# THE CANADIAN PATROL FRIGATE

BY

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## Introduction

Canada needs a Navy to protect its sovereignty and to participate with its allies in mutual defence. The exercise of sovereignty over the Canadian continental shelf, with its fisheries and potential oil and gas resources, requires a strong naval presence and capability. In NATO, Canada has tended to specialize in anti-submarine warfare. Further, Canada has one of the longest coastlines in the world. As a major trading country, the security of our sea lines of communication is of major importance. The need for a strong, modern Navy is clear.

Studies undertaken to review maritime policy have concluded that Canada needs to maintain a balanced force of ships, submarines, and aircraft to provide protection for its extensive and growing maritime interests, and to contribute effectively to naval deterrent forces in the NATO Alliance. A fleet of 24 vessels has been accepted as the requirement to meet Canada's commitment to collective defence. In consideration of the age of the fleet, the Government announced its decision in December 1977, to proceed with the definition of a programme to produce six fully supported frigates[1] as the first part of a long-term future ship replacement programme for the Navy.

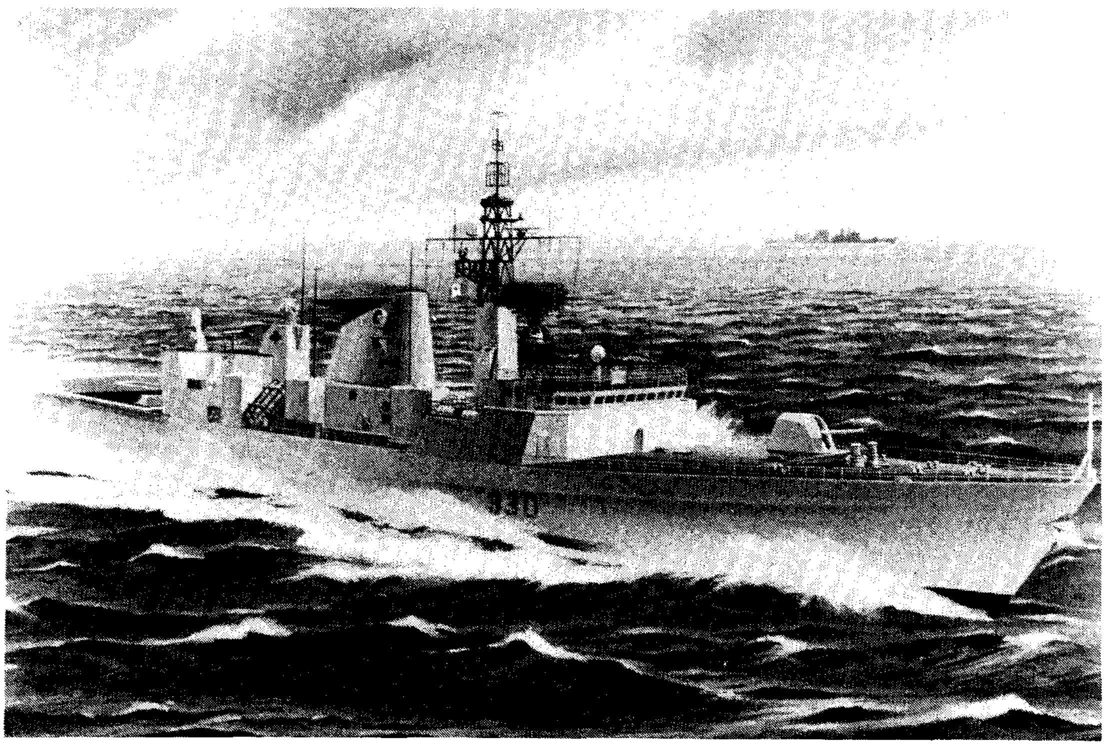

FIG. 1—ARTIST'S IMPRESSION OF THE CANADIAN PATROL FRIGATE

## Programme Management

The Naval Staff Requirement was embodied in a Statement of Requirement (SOR). This SOR detailed the performance requirements for the ship, its weapon systems, and the installed systems and equipments. As specific manufacturers were not designated, any firm producing equipment/systems which met the required performance parameters could enter into competition to supply their products for incorporation into the Canadian Patrol Frigate (CPF). The resultant competition should ensure that fully capable equipment is supplied at the most favourable terms possible.

Project Definition was initiated in 1978 with the establishment of an interdepartmental Project Management Office (PMO). The PMO is a joint office composed of representatives of the Departments of National Defence, Regional Industrial Expansion, and Supply and Services. This team is headed by a Canadian commodore. Its first task was the selection of suitably qualified contractors to undertake the definition of the ship and its necessary support. A Request for Proposals produced five respondents who were ultimately narrowed down to two contractors, Saint John Shipbuilding Limited, and SCAN Marine Incorporated.

A Contract Definition competition was initiated between the two selected contractors. Each received a contract in July 1981, worth approximately 20 million dollars, to prepare their proposals for the CPF Program. The contractors were required to develop a requisite ship design, develop the required life cycle support measures, maximize the Canadian industrial benefits, and put all these various aspects into one contractual and financial package. A prime aim of the CPF Program is to establish a long term capability in the Canadian shipbuilding industry to handle future ship requirements for the Canadian Navy. This aspect was fostered by requiring that the prime contractor be Canadian. Although it was recognized that weapon systems would have to be acquired from abroad, systems integration would be undertaken by a Canadian firm. Working within these guidelines both contractors made submissions containing approximately 35 000 pages in the early fall of 1982.

Both contractors produced fully acceptable proposals. The merits of each proposal were examined by the government departments involved, with the federal cabinet making the final decision in July 1983. Saint John Shipbuilding Limited was awarded an Implementation Contract with a project ceiling cost of \$3·85 billion, and a target cost of \$3·414 billion (all figures in 1983/84 dollars). Profit is maximized at target cost and reduces to zero as the ceiling cost is approached. The contract includes price incentive arrangements for meeting or exceeding certain performance requirements (such as acoustic signature) and a ceiling above which the contractor will assume total liability for additional cost. It should be noted that these figures include not only the cost of the six ships in a sailaway condition, but also the cost of all shore support facilities and the integrated logistics support. The contractor is now embarked on development of the detailed design, construction, trials and delivery of the new ships, establishment of the ships' life cycle support infrastructure, and realization of the programme's industrial benefits package.

The ships will be known by the names of some of Canada's major cities, and will also perpetuate the names of earlier Canadian warships that distinguished themselves in service. The class will be known as the CITY Class of Canadian Patrol Frigates.

One of the intrinsic features of the programme which influences all aspects of the ship is the design to cost approach. The Canadian Navy desires the most capable ship possible for the funds allocated, and the responsibility for achieving this has been transferred to the contractor. Trade-off studies must be undertaken by the contractor and, based on the results, the difficult decisions regarding system and equipment selection are taken. The ship depicted in the following pages should be assessed on this basis.

One further aim of the naval re-equipment programme is to develop and maintain high-tech capabilities and skills across Canada. As a consequence the new frigates will be built in two areas—three ships at the Saint John Shipbuilding facilities in Saint John, New Brunswick, and three ships at facilities located on the St. Lawrence Seaway. Additional costs attributable to splitting the work between different shipyards will not be assessed against the naval budget.

TABLE I—*Canadian Patrol Frigate design*

| | |
|---|---|
| Ship Particulars | |
| Displacement | 4200 tonnes |
| Dimensions | |
| length | 134·0 metres |
| beam | 16·4 metres |
| draft | 6·8 metres |
| Speed | Similar to DDH 280 Class Destroyer |
| Range | Greater than 4500 nautical miles |
| Sensors | |
| Underwater | Towed Array sonar<br>Hull mounted sonar |
| Above water | Long range air search radar<br>Medium range search radar<br>Navigational radar<br>Fire control systems |
| Electronic surveillance measures | Radar and communications surveillance capabilities |
| Weapons | |
| Anti-submarine | Torpedo tubes |
| Anti-air | Vertically-launched surface-to-air missiles |
| Anti-ship | Surface-to-surface missiles |
| Close-in anti-air weapon | 1 unit |
| Medium range anti-air/ship | 1 57 mm gun[2] |
| Electronic countermeasures | Jammer, chaff, infra-red decoy |
| Command and Control | Fully integrated system |
| Communications | Meet NATO requirements |
| Helicopter | 1 CH124A Sea King or replacement |
| Ice Capability | Brash ice |
| Accommodation | 226 all ranks |

| | | |
|---|---|---|
| Delivery Schedule Plan* | | |
| Lead Ship — start steel fabrication | Fall 1984 | |
| — lay keel | Mid 1986 | |
| — trials | Fall 1988 | |
| — operational | Spring 1989 | H.M.C.S. *Halifax* |
| Delivery, Ship 2 | April 1990 | H.M.C.S. *Vancouver* |
| 3 | October 1990 | H.M.C.S. *Ville de Quebec* |
| 4 | April 1991 | H.M.C.S. *Toronto* |
| 5 | October 1991 | H.M.C.S. *Regina* |
| 6 | April 1992 | H.M.C.S. *Calgary* |

*The information in this table has been released as unclassified by the Canadian government.

## The Ship Design

As a result of the Contract Definition phase the major parameters of the CPF were decided. TABLE I provides an overview of the selected design. As the vessel is intended primarily for anti-submarine warfare, stringent requirements for noise minimization were incorporated. The engines and generators are enclosed and raft-mounted. A Masker air emission system is fitted which utilizes bleed air from the gas turbines. Escher Wyss propellers of an advanced design are incorporated, with cavitation inception occurring at an unusually high speed. Trials in the Netherlands Model Basin indicate the design is one of the quietest ever seen. Consequently the CPF should be an extremely quiet ship.

In order to perform effectively as an anti-submarine escort, a long range was desired. The original requirement called for a range of at least 4500 nautical miles at cruising speed. It is not Canadian practice to utilize water displacement fuel systems, so separate fuel and ballast tanks are incorporated into the design. The systems can be cross-connected so that in a wartime situation it would be possible to carry fuel in the ballast tanks. This arrangement enables extremely good ranges to be obtained. On the cruise diesel a range well in excess of the requirement can be attained. Engine testing indicates that the cruise diesel installation will be exceptionally quiet. One gas turbine operating with the air emission system on and the TACTASS streamed will still permit a quite useful range to be achieved.

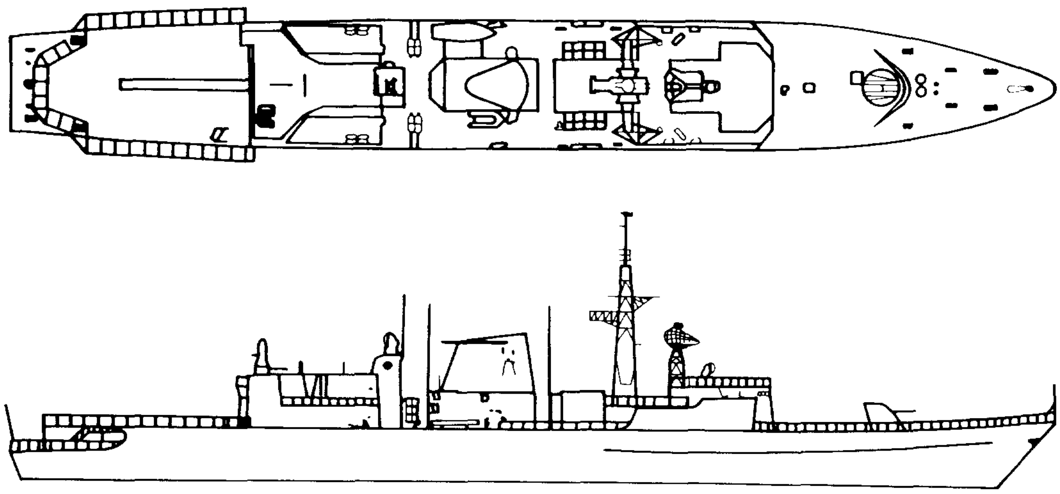

FIG. 2—PLAN AND PROFILE OF CANADIAN PATROL FRIGATE

## Weapons Fit

The ship's primary role as an anti-submarine frigate fitted with a towed array system has strongly influenced the weapons fit. An American tactical towed array sonar tail will be coupled with a Canadian-developed signal processor to produce a unique system. A Sea King helicopter, or its successor, will be embarked by the ship in order to localize and prosecute submarine contacts detected at a considerable distance from the ship. Close-in contacts will be detected and prosecuted using a Canadian Westinghouse hull-mounted sonar and torpedoes carried in tubes located in the superstructure. For self-protection a towed torpedo countermeasure device will be provided.

As the ship will be expected to operate autonomously it will be fitted with the necessary sensors and weapons (see TABLE I) to survive in a hostile environment. The ship will also be capable of providing a limited measure of protection to vessels being escorted. Long range air search capability is provided by a Raytheon SPS 49 radar. An Ericsson Sea Giraffe radar provides medium range coverage. This set provides high angle coverage as well as surface search with the high data rates necessary for target designation purposes. Two HSA dual frequency STIR fire control systems will be fitted. Magnetron transmitters are utilized which constitute a cost-effective solution considering the tasks and ranges involved. A Sperry Mark 340 navigation radar will also be fitted.

Both surface-to-surface and surface-to-air missiles will be carried. Harpoon surface-to-surface missiles will be mounted in the same manner as envisaged for the Type 23, but will be located just forward of the hangar in the CPF.

Vertical launch AIM 7M Sea Sparrow SAM missiles will be fitted amidship in a fully flexible arrangement requiring no deck penetrations. This approach makes it possible to increase the number of missiles carried at a future date if deemed desirable. In order to provide a measure of protection for the missiles, the containers will be located behind steel/kevlar shields.

A Bofors 57 mm Mark II gun[2] will be fitted forward and a single CIWS will be fitted aft on the top of the hangar. The CIWS selected is the Block 1 Phalanx gun system. This is an improved version of the system that is fitted in the INVINCIBLE Class. The Canadian Navy's requirement to provide shore bombardment was not strong enough to justify the expense of a gun larger than 57 mm. On the other hand a gun is required in order to be able to exercise sovereignty over the Canadian extended economic zone, and to deal with small warships. Bofors claim that their 57 mm gun will outrange current 100 mm and 3 inch weapons when utilizing their recently-developed HCER (High-Capacity Extended Range) round against surface vessels. Its effectiveness is enhanced by a high rate of fire (225 rounds/min.) and detonation within the target ship. In missile engagements, a recently developed proximity fuze for the 57 mm shells assures a high kill probability. This latter capability enables the Bofors gun to supplement the CIWS and eliminate its blind arc.

Electronic Support Measures will be met by the Canadian Electronic Warfare System known as CANEWS. The Plessey Shield offboard decoy system employing both chaff and IR decoys will be fitted. A Ramses ECM jammer has been selected.

The weapons fit will be linked and controlled by a distributed Command and Control system utilizing numerous mini- and micro-computers. This will be an automatic system incorporating a decision-making capability. The integration of the weapons systems and the development of the CCS will take place in Canada in a new facility built for this programme. Some of the concepts of SHINPADS (Shipboard Integrated Processing and Display System), which has been developed under the auspices of the Canadian Navy over a period of some years, will be incorporated into the design. Great expectations are held for the new system.

**Interior Communications**

Canadian defence-sponsored research has resulted in Leigh Instruments of Ottawa developing SHINCOM (Shipboard Integrated Interior Communication System) which will be fitted in the CPF. This system uses digital switching technology to combine the functions of four communication subsystems and employs a dual star configuration for high survivability. Central switches located fore and aft are connected by a common data link. Operationally essential terminals and interfaces are connected to both switches. Each terminal is equipped with its own microprocessor, which eliminates crosstalk and allows for secure voice communication. The four subsystems embodied in SHINCOM are the intercom, telephone exchange, public address, and remote control of radios. Interfacing is possible with any external communication system such as the underwater telephone, sound powered RAS telephones, and shore telephone systems. The software control package not only facilitates all the functional capabilities but also caters for on-line diagnostics and maintenance requirements. It is possible rapidly to reconfigure the system around out-of-service terminals. This system should meet the requirements for shipboard communications with significant cost savings in cable which render it extremely attractive.

**Complement and Habitability**

Although the complement will be smaller than in previous Canadian classes of ships, it will be larger than that envisaged for the Type 23 design. The crew size is predicated upon the Naval Staff Requirement that the ship be capable of autonomous operation for extended periods. Full helicopter support facilities will be incorporated. Accommodation for approximately 226 is catered for in the following categories:

| | |
|---|---|
| Officers | 24 |
| Chief petty officers | 6 |
| Petty officers | 52 |
| Leading seamen & below | 144 |
| Total | 226 |

A centralized galley with adjacent cafeterias is planned, whilst the wardroom and Captain's cabin have separate serveries. Accommodation is distributed forward and aft, with none located below three deck. As no accommodation is located directly over tanks, no condensation problems are expected. Officers will be in single and double cabins. A single cabin is provided for the most senior rating, with the remainder of the chief petty officers in a 5-man mess. The petty officers are accommodated in messes containing not more than 9 berths; leading seamen and below are in messes of 21 or fewer. All heads and washplaces are close to the accommodation.

**Main Machinery Arrangement**

The general arrangement of the plant is illustrated in FIG. 3. The machinery is in four spaces—the Forward Auxiliary Machinery Room (FAMR), the Forward Engine Room (FER), the After Engine Room (AER), and the After Auxiliary Machinery Room (AAMR). The main machinery is installed in a CODOG arrangement with the gas turbines driving the ship at high speeds and the diesel engine at cruising speeds. The gas turbines will operate with the diesel engine only during the changeover period. Each gas turbine is arranged to drive one set of shafting and the Controllable Reversible Pitch (CRP) propeller through the associated main gearbox, or to drive both sets of shafting and propellers through the cross-connect gearbox and the other main gearbox. The diesel engine is arranged to drive both sets of shafting and propellers through the cross-connect and main gearboxes. Each gas turbine input has a synchronizing clutch within the main gearbox and the diesel input has a friction clutch within the cross-connect gearbox. A friction clutch is provided between each main gearbox and the cross-connect gearbox. The gas turbines are General Electric LM 2500-30s giving a total output of over 33 MW, and the diesel cruise engine is a SEMT-Pielstick 20PA6 giving 6·5 MW. The gearing is double helical, designed and manufactured by De Schelde to meet a requirement for the highest attainable standard of quietness. The combination of the gearbox design and the fact that it is resiliently mounted will result in hull vibration and underwater noise levels which are better than those previously achieved for warships. Manoeuvring is accomplished by CRP propellers with oil-filled hubs and hydraulic elements with controls that are mounted inside the ship's hull.

Both gas turbines are mounted on a common raft structure which is solidly connected to the main gearboxes, and the entire structure is flexibly mounted to minimize the transmission of machinery vibrations to the hull.

The diesel engine is flexibly mounted on a separate raft structure which itself is flexibly mounted, i.e. the diesel engine is double mounted, to minimize the transmission of machinery vibrations to the hull.

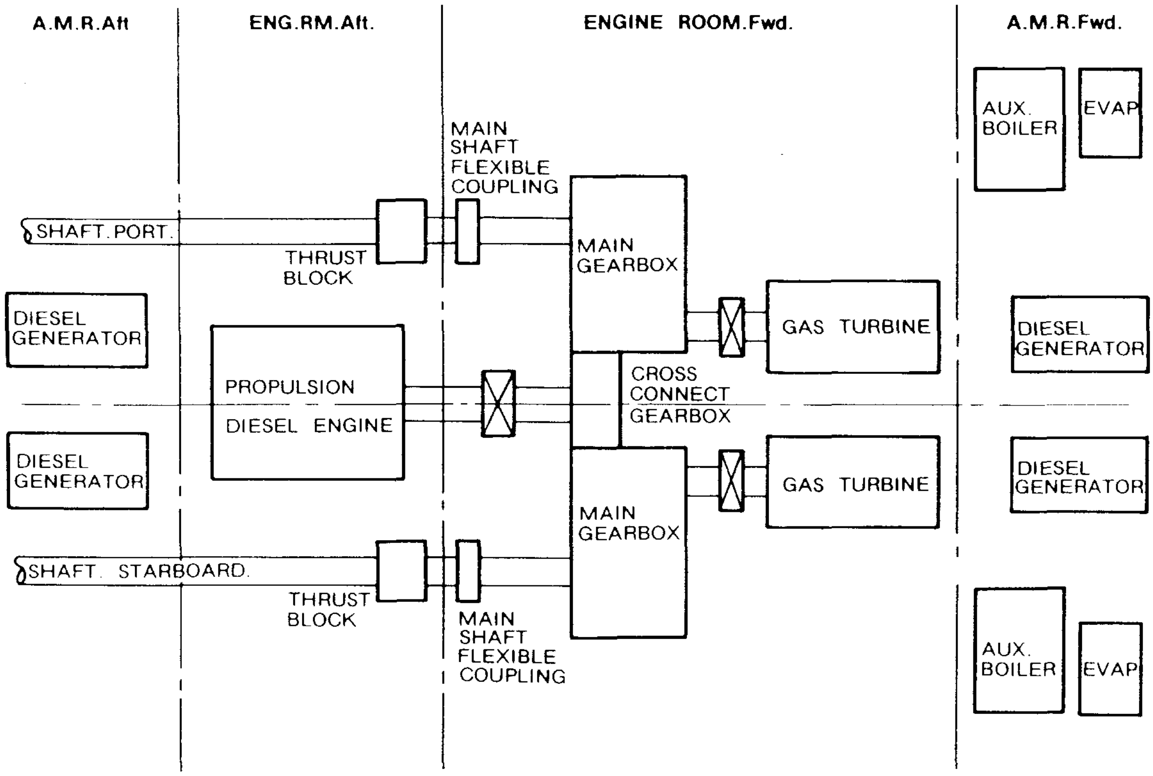


FIG. 3—MACHINERY ARRANGEMENT IN CANADIAN PATROL FRIGATE

Flexible couplings to accommodate movement and to attenuate noise are provided in the torque tube between the diesel engine and the gearing and in each transmission shaft between the main gearbox output flange and the thrust block.

The propulsion machinery is designed to meet specified naval shock and blast standards. In the event of a failure in the electrical power system, the propulsion machinery will operate for a period of at least ten minutes at powers up to and including full power. Normal control of propulsion engines and of ship speed is from the bridge. The engineering watch performs all other engineering functions, including machinery health monitoring, from the Machinery Control Room (MCR).

## Main Engines

The Pielstick 20PA6 V280, although not yet in service, is produced by a well-established manufacturer who supplies many engines to the French Navy. The engine offers a reasonable power for ship cruising purposes and excellent fuel consumption. The engine is of the four-cycle, single-acting, twenty-cylinder, V-form type, incorporating twin turbochargers with intermediate air cooling. An insulated enclosure is provided to attenuate the noise of the diesel and to reduce heat radiated into the engine room. The enclosure consists of a steel frame with easily removable panels to facilitate routine maintenance. The space between the engine and enclosure is ventilated by a self-contained system within the enclosure with only sufficient exhaust to and make-up air from the engine room system to prevent oil mist build-up within the enclosure. Combustion air for the diesel passes through a two-stage filter which removes salt water and other contaminants.

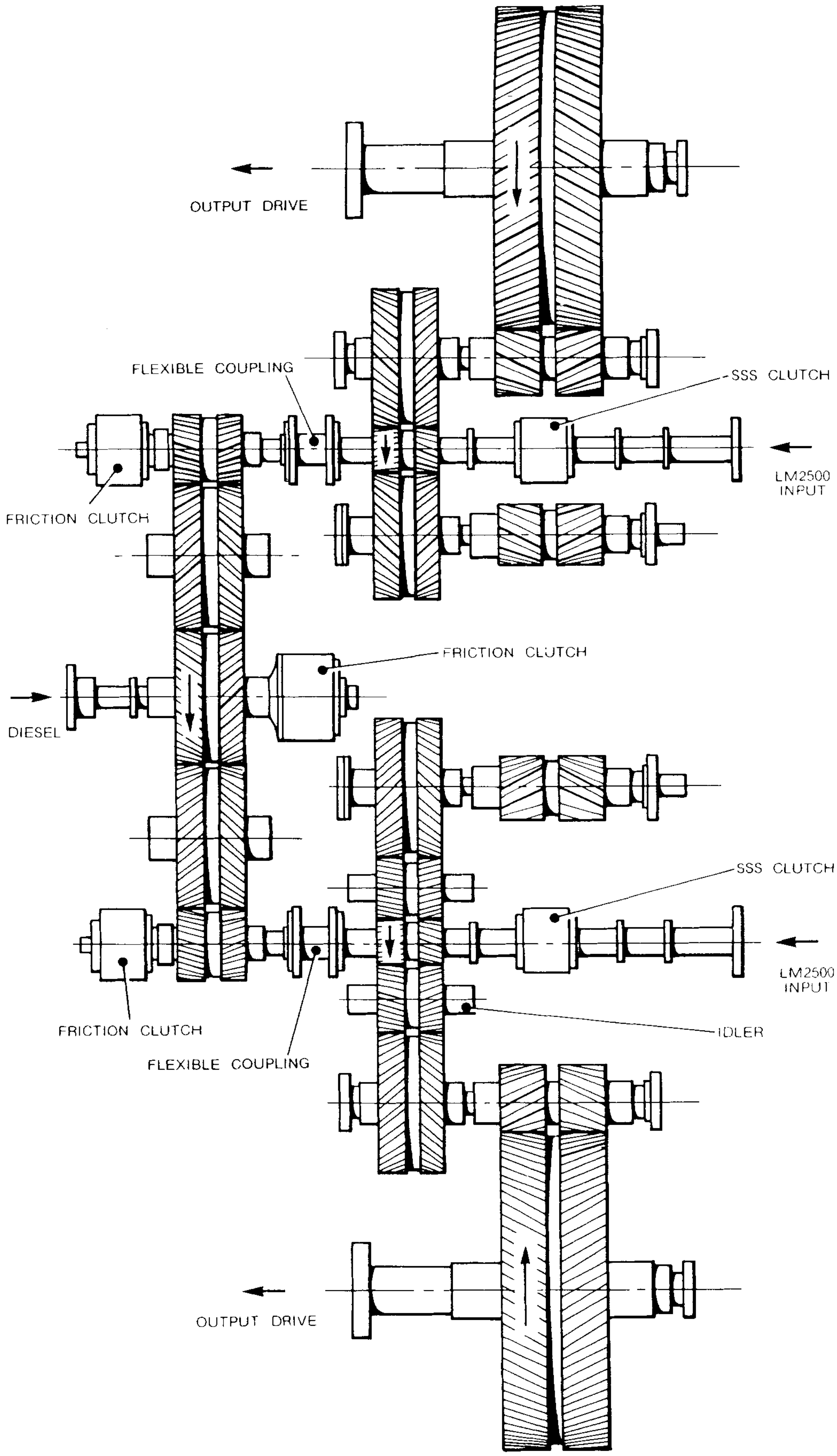


FIG. 4—CANADIAN PATROL FRIGATE MAIN GEARING (DIAGRAMMATIC VIEW)

The gas turbine engine, the LM-2500, was developed from the TF39 and CF6 aircraft engines. The first LM2500 marine engine was placed in service on the U.S. Military Sealift Command Ship, G.T.S. *Admiral William M. Callaghan* in 1969. In 1975 the engine completed a comprehensive quality assurance test programme and was fully qualified for ship propulsion systems by the U.S. Navy in conjunction with the U.S.S. SPRUANCE (DD 963) Class destroyer programme. Since that time the engine has been adopted by many other navies and has accumulated over a million hours of operating experience. It is a fully developed and proven marine gas turbine which offers specific fuel consumptions comparable to those of the Spey, albeit in a higher power range.

The LM2500 engine is a simple cycle, two-shaft engine consisting of a gas generator and a power turbine with the shaft power extracted via a flexible coupling through the exhaust duct. The gas generator consists of a variable geometry compressor, an annular combustor, a high pressure turbine, an accessory drive gearbox, and controls and accessories. The power turbine is a six-stage, low pressure turbine driven by the gas generator exhaust gas.

To contain noise and heat, the gas turbine module includes an enclosure which houses the gas turbine, inlet plenum, exhaust collector, and fire protection systems. Interior lights are fitted so that inspection and maintenance can be carried out within the enclosure. Enclosure ventilation is achieved by the use of an educator nozzle on the exhaust collector to provide the required secondary cooling without the need of fan power to permit the engine to continue in operation during a ship service electrical power failure.

To remove water, salt, and other contaminants from the gas turbine combustion air, the intakes are provided with two filtration separator modules. Each module incorporates two stages of moisture separation; stage one is of the impactor assembly type and stage two is an inertial vane assembly. The stages are designed to complement one another.

For engine starting, hydraulic fluid is supplied to each engine-mounted starter by a hydraulic power pack manufactured by New York Air Brake. The package incorporates two 200 h.p. electrically driven hydraulic pumps (one working, one standby) which are cross-connected to serve either gas turbine. The engines are started consecutively and it is possible to have both engines on line in two minutes.

As in previous installations, gas generator replacement will take place via the downtakes. Condition-based maintenance will be adopted for the gas turbines, as well as other equipment. It is intended that gas turbine condition will be assessed by borescope (endoscope) inspection, vibration readings, records of r.p.m./b.h.p. relationships and other performance data as well as spectrometric oil analysis. The machinery control system software will cater for extensive machinery health monitoring.

## Infra-Red Suppression

Gas turbine and diesel exhaust gas will be cooled by a Canadian-developed device known as the DRES BALL. This device, which was designed by the Defence Research Establishment in Suffield, Alberta, is fitted high in the uptakes and provides both funnel and plume cooling. The installation should be highly effective. The penalties are that it contributes to topweight and it imposes a considerable back-pressure on the gas turbine. On the plus side it provides high look protection against pop-up missiles.

## Gearing and Clutches

The CODOG gearing transmission is designed and manufactured by De Schelde. FIG. 4 is a diagrammatic representation of the gearing trains. The drive modes that are possible are as follows:

(*a*) Each propeller driven by its associated gas turbine independently.
(*b*) Each propeller driven by its associated gas turbine, with starboard and port shafts cross-connected.
(*c*) Both propellers driven by one gas turbine.
(*d*) Both propellers driven by the single diesel engine.
(*e*) One propeller driven by one gas turbine in a cross-connected mode. This is an emergency condition.

The port and starboard gearboxes are of the double reduction articulated locked train type with an overall reduction of 17·2 to 1. Each main gas turbine feeds into its gearbox through self-synchronizing clutches. Since the LM2500 is not supplied with handed power turbines, two idlers are included in the starboard gearbox to obtain the correct direction of rotation for the propellers. Otherwise the gearbox rotating elements are essentially the same. The gearing has hobbed and shaved double helical gear teeth, with gearwheels through-hardened and with pinions and idlers nitrided. All bearings are conventional journal bearings provided with resistance temperature detectors. Oil flow indicators are included in the design as necessary. Axial locating bearings of the tilting pad type are provided where necessary. The gearbox casing is fabricated in steel and provided with transparent acrylic viewing windows for tooth inspections. To minimize airborne noise the gear casing has sound-damping plating on the external casing surfaces. The gearing is capable of transmitting 120% of the maximum rated gas turbine torque and also provides an additional 30% margin for transient torque peaks which may occur in turns at full power or during emergency manoeuvring.

The gas turbine clutches are SSS clutches which have given reliable service over a number of years in many warship classes including the DDH 280 Class destroyers. The wet, multiple-disc type clutches of the cross-connect gearbox and diesel input are manufactured by the Philadelphia Gear Co. These clutches are air-activated and are provided with switch mechanisms to give remote and local indications of the clutch status. Oil supplied from the lub oil system carries away the heat developed in the clutch as a result of slippage. The diesel input clutch is designed to provide the dead shaft pick-up duty as well as the disengage and engage functions. Each propeller is to be started independently, thereby reducing the torque demand in the diesel engine. Output coupling requirements are met by a Holset cardan shaft coupling manufactured by Koppers Company which can accommodate relative movement as well as attenuate vibration between the propeller shaft and gearbox. Other features of the gearbox include:

(*a*) An electrically powered turning gear (manually engaged).
(*b*) A shaft locking device (manually operated when the shaft is stationary).
(*c*) A gear-driven sea water circulating pump.
(*d*) A lub oil sump formed by the lower sections of both main gearboxes.

**Propellers**

The inward turning five-bladed controllable pitch propellers and their associated equipment are supplied by Escher Wyss. The design uses an all-mechanical propeller hub with the actuating hydraulics located well inboard. Each propeller is provided with its own hydraulic actuation system which utilizes an electrically driven hydraulic pump. Standby shaft-driven pumps will be automatically activated if a failure occurs. Further redundancy is provided by cross-connections between the port and starboard hydraulic systems. A header tank provides the requisite oil pressure to counteract the seawater head when shut down. A double oil tube follows any movement of the servomotor piston and provides an indication of the actual pitch completely independent from the command signal. The actuating unit incorporates a pitch locking facility and, in the event of a hydraulic actuation failure, the propeller blades can be locked mechanically in the ahead position. Change of blade pitch into the locking position is achieved by a hand-operated hydraulic pump. To reduce noise emission from the propeller, Prairie air is conveyed to the leading edges of the blades from a shaft-mounted air transfer box. This air transfer box, which is located forward of the actuating unit in the AER, transmits air to the propeller hub by a stainless steel tube located within the shaft bore. The propeller blades are bolted to trunnions which enable a blade to be replaced in less time than is required for changing a fixed pitch propeller and without the need for dry docking. The control system for propeller pitch is integrated with the main machinery power output control system. In addition there are local manually operated valves.

**Machinery Control System**

The machinery control system[3], as portrayed in FIG. 5, will be provided by CAE Electronics of Canada. This firm has extensive experience in the design and provision of real-time computer systems. They have a world-wide reputation for flight simulators and have provided complete control systems for nuclear power plants. Of more relevance, however, is their recent involvement in the ongoing development work in connection with SHINMACS (Shipboard Integrated Machinery Control System) which has been fostered by the Canadian Navy over a number of years.

SHINMACS is a digital distributed system which incorporates redundant serial data buses between the control consoles and the microprocessors located in the machinery spaces. A number of mini- and micro-computers are incorporated in the design. The aim is to employ only digital electronic units which are qualified for military use and to achieve standardization with the various other systems fitted in the ship. Control algorithms will be implemented utilizing a combination of software and firmware. Major emphasis will be placed on the man-machine interface (MMI) in this design. The MMI will be achieved with the use of Visual Display Units (VDU) which incorporate colour graphics for effective pictorial presentation of data and system status. Control will be exercised by the operators by means of a functional keyboard. Use will be made of special purpose keys as well as others whose functions will vary depending upon the control sequence in progress. Operator situation appreciation and reaction will be facilitated by schematic presentation of systems. This approach, which is quite new to naval engineers, has already been proven extensively in industrial applications. In order to assure the success of this installation considerable design effort has been put into the production of an Advanced Development Model. The unit has been extensively exposed to marine engineering personnel who feel that its introduction will not pose any problems with respect to the MMI.

Control consoles with their associated VDUs will be located on the Bridge and in the Machinery Control Room (MCR). The control capability at each console will vary but reconfiguration will be possible to obviate the effects of failures or battle damage. In the MCR there will be consoles for the watch supervisor, for the plant watchkeeper, and for maintainer/electrical personnel use. Local Operating Panels (LOP) will be situated in each engine room for emergency control of the main machinery. The LOPs will embody hard-wired instruments and controls.

Two Digital Propulsion Controllers (DPC) will be fitted for the monitoring and controlling of the plant. Each DPC will be capable of handling the whole plant. They will be operated in a dual redundant mode so that the standby unit will take over immediately in the event of a failure. In order to cope with electrical power failures an uninterrupted power supply system will be provided. Each terminal will also have its own battery back-up.

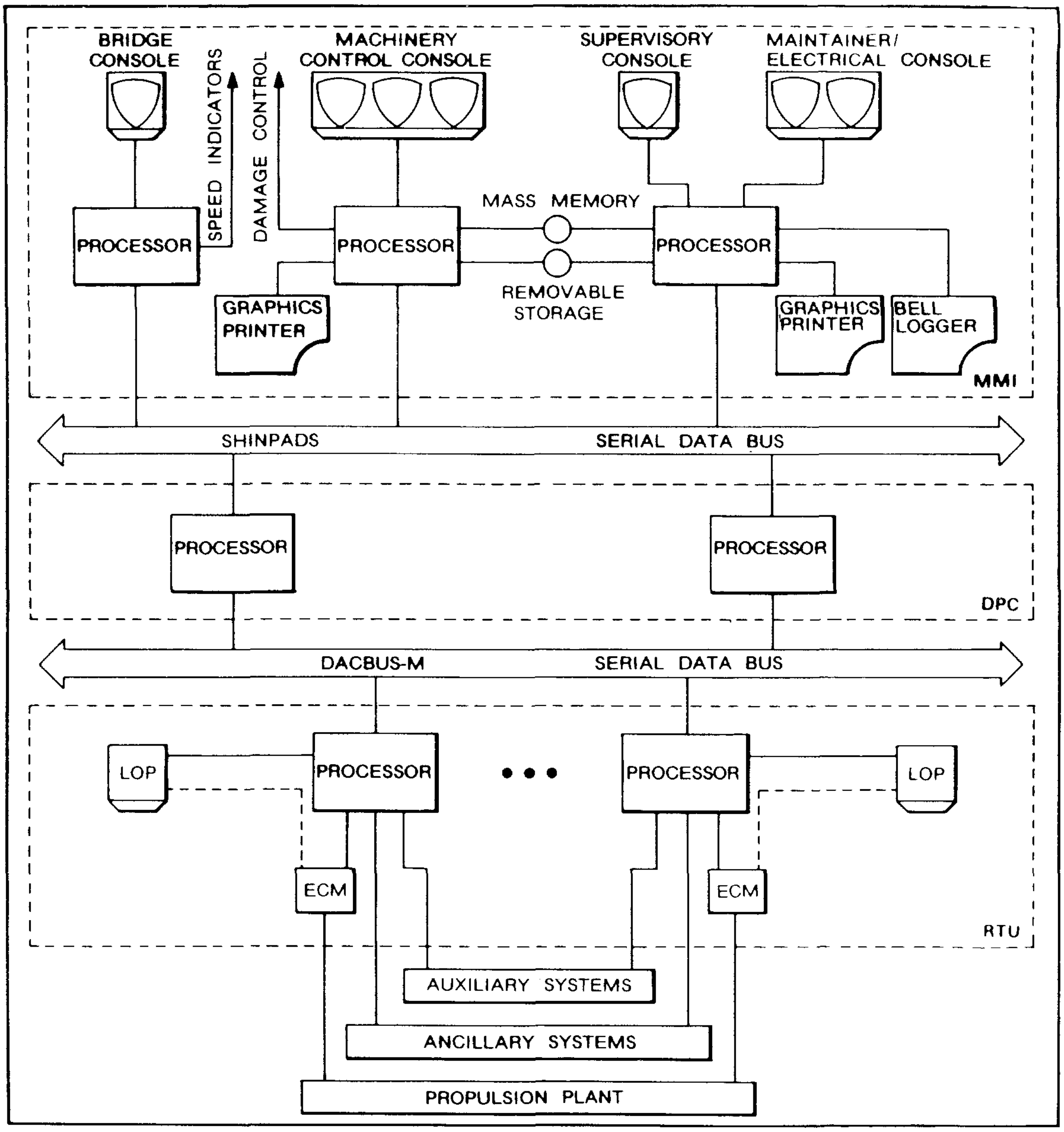


FIG. 5—MACHINERY CONTROL SYSTEM IN CANADIAN PATROL FRIGATE
MMI: Man Machine Interface group
DPC: Digital Propulsion Controller group
RTU: Remote Terminal Unit group

The majority of the system software will be written in a high level language in order that full advantage can be taken of the benefits of structured programming. Assembly language will be utilized where necessary in order to meet reaction time requirements. A 'top down' development philosophy will be employed in software system design. Integration and testing of software will follow the 'bottom-up' philosophy.

**Electrical System**

Electrical power will be provided by four diesel alternators each rated at 850 kW which are supplied by AEG Telefunken of Germany. The prime movers are 16 cylinder V-form turbocharged MWM (Motoren-Werke Mannheim) diesel engines. The alternators are produced by A. V. Kaick of Germany. These units are similar to the 750 kW diesel alternators fitted in the German F 122 frigates. In order to limit noise generation, the generator sets will be double-mounted using a raft arrangement and fitted with acoustic enclosures.

Two switchboards will be fitted, with interconnectors. Alternators on line will be run in parallel and the two switchboards will normally be operated in the interconnected mode. This equipment is supplied by Merlin Gérin of France who supplies similar equipment to the French Navy. The system design includes extensive automation for starting, paralleling and load sharing for the alternators, as well as automatic load shedding to deal with overload situations.

This advanced system incorporates many other innovations for the Canadian Navy. Power conversion for the 400 Hz supplies will be provided by solid state static frequency converters. Taking cognizance of the Falklands experience, zero halogen (low smoke, low toxicity) electrical cabling will be used throughout the ship. It is understood that this is similar to the cabling being fitted in current R.N. ships.

**Fuel System**

Experience with the gas turbine powered DDH 280 Class has demonstrated the merit of giving careful attention to the quality of fuel. Success in this regard has been achieved in the DDH 280 Class, and will be realized in the CPF by utilizing both centrifuges and coalescers. All fuel is centrifuged before it is placed in the service tanks. If the fuel condition is still not acceptable or deteriorates, it can be recirculated through the centrifuges. Final conditioning of the fuel involves passing it through heaters and coalescers immediately before use. The ship has four service tanks and two completely separate fuel systems. The usual cross-connections and system redundancy are provided. All fuel tanks, with the exception of an emergency header tank, are located below the waterline. The emergency fuel header tank is for use during power failures; it is fitted with an overflow and is continuously trickle replenished.

**Auxiliary Machinery**

A full range of auxiliary machinery will be fitted which is fairly standard in nature. Many of the details are not being released at this time as specific contracts have not been signed with the individual suppliers. As a consequence, only the major items will be discussed.

Two *distilling plants,* each capable of producing 30 tonnes per day, will be fitted. These units will be Mitchell flash evaporators similar to the ones fitted in the DDH 280 Class. It should be noted that the Statement of Requirement was prepared well before the Falklands war and, as a consequence, it did not encourage the fitting of reverse osmosis (RO) plants. It is highly probable that the Canadian Navy will adopt RO for the follow-on class of ships.

In order to provide the requisite steam for the distillation plants, two *auxiliary boilers* will be fitted. These boilers again are similar to the ones fitted in the DDH 280 Class. Each boiler has an output of 3200 Kg of steam at a pressure of 7·0 bar. The boilers will be fully automatic after initial local manual start. Both the auxiliary boilers and the distilling plants will be shock qualified.

A *Pollution Abatement System* will be fitted. This is noteworthy as this will be the first instance in which a major Canadian warship will be fitted with such a system. The system will cater for the following:

(*a*) Black water and grey water collection, treatment and disposal.

(*b*) Waste disposal.

(*c*) Oil pollution abatement and bilge stripping.

The black water plant is an electrolytic unit produced by Omnipure of Texas. This plant eliminates all 'bugs', and discharges pure water along with solid material suitable for consumption by fish. The introduction of this system will doubtless be followed with great interest to see whether it really does constitute the ultimate solution to the pollution abatement problem. An incinerator will be provided for dry waste.

The *heating, ventilation and air conditioning system* will include four 85 ton chilled water plants assembled in Canada employing Carrier (Carlisle) compressors. Two gas citadels will be incorporated into the design. Although no NBC detection system will be fitted initially, it is intended that a suitable system will be retrofitted.

**Fitted Damage Control Systems**

Several highly automated damage control systems[4] are fitted in order to improve reaction time in emergency situations. There are some 400 smoke and heat detectors fitted throughout the ship. The detectors are grouped into 75 zones, with indication of the zone in which the fire is located being displayed in Damage Control Headquarters (HQ 1) and at the Quartermaster Position for when the ship is alongside. Automatic sprinkling is fitted in 18 compartments to extinguish class A (solids) and ammunition space fires. This system can be either overridden or initiated from Damage Control centres to meet special situations such as precautionary flooding of magazines. Main and reserve banks of Halon 1301 are provided for fire suppression in 44 compartments containing electrical or electronic equipment. This system will be automatically activated for any compartment in which two detectors indicate alarm. Interlocks with the ventilation control system automatically stop the correct fans prior to the release of Halon. An Aqueous Film Forming Foam (AFFF) system is provided to extinguish Class B (fuel) fires in 13 compartments. This system can be activated either locally or from HQ 1. The galley exhaust hood and deep fat fryer will be protected by a wet chemical fire extinguishing system. A Twin Agent Unit will be provided for the Flight Deck. These systems will afford the CPF a survival capability which far exceeds that of existing ships of the Fleet.

The firemain is supplied by 7 pumps with automatic starting and stopping in order to match demand. A jockey pump with a capacity of 50 cu m/hr will normally maintain firemain pressure. Flow will be augmented as necessary by four other high capacity motor-driven pumps and two additional diesel pumps, each with a capacity of 146 cu m/hr. In addition to supplying fire hydrants and sprinkling systems, the firemain feeds the prewet system and the machinery space educators. The status of all isolating valves is displayed in HQ 1. All compartments fitted with eductors have bilge flooding alarms which are also displayed in HQ 1.

A liquid level management system is fitted which provides centralized monitoring and control of all ship's tanks. The system considerably automates filling of fuel tanks during replenishment. Quantities of liquid held in individual tanks are displayed centrally to facilitate stability calculations. Remote manual operation of system valves and pumps permits rapid correction of list or loll.

**Other Features**

Ths ship will be fitted for carrying out Replenishment at Sea operations forward and amidships. A rigid inflatable boat (RIB) with an appropriate crane is being proposed. In addition, a 10-man and a 6-man inflatable boat will be carried. A single bower anchor and associated handling system will be fitted. The ship will be capable of deploying, maintaining and controlling the Sea King helicopter or its replacement. An advanced version of the proven Canadian helicopter haul-down and traversing system will be fitted.

**Postscript**

The gestation period associated with the acquisition of these ships has been somewhat longer than naval personnel would have wished and it will be some time yet before the first ship, H.M.C.S. *Halifax*, joins the Fleet. Great expectations are held with respect to the new frigate, and its arrival is eagerly awaited.

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