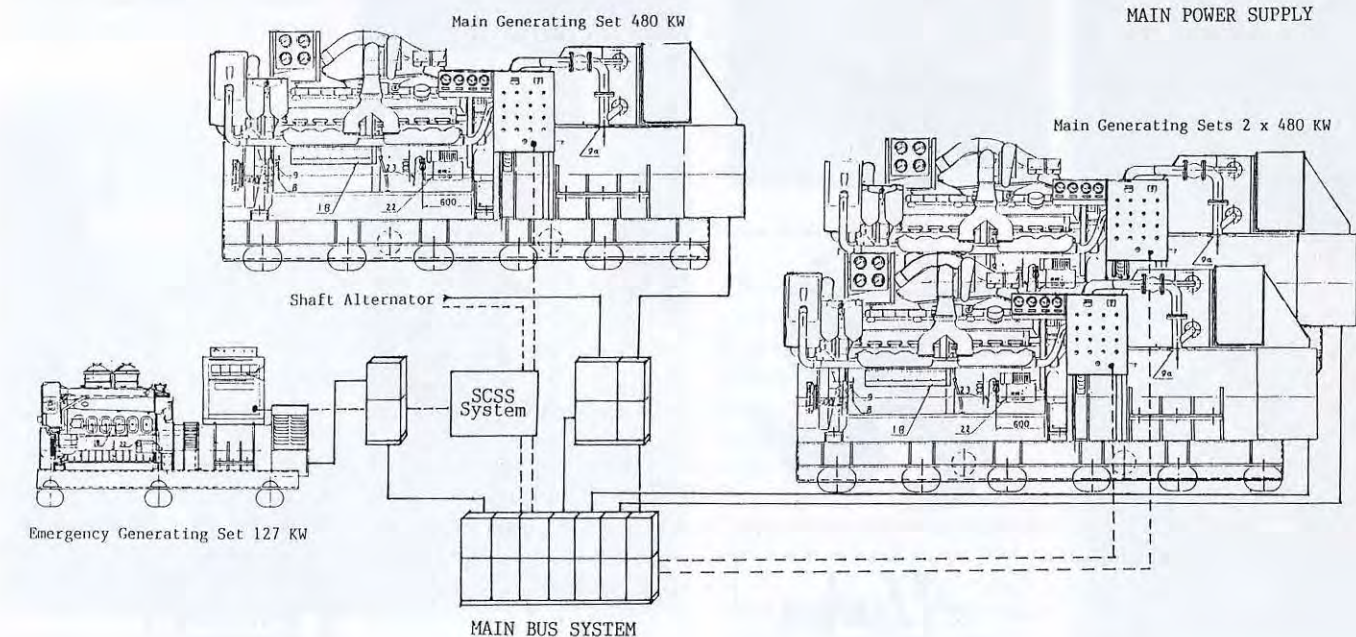
gency airstart compressor and switchboard system, is placed in the forward section of the vessel.

DETROIT DIESEL ENGINES are manufactured for a wide range of applications, including marine service for the Royal Danish Navy as well as numerous other navies all over the world. For propulsion and auxiliary duties, these moderate to medium powered engines are highly acclaimed for reliability and economy.

The product programme from VØLUND MOTORTEKNIK also includes ALLISON Gas Turbine Systems for main propulsion system, power supply units, and as heat-power supply plants in the range of 3.5MWe - 7 MWe, which have been used in naval ships, offshore and onshore sec-

tions, and in specialized applications in industrial and public processing plants.

VØLUND MOTORTEKNIK A/S
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Thetis class Patrol Frigates:

The Patrol Frigates are fitted with a Brunvoll 660 kW C.P. Bow Thruster and a Brunvoll 800 kW C.P. Retractable Azimuth Thruster. Both thrusters are driven electrically by constant speed squirrel cage electric motors.

The azimuth thruster was designed by the Brunvoll engineering team especially to suit the limited space available on the vessel. When retracted, the azimuth thruster is stowed in a trunk inside the vessel, and the bottom opening closed by a flush plate.

The bow thruster provides harbour maneuverability. The azimuth thruster gives both maneuverability and auxiliary propulsion when loitering, on patrol, or in emergency take-home situations.

The azimuth thruster can provide a vessel speed of over eight knots.

Brunvoll A.S.

Brunvoll, A.S. is one of the world's foremost producers of thruster systems.

Backed by more than 75 years of marine propulsion experience, the company's thrusters are exported on an ever-increasing scale for installation in a growing number of ship types. These include fishing craft, roll-on/roll-off ships, tugs, offshore support ships and vessels for dynamic positioning.



CP Tunnel Thruster for Electrical Drive



800 Kw Retractable CP, Propulsion Thruster during testing.

The company started in 1912 as a manufacturer of marine engines and controllable pitch main propellers. Thruster systems have been its main product since 1965.

Bow and Stern Thrusters

Brunvoll makes conventional tunnel thrusters from 25 to 2000 hp, with controllable or fixed pitch propellers.

Azimuth Thrusters

Brunvoll also makes azimuth thrusters. They are designed for main or auxiliary propulsion and maneuvering with 360° continuous turn. They feature controllable or fixed pitch propellers.

Brunvoll azimuth thrusters can be mounted either inboard or outboard, and are intended for use on tugs, ferries, barges, floating cranes, special vessels with dynamic positioning, and vessels for inland waterways or other waters with draught limitations.

Propellers come in a wide range of diameters, with or without nozzle.

Finally propeller and nozzle designs are tailored to each vessel.

Drive and control systems

Brunvoll also makes complete drive and control systems individually tailored to each vessel. High pressure hydraulics, direct diesel and electric drive systems are used as required.

Thrusters are remote-controlled from the bridge. Control systems include electronic-hydraulic follow-up steering and emergency electric impulse steering.

Brunvoll thruster controls can be connected to auxiliary control panels at additional locations, integrated remote control systems and dynamic positioning systems.

Elastic Suspension of Tunnel Thrusters

Brunvoll's noise suppression technology for tunnel thrusters reduces noise by 12-15 db(A). Special features include a double tunnel system with full length elastic

tunnel suspension, and separate seals and damping elements.

Service

Brunvoll sends spare parts swiftly to any part of the world. Highly-qualified service engineers are quickly available whenever required to tackle difficulties with equipment in service.

Brunvoll's service arrangements include individual sales consultancy, after-sales engineering, follow-up with shipyards, and direct service to shipowners and other users of its thruster systems. Our engineers are prepared to answer any enquiry about Brunvoll thruster equipment.

BRUNVOLL A.S.
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6401 Molde
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The propeller for the Thetis class was designed, model tested and manufactured at KaMeWa. The propeller was optimized to give the best possible performance over the entire range of operation, from the MCR condition down to 7 per cent of the MCR power, at reduced shaft speed and reduced pitch/diameter ratio.

The blades of the 4-bladed propeller are featherable, i.e. can be set at a 90° pitch angle for minimum resistance when the vessel is propelled at low speed with the azimuth thruster. The high-skew blade shape was developed especially for controllable pitch propellers by KaMeWa, to ensure a low hull vibration level.

The model test was performed in the conventional tunnel of the KaMeWa Marine Laboratory. The test consisted of two parts,

- an »open water« test, with the propeller alone at several pitch ratios, determined the propeller efficiency

- a test in the behind condition, with the propeller working in a simulated wake field behind an afterbody dummy. The cavitation pattern was observed, and propeller-induced pressure pulses acting on the hull plating were recorded. Based on the behind test a slight modification was made to the blade design.

KaMeWa AB in Kristinehamn, Sweden, started in 1849, making steam locomotives and boilers. About 1870, the company began making water turbines, a product programme that was extended around 1920 to include pitch controlled Kaplan Turbines. The experience from the Kaplan Turbines was used to develop a controllable pitch propeller, and the first KaMeWa propeller was delivered in 1937.



Jet propulsion systems

thrusters, water jet propulsion systems and related electronic control systems.

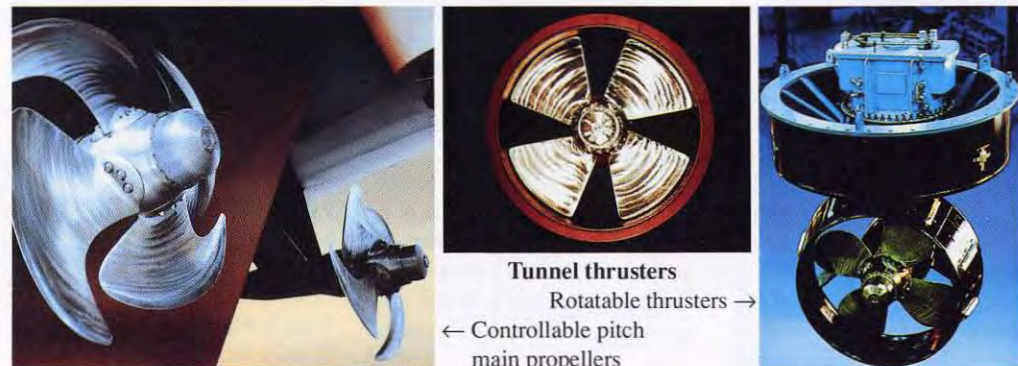
After many years within the Swedish Axel Johnson Group, KaMeWa AB was in 1986 acquired by Vickers PLC in Great Britain and their marine engineering division. Other business areas within Vickers PLC are the famous Rolls-Royce and Bentley cars, defence activities, a medical division and a number of other activities.

One of the most important factors behind the success of KaMeWa's marine products is the high quality strategy, not only for mechanical design and production, but also in the field of hydrodynamic design and development. The first hydrodynamic laboratory for water turbines was built in 1906 and the first marine

laboratory in 1945. The present modern laboratory, with two cavitation tunnels, is one of the most advanced privately-owned facilities in the world for propulsion technology research. This laboratory has, for example, strongly contributed to the development of highly skewed blades on controllable pitch propellers and the development of the KaMeWa water jet propulsion systems, which dominate the market. KaMeWa also designs and produces electronic control systems for its product range. The latest development is a control system based on a microprocessor.

To meet the demand for quick and reliable service KaMeWa has a worldwide service organization, with service engineers educated at KaMeWa's training school in Kristinehamn. This facility also provides training for the crew who will use the products onboard.

KaMeWa AB
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Telefax +46 550 181 90



Tunnel thrusters
Rotatable thrusters →
← Controllable pitch main propellers



DESMI PUMPS – Genuine Marine Pumps

Each of the Thetis class has been equipped with 50 centrifugal pumps from DESMI.

These pumps have been manufactured according to the shock resistance requirements specified in NMG-PS 2.

The DESMI pump range covers most marine applications including: Seawater and freshwater cooling pumps, deckwash pumps, fire-fighting pumps, and bilge and ballast pumps.

The DESMI pump range includes:

MODULAR V-Vertical in-line centrifugal pumps, with spacer coupling or close-coupled.
Capacity range up to 300 m³/h.
Pressure range up to 140 mWC.

MODULAR 5-Horizontal self-priming centrifugal pumps, also in close-coupled design.
Capacity range up to 400 m³/h
Pressure range up to 150 mWC.

MODULAR H-Horizontal end-suction centrifugal pumps,

also in close-coupled design.
Capacity range up to 280 m³/h.
Pressure range up to 90 mWC.

SL-Vertical in-line centrifugal pumps with spacer coupling or close-coupled.
Capacity range up to 1600 m³/h.
Pressure range up to 220 mWC.

DKVAZ-Vertical in-line centrifugal pumps.
Capacity range from 500 to 1800 m³/h.
Pressure range up to 80 mWC.

The DESMI range of products also comprises gearboxes and oil recovery equipment for combating oil pollution at sea.

More than 50 countries protect their environment with DESTROIL skimmer systems.

DESMI has been active within the marine market for more than a century. DESMI pumps can be bought and serviced in more than 40 countries.

A/S De Smithske
Tagholm 1
P.O.Box 226
9400 Norresundby
Denmark
Telephone: +45 98 17 81 11
Telefax: +45 98 17 54 94
Telex: 6920 desmidk
Cable: DESMI DK



Automatic Valve Controls

The SCS system for total ship operation requires the use of many remote controlled valves in the following sub-systems:

- Seawater cooling system, main engine
- Fuel oil system
- Bilge system
- Ballast system
- Fire and deck wash system

The valves that NORDISK MARINE HYDRAULIK A/S supplied are actuated hydraulically.

Power is supplied by two hydraulic power packs, via two ring mains arranged so that all valves can operate even if one of the mechanisms fails. If the hydraulic mechanisms fail, the SCS system automatically switches to back-up valve control arrange-

ments. This change-over can also be made manually.

Hydraulic Actuation of valves

Actuators can be delivered for all types of valves – butterfly, ball, gate and globe valves, etc. – with or without mechanical/hydraulic emergency operating devices.

All models are prepared for mounting of hydraulic control blocks and indicating systems (hydraulic and electric).

The actuators meet all present classification society requirements.

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Telex: 40 124 marin dk
Cables: Marinehydraulik





Air Conditioning and Ventilation of the THETIS class

As one of our latest major naval jobs, NOVENCO HI-PRES participated as consultants in the design and supply of equipment in our field for the THETIS class. For the THETIS class, we have delivered among others the following equipment and services:

- Air conditioning plants, incl. automatic control
- Ventilating plants for engine rooms, etc.
- Fire dampers
- Cooling plants
- NBC-protection plants
- Working drawings for installation
- Cooling systems for electronic equipment
- Coordination between the air-conditioning and SCS systems

During the last 39 years, HI-PRES has been the main supplier of air conditioning, ventilation, cooling, and NBC-protection plants for newbuildings and conversions for the Royal Danish Navy; in addition to equipment for a great number of foreign navy ships.

Recently, we also delivered for a foreign navy a number of cooling systems specially designed for new electronic equipment installed in existing ships.

Consequently, NOVENCO HI-PRES has the capability to plan, design, procure, deliver, test, and commission a full range of tailor-made systems and equipment, including special requirements for shock resistance, antimagnetic



execution, and NBC-protection as »change over« system as well as »constant sealed« system.

HI-PRES Systems

NOVENCO HI-PRES designs conditioning plants and ventilation systems for all kinds of ships and offshore constructions – from the largest to the smallest units.

NOVENCO HI-PRES specializes in climate control under extreme conditions ranging from hot summer to arctic winter.

The objective is to create and maintain optimum climatic conditions in the accommodation of both passengers and crew.

All kinds of air conditioning requirements are met by the following three systems, which provide individual temperature control in each cabin:

· The SINGLE-PIPE system with its simple design provides fresh and cooled air under tropical conditions and heating when operating in temperate and cold

zones – a type of system which is found aboard thousands of oil tankers, multipurpose carriers, bulk carriers, etc.

· The TWIN-PIPE system meeting more sophisticated requirements, is mostly used aboard passenger ships and yachts often with fully automatic, individual control in the cabins.

· The RE-HEAT system is specially designed for ships sailing in temperate and arctic zones, but is also suitable for tropical operation. This system was chosen for the THETIS class.

NOVENCO HI-PRES is the solution when small duct dimensions are required, and individual control in each cabin is required. The low sound level of the HI-PRES systems, together with the continuous development of sound reducing measures, will also fulfil the requirements of tomorrow.

In cruise liners, passenger ships and yachts, the air conditioning system has a high priority. Generally, the requirements for interior conditions are greater than those for cargo vessels.

The TWIN-PIPE system is the solution for cabin areas. For public compartments, the low-pressure VAV system (Variable Air Volume) comprises VAV air handling units, and a zone-divided low-pressure rectangular duct system with grilles and diffusers integrated in the ceilings. This system is perfect for large

rooms, such as dining areas, lounges, TV-rooms, and halls.

To reduce energy costs as much as possible, the HI-PRES enthalpy exchanger system is recommended for both cabin and public areas.

NOVENCO HI-PRES A/S

Since we invented the high-pressure air conditioning system in the early fifties, an amazing de-



velopment in ship design and ship technology has taken place.

Being a leading company within marine air conditioning ventilation and fire fighting NOVENCO HI-PRES has an obligation to be in the forefront of development within our field.

HI-PRES activities were separated into an independent limited liability company, NOVENCO HI-PRES A/S, after the acquisition of Semco Marine (G.W. Ventilation). NOVENCO HI-PRES A/S is owned by NOVENCO A/S, which is part of the Danisco Group. Danisco is one of the largest industrial groups in Denmark.

NOVENCO HI-PRES utilizes the latest technology when developing our products and systems.

Today, NOVENCO HI-PRES has a worldwide organization ready to serve the more than 7,500 ships we have equipped with our systems. We are also ready to serve shipowners and shipyards who want to put new ships into operation equipped with highly reliable air conditioning, ventilation and fire-fighting systems. The

Mechanical Engineering

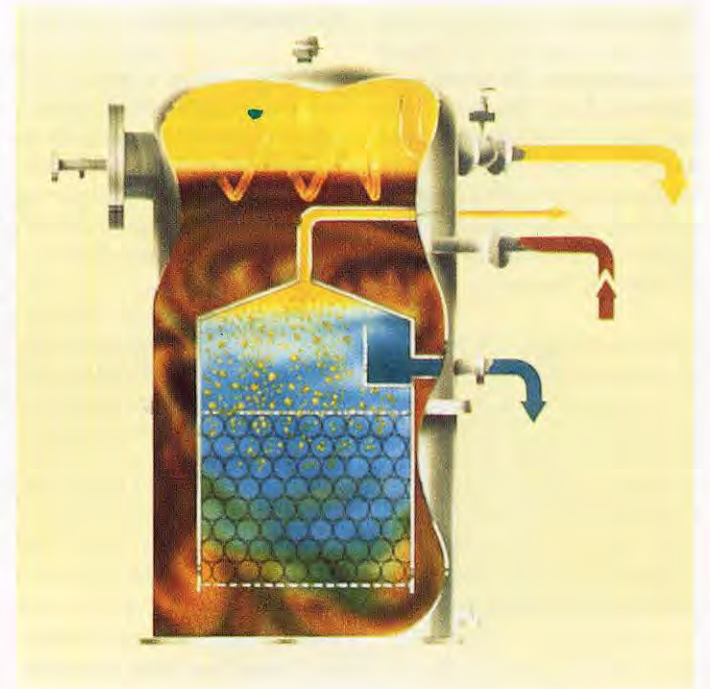
Plants and systems for shipbuilding, an important part of the BLOHM + VOSS production program

BLOHM+VOSS SIMPLEX COMPACT folding fin stabilizers, type SK10-3.6m2, and TURBULO oily water separators, type TPC 2.5, are operating successfully in the new IS 86 Fishery Inspection Vessels of the Royal Danish Navy.

SIMPLEX COMPACT fin stabilizers decisively increase operating capacity of naval units and weapon systems, and increase crew endurance, regardless of weather conditions.

Special features of the SIMPLEX COMPACT fin stabilizer system include:

- Compact design
- Minimum space requirement
- Low weight and low noise level
- Economic power consumption
- Simple service and maintenance
- No electric or hydraulic peak loads



The system is also ideally suited for subsequent installation

This TURBULO oily water separator without filter elements has been tested and approved in accordance with IMO Resolution A.393 (X). Residual oil content in the effluents well below 15 ppm.

The special features of the TURBULO TPC system are:

- Highly reliable operation

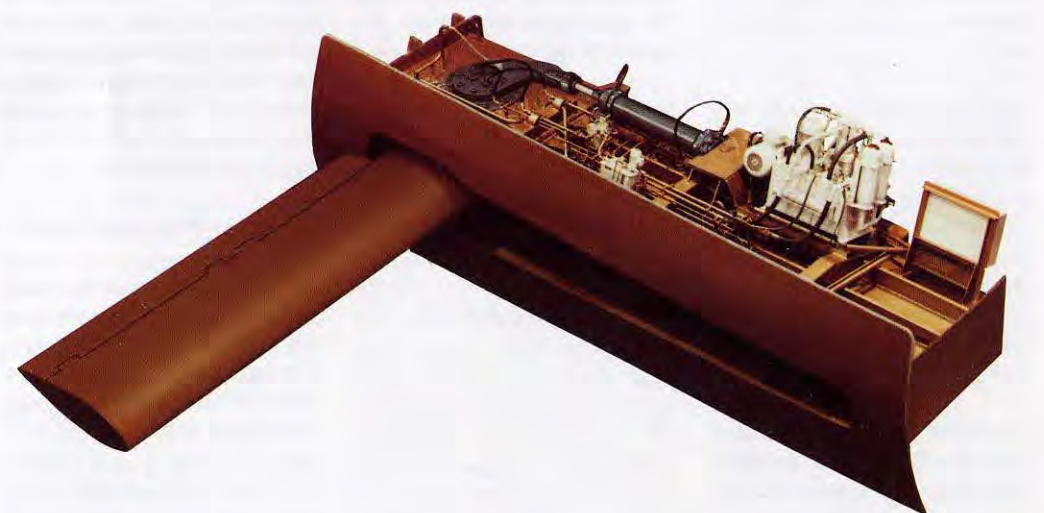
· Simple installation and maintenance

· No filter elements, no moving parts

· Fully automatic operation

· Extremely compact design

Blohm+Voss AG
Hermann Blohm Strasse 3
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Germany
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Naval work

As consultants for Svendborg Shipyard Ltd., Logimatic has undertaken the task of detailed design of automation and instrumentation, including interface specifications and project management for the Ship Control and Surveillance System.

Close cooperation with the Danish Naval Materiel Command has given Logimatic unique know-how during the Royal Danish Navy's building programme including the THETIS class patrol frigates.

Company Facilities

Logimatic A/S is a professional consulting engineering company offering worldwide assistance and support in the fields of electrical engineering, instrumentation, automation, software development and commissioning.

In the preparation of designs, drawings and documentation, Logimatic makes use of modern computer technology, thus ensuring efficiency in administration, economy in use of time and maximum application of up-to-date expertise and know how.

Marine work

The Danish Naval Materiel Command's pioneer utilization of advanced technology in naval vessels has given Logimatic some valuable spin off to the advantage of civilian shipyards and ship-owners. The list of references includes a varied and specialised involvement in the development, design and commissioning of cruise liners, ferries, reefer vessels, offshore platforms, etc.

As technical consultants to the Danish Ministry of Industry, Logimatic is involved in the development of tomorrow's ships through the introduction of Integrated Ship Control.

LOGIMATIC A/S
Sofiendalsvej 9
9200 Aalborg SV
Denmark

Software

Logimatic has a remarkable role in developing technical and administrative software applications. In contrast to many other dedicated software companies, Logimatic makes great use of experienced, highly educated engineers in the development of programs. This practical experience gives a down-to-earth approach and close understanding of our clients' needs.

For the Danish Naval Materiel Command, Logimatic is developing a comprehensive configuration and maintenance system especially for complex electronic systems.

Telephone: + 45 98 186511
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Dwinger Marineconsult as

Naval Architects • Marine Engineers • Surveyors



Carl Bro Group

Dwinger Marineconsult als was awarded the tender design contract for THETIS class by the Naval Materiel Command of the Royal Danish Navy. The work was subsequently undertaken in cooperation with Yard Ltd. of Glasgow as a prime subcontractor.

After the building contract was won by Svendborg Shipyard Ltd., the order for the major part of the detailed design of the ship and machinery was awarded to Dwinger Marineconsult als, which in turn subcontracted the basic electronic and automation design to Logimatic A/S, (see above).

Established in 1966, Dwinger Marineconsult als today undertakes complex design tasks using CAD and computer systems.

The designs produced by Dwinger Marineconsult als include almost all ship types ranging from naval vessels to merchant ships, since 1966 more than 110 ships have been built to the firm's designs. Moreover, at least 50 conversions have been designed by the firm.

Dwinger Marineconsult als also undertakes marine transportation feasibility studies, document appraisals, building supervision, condition and casualty surveys as well as other related tasks. The firm's export business is usually between 30% and 50% of its turnover.

Naval Ships

The design of the Thetis-class has meant that Dwinger Marineconsult als has gained considerable new know-how. The Thetis-class is probably the most versatile and cost-effective patrol vessel type available on the market today. Recently, the company designed a cutter, also based on merchant ship standards, for the Home Guard Naval Division.

Other Non-Merchant Ships

Pilot boats, rescue craft, megayachts, tugs, supply vessels, a research vessel, a cable vessel and a merchant marine training vessel represent some of the ship designs by Dwinger Marineconsult als.

Merchant Ships

Ferries for cars, trains and passengers are one of the firm's specialities. But reefer vessels, special tankers, container ships and other dry cargo ships count also heavily in the firm's design reference list.

Dwinger Marineconsult als – Quality in design from concept to detail

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Telefax: + 45 42 86 91 39
Telex: 37346 dmship dk

INTERING

The THETIS class is equipped with the INTERING stabilizer and ice-heeling system, designed for:

- Roll stabilization at low and zero speed.
- Improving of navigation in ice by heeling operations.
- Automatic anti-heeling operations.
- Check of the vessel's stability, which is especially important for the effect of icing on the superstructure.

All modes are realized with the same U-shaped tank system, arranged around the engine room.

Starting in 1969, INTERING has become the leading specialist for stabilization and anti-heeling systems. Our systems have been fitted to more than 300 RoRo-vessels, the world's largest train ferries, research vessels, passenger ships, container vessels, cable-layers, ice-breakers, polar research vessels, minehunters and marine acoustic research vessels.

The system has no moving parts in contact with water, requires very little maintenance and comes with a 3-year guarantee.

The INTERING Stabilizer

The ship's roll causes an athwartships oscillation of the tank water, which is automatically adapted to counteract the vessel's roll by computer-controlled stabilizer valves.

The system reacts immediately to the ship's roll, and maintains its efficiency over the whole range of loading/sea conditions.

By reducing the ship's roll, the stabilizer system avoids cargo damage, increases comfort on board, and helps reduce fuel consumption. The system is also available in a nonmagnetic version, with the required shock tests.

Increased Stabilizer Efficiency with »INTERING HEAVY FLUID«

The development of a high-density liquid makes the INTERING Stabilizer Systems increasingly attractive for naval application. This liquid, patented and registered under the trademark »INTERING HEAVY FLUID« has a density of 1.55 t/m³ and about the same viscosity as water. It inhibits corrosion of steel so no special tank coating is required. The crystallization point is below -10° so tank heating is unnecessary. A special colouring enables easy identification.

For any new ship design, when the centre of gravity is known only after the inclining experiment, »INTERING HEAVY FLUID« offers an attractive feature. The density of the fluid can be set anywhere between 1.55 and 1.0 (water) to meet final stability requirements.

The INTERING Anti-Heeling System

To compensate for the ship's heel, tank water is automatically shifted athwartships by blower air.

Continuously running blowers and fast-acting computer controlled air valves enable immediate reversal of water flow.

Rates of anti-heeling moment up to 4000 tm/min (transfer rate 25000 m³/h) have been realized. Even larger values can be achieved with standard and proven components.

In ferries, RoRo-vessels, and ships with deck cranes, the INTERING anti-heeling system reduces time spent in harbour, which can then be used to reduce speed. This leads to fuel savings so that investment costs for the system can be recovered in two years or less.

For ships that operate in ice, such as the THETIS class, the combined INTERING stabilizer and

anti-heeling system offers the following features:

- Cyclic heeling for lubrication of hull/ice, reduction of ice friction coefficient.
- Reduces the turning diameter by up to 60% when sailing in level ice.
- Allows faster passage through ice ridges and pack ice; and allows the vessel to be freed when trapped in ice.

A special control procedure, using a dynamic »quick flow« phase when opening the stabilizer valves, enables the ship to be rocked. This increases the peak moment frequency, an important advantage when penetrating ice ridges.

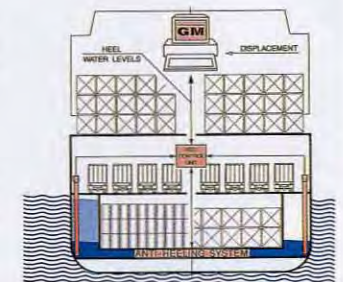
The INTERING Stability Test System improves the ship's safety and economy. By using the anti-heeling system for athwartship water transfer, the ship's actual GM is checked by an in-service inclining experiment within 3 to 5 minutes. All weights with exact position, real centres-of-gravity and all free surfaces are considered, and the results are nearly 10 times more reliable than those of computer calculation. Improved ship's safety is the result.

The system includes an operating tank level measuring system and a computer. For easy handling, the heeling angle, minimum GM, and test moment are permanently determined/monitored and recorded during the test.

The system monitors the ship's rolling moments and gives an automatic warning when the GM gets close to or below GM_{min}. A print-out allows analysis of the total test procedure.

The exact determination of stability allows the ship's deadweight capacity to be fully used. Stability calculations on loading computers must consider the centre of gravity of a container at 45% of its height to cover uncertainties. Investigations, however,

determined a VCG at 40% height for 80% of all loaded containers. This difference, when verified by the INTERING Stability Test System for a 2400-TEU container ship, represents an average ballast reduction of 420 tons which translates into greatly increased annual freight.



INTERING GMBH

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Germany
Telephone: + 49 40 523 20 57
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Semco Marine of Svendborg has acquired its know-how by experience in the construction of all kinds of ships.

The latest project in which we have played a major part is delivery of the electrical installations for the new, Royal Danish Navy THETIS-class patrol frigates. We were there from planning and design to the delivery of all electrical items: lighting fixtures, cables, switchboards, etc.

Of course, all installations are in accordance with strict navy speci-

fications and have been completed in collaboration with the Naval Material Command and Svendborg Shipyard Ltd., with whom we have worked closely for many years.

All electrical distribution systems comprise the utmost in safety, with redundant supply for all important equipment.

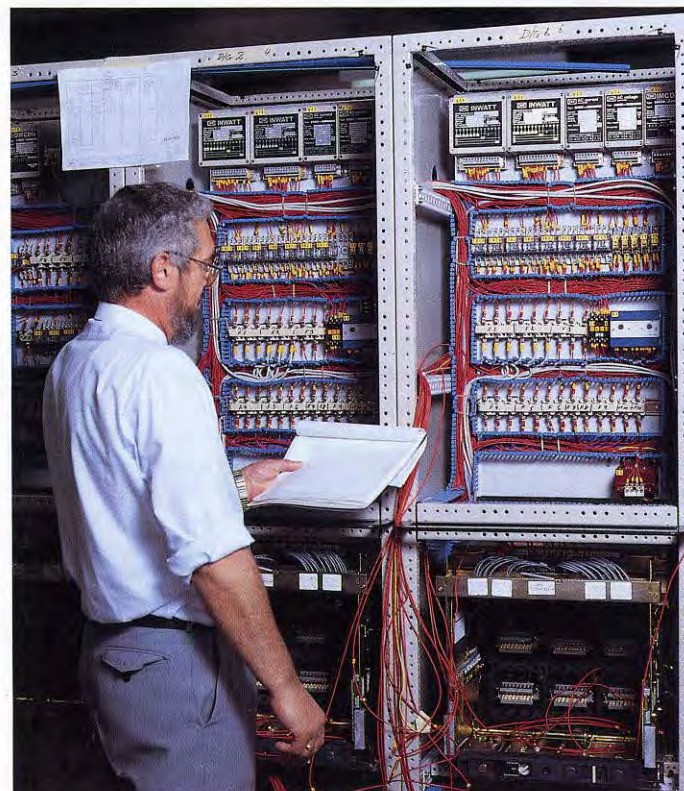
The main switchboards are secured to the base with shock absorbers and are tested to 15 G.

All wiring within the switchboards is halogen-free to prevent the emission of acidic gases in the event of fire.

These are just a few examples of the high technological standards we employ to meet the navy's requirements for a safe ship.

To be selected as a supplier to such a sophisticated project, a company has to have the experience, expertise and capacity, as well as a broad base of activities.

It has been a valuable experience, and a pleasure, for Semco Marine to participate in the Thetis-class project.



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As producer of SVENDBORG Steering Gear and DANWINCH winch equipment, A/S Motorfabriken DAN, part of the Ulstein Group, delivered the following equipment for the THETIS-Class patrol frigates:

Steering Gear:

1 Svendborg steering gear (type 36TN-36OB/2PV50) with hydraulic pump units.

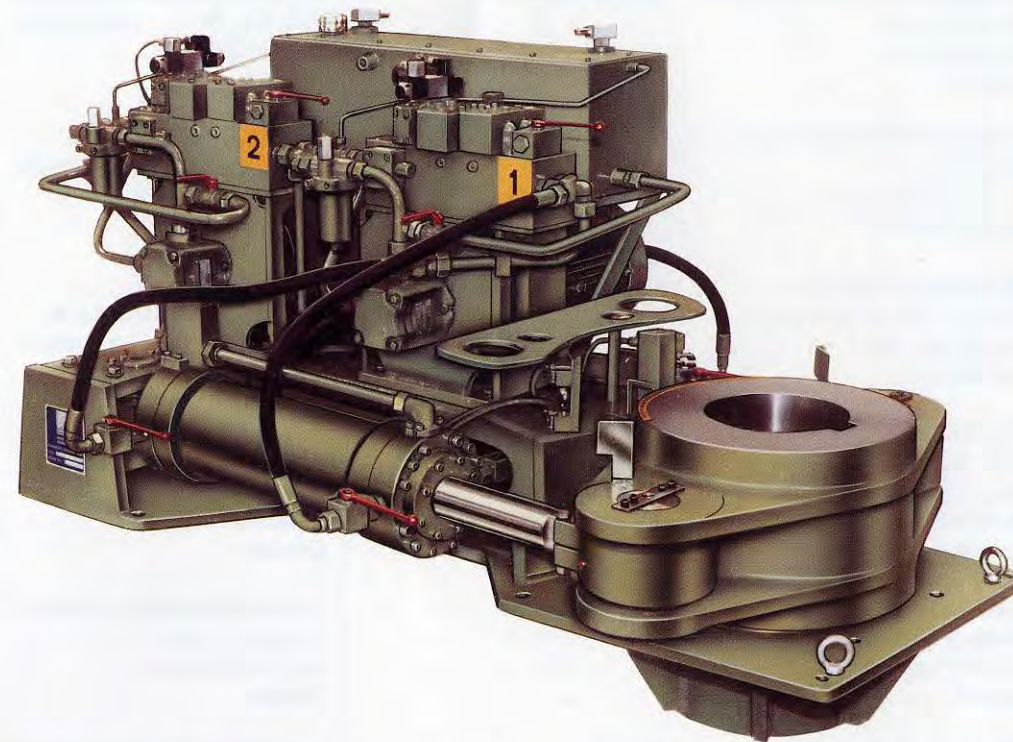
Winch Equipment:

1 hydraulic anchor windlass (type 2HA 39/44) for 40mm U3 chain.

1 set of chain stoppers.

2 hydraulic capstans (type HC100) with remote control.

1 hydraulic towing winch (type 20T) with a maximum pull of 20 tons.



1 complete hydraulic pump station.

All equipment delivered meets DSC3Y shock class requirements, and user demands for reliability, and easy maintenance. All equipment is backed by a comprehensive service and maintenance programme.

A/S Motorfabriken DAN began

working with Norwinch of Bergen in 1963. In 1966, the company began producing steering gear systems. In 1986, it gained the rights to produce Svendborg Steering Systems.

Since joining the Ulstein Group in 1983, the company has developed together with the Norwegian firm. Starting in 1992, all production will take place in Nor-

way. In Denmark, the company will represent all Ulstein products, and back those products with a competent service staff.

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GS-HYDRO-DANMARK ApS Kløverkærvej 16 DK-6000 Kolding Denmark	Piping systems	SETEC CONTRACTING A/S P. O. Box 75 N-4260 Torvastad Norway	Helicopter fuel filter unit
GLACIER NEDERLAND B.V. Maxwellstraat 22 NL 3316 GP Dordrecht The Netherlands	Stern tube bearings	GINGE KERR AS Stamholmen 111 DK-2650 Hvidovre Denmark	Fire detection system Halon system
DEEP SEA SEALS LTD. 4 Marples Way, Havant, Hants England PO9 1NX Great Britain	Stern tube and bulkhead seals	SVENSKA SKUMSLACKNING A/B P. O. Box 32 S-442 21 Kungälv Sweden	Flight-deck foam system
LOHMANN & STOLTERFOHT GMBH Falkoner Allé 7 DK-2000 København F Denmark	Radial Bearings	EMRI A/S Marielundvej 37A DK-2730 Herlev Denmark	Steering gear Control system
BRØDRENE EEGHOLM A-S Grundtvigs Allé 165 DK-6400 Sønderborg Denmark	Electric motors	DANSTOKER A/S Industrivej Nord DK-7400 Herning Denmark	Boilers
ALFA-LAVAL INDUSTRI A/S Kronrådsvej 7 DK-2610 Rødovre Denmark	Pumps Heat exchangers	AIR-CON EBELTOFT A/S Erhvervsparken 6 DK-8400 Ebeltoft Denmark	Fire dampers
WESTFALIA SEPARATOR AG Werner-Habig Strasse 1 D-4740 Oelde Germany	Separators Preheater	ANKERLØKKEN MARINE A/S Hasselager 23 DK-2605 Brøndby Denmark	Electro-tyfon
BOLL & KIRCH FILTER APS Møllelodden 4 DK-2791 Dragør Denmark	Filters	SABROE REFRIGERATION A/S Chr. X's Vej 201 DK-8210 Højbjerg Denmark	Provision stores Refrigerating plant
SPERRE MEK. VERKSTED A/S N-6057 Ellingsøy Norway	Air compressors	TEAMTEC A/S P. O. Box 100 N-4912 Gjerving Norway	Incinerator
ESPHOLIN TRYKLUF - MASKINER A/S Smedeland 6 DK-2600 Glostrup Denmark	Air receivers	HAMWORTHY ENGINEERING LIMITED Fleets Corner, Poole Dorset BH17 7LA Great Britain	Sewage treatment plant
SVENDBORG SKIBS- HYDRAULIK A/S Kuopiovej 20 DK-5700 Svendborg Denmark	Hydraulic pipe systems	DAN-ELEVATOR A/S Birkedevej 1 DK-4130 Viby Sj. Denmark	Stores lift
K. E. JEPSEN Ambolten 2 DK-2970 Hørsholm Denmark	Butterfly valves	MASKINFABRIK ACTA A/S Industrivej 9 P. O. Box 271 DK-5100 Odense C Denmark	Hawseholes Guide pulleys Cranes

C. C. JENSEN A/S Rødeledsvej 60 DK-5700 Svendborg Denmark	Windows Side lights
J C HEMPELS SKIBSFARVEFABRIK A/S Lundtoftevej 150 P. O. Box 280 DK-2800 Lyngby Denmark	Painting
DAMPA A/S DK-5690 Tommerup Denmark	Ceiling (accom.)
CUFADAN A/S Buckersvej 140 DK-2300 København S Denmark	Deck covering
RASM. HOLBECK & SØN A/S Victoriagade 40-44 P. O. Box 926 DK-5100 Odense C Denmark	Sanitary equipment
EVAC AB P. O. Box 81521 S-104 82 Stockholm Sweden	Vacuum toilet-system
PERSOLIT A/S Smedeløkken 2 DK-5330 Munkebo Denmark	Pipe insulation
HMA-INDUSTRIAKUSTIK A/S Avedøreholmen 78 DK-2650 Hvidovre Denmark	X-mounts
H C PUCK A/S Mileparken 28-30 DK-2730 Herlev Denmark	Elaflex compensators
A/S SANDVIKEN Abildager 26-28 DK-2605 Brøndby Denmark	Stainless steel pipe
GUSTAF FAGERBERG A/S Kornmarken 8-10 DK-2605 Brøndby Denmark	Stainless steel valves
LOCKER AIR-MAZE LIMITED P. O. Box 17, Folly Land Warrington Cheshire WAS 5NP Great Britain	Engine room air filters



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