4. Warship Designs

This Chapter relates to the design work done on a ship-by-ship basis, and from time to time involves both the specific Design House and the shipyard staff in which the particular ship was built.

As has been mentioned elsewhere, the output of the Design House invariably required Production Engineering activity in order for the particular shipyard to build the ship in detail as produced by the Design House. This also meant that if a ship class were built in more than one shipyard, as in the case of the original seven St. Laurent Class, then there would certainly be some minor differences between all (in essence) seven "lead ships". This posed a problem of configuration control so that as modifications to the ship class were produced over time the details of the design may well provide a clash in the actual build space of some of the ship class. However, ships being less congested and more able to accept minor variations than aircraft, this was not normally a major problem; e.g. ship stability was less stringent than aircraft centre of pressure and variation in mean aerodynamic chord.

This Chapter is sub-divided into 6 parts for convenience, viz:

4.1 **Warship Design –** one process followed in the design of a new warship as practised by MIL Systems Engineering.

4.2 **DE's to DDH's Ship Classes** - the design work carried out under the ***NCDO/MDDO*** contracts by the original Design Team assembled by Canadian Vickers. The design work for the various ship classes as shown in the chart contained in Chapter 1, Overview often overlapped time-wise. The design of the following warship classes were, however, contracted for separately.

4.3 **FFH 330 Halifax Class** - the Concept Design was provided by MIL Systems Engineering Inc. in Ottawa, Ontario. The Detail Design and associated Production Drawings were also provided 70% by MIL Systems Engineering and 30% by the Prime Contractor, St John Shipyard Ltd. in Saint John, New Brunswick, who contracted out much of its design work to specialist companies such as YARD Ltd. of Glasgow, Scotland for its expertise in anti-noise vibration mounting of main machinery packages, for example. Nine of the ships were built at Saint John Shipyard in New Brunswick, and the other three at the MIL Davie shipyard in Levis, Quebec.

4.4 **FHE 400 Bras d'Or Class** - the design work was carried out by de Havilland Aircraft of Canada in Downsview, Ontario, because the design philosophy was that the ship would utilize hydro-dynamic air foils to sustain its mass whenever it performed at high speed. The ship was built by Marine Industrie at Sorel, Quebec.

4.5 **DDH 280 Class TRUMP** - the design work was carried out by MIL Systems Engineering Inc.and the modification of all 4 ships was carried out by MIL Davie at Levis, Quebec.

4.6 **MCDV 700 Kingston Class** - the design work was done by Fenco MacLaren of Toronto but all 12 ships were built at HalShips in Halifax, Nova Scotia.

As a prelude to this subject, it is useful to reproduce here the technical parts of a description of the process followed in the design of a warship by MIL Systems Engineering. The document was raised for the benefit of DSS personnel to facilitate their understanding of the complexity of the process, hence the minute detail that the work entailed. The description was raised under the supervision of ***Tom Campbell***, who at the tine was Senior Vice President, Operations at MIL Systems Engineering. Sections 3, 4 and 5 of the original document are reproduced hereafter.

SECTION NO. 3 - PHILOSOPHY OF WARSHIP DESIGN

Sub-Section A - Introduction

The start point of any Warship Design rests with the Crown who identifies a need and a **Mission Profile** of the warship.

A Technical Statement of Requirements defines the operational requirements of the warship and the specific requirements of the systems that are integrated into the operating entity - **the ship.**

This "wish list" supports the Mission Profile that the Crown has indicated as its need in the overall planning of Department of National Defence. The Mission Profile and Statement of Requirements represents the first technical communication that the designer has with the Crown.

SECTION NO. 3 - PHILOSOPHY OF WARSHIP DESIGN

Sub-Section B - Spiral Design

The overall approach to a warship design is from a systems engineering viewpoint which encompasses all design, Integrated Logistic Systems engineering and management activities necessary to integrate the ship, its installed subsystems, equipment and operators into a single system compatible with the specified operational tasks and performance requirements. It also encompasses integration of the ship system with the shore support systems and infrastructure.

The basic requirement for a warship is to support a payload and achieve a specified operational criteria (for example, a maximum speed in a particular sea state or noise or survivability). The payload consists of its combat systems and crew.

The desired payload and performance to be developed for the ship are defined in the Technical Statement of Requirements and the Integrated Logistics Concept. It is the task of the designer to develop these requirements into an achievable and balanced ship design and support infrastructure within the specified economic envelope. This will be achieved during Project Definition through the means of concept and preliminary design studies leading to the Production Design.

Preliminary design supported by trade-off studies will evolve the concept design into a balanced, feasible design which meets as many of the design requirements as can be technically and economically catered for within the cost and schedule constraints.

Designing a ship is essentially an iterative process based on new technology, sound engineering and skillful trade-offs. It can be described as proceeding along a spiral, the centre of which is hopefully reached when all the features making up the design have been balanced.

Figure No. 1 provides a graphic representation of this design spiral.

During the course of the design, each of the spiral loops will have been travelled successively, and within each individual loop several internal cycles around the entire loop or on various aspects of the design may be required in order to obtain "convergence" at the end of the loop.

This iterative process has to be developed within technical and economic constraints and, therefore, throughout the development of the design trade-offs between sometimes conflicting requirements will have to be made. This trade-off process and the success of the ultimate design depends to a large extent on the skill and experience of the design team.

The design spiral depicted at Figure No. 1 emphasizes the intent that the design converges on a specific solution and indicates the sensitivity of the solution to a change in one of a number of features. It does not, however, convey the openness of the design process. Figure No. 2 suggests another model in which the classic design spiral can be seen as a section through a gradually converging conical solid. This allows for the many dialogues and constraints which operate on the designer to be shown as fundamental to the process. Figure No. 3 identifies three categories of constraints that impinge on the design of a ship:

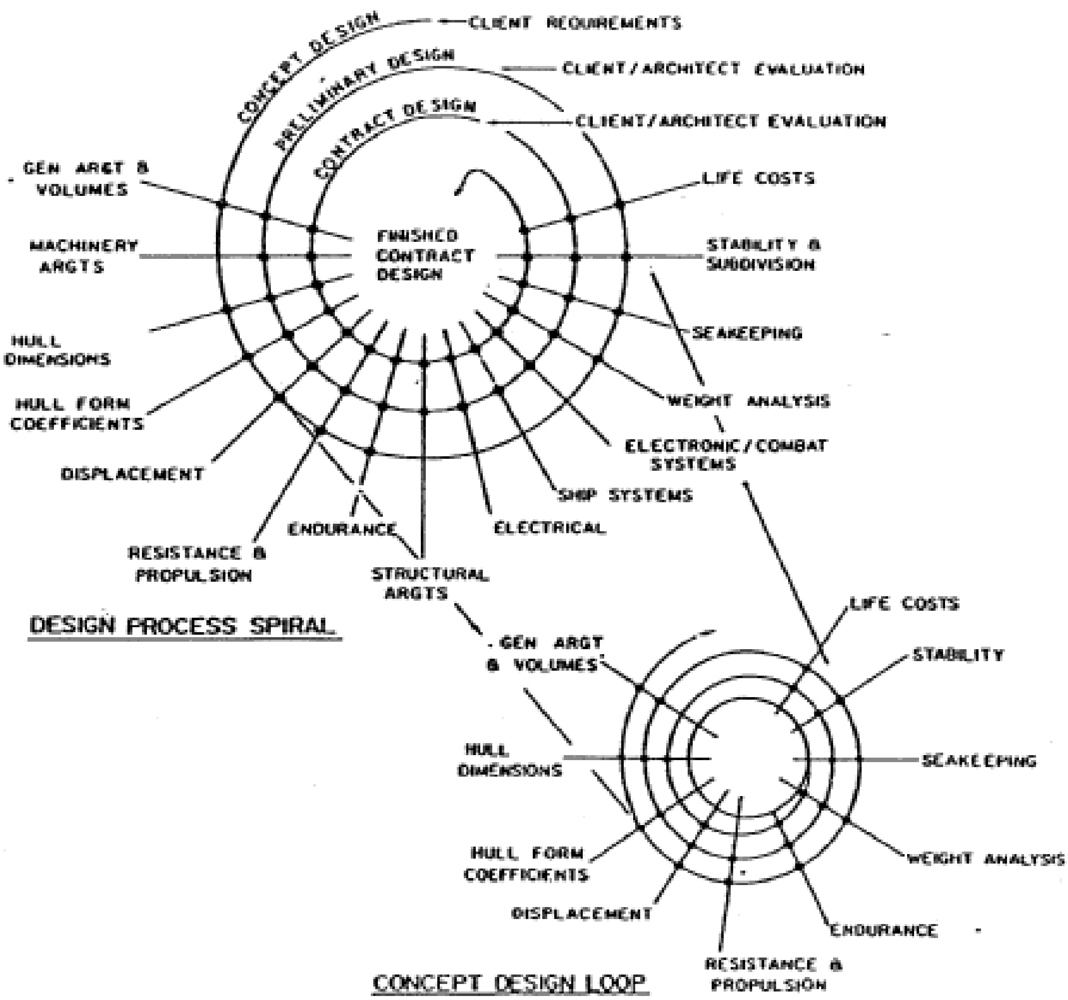
a) those directly and usually explicitly stated

b) those directly limiting the scope of the designer

c) those wider constraints on the environment in which the designer functions

Figure No. 3 is a table which attempts to explain these categories by giving typical examples of each.

Given the basically multi-functional nature of warships, in that they have many, often conflicting requirements all of which have to be met to some degree, the designer's problem is one of achieving a balanced and adaptable solution. Any discussion of the ship design process which neglects the limitations imposed by constraints on the designer is unlikely to provide a real framework within which the design may proceed.



CONCEPT DESIGN
CLIENT REQUIREMENTS
PRELIMINARY DESIGN
CLIENT / ARCHITECT EVALUATION
CONTRACT DESIGN
CLIENT/ARCHITECT EVALUATION
GEN ARGT & VOLUMES
LIFE COSTS
MACHINERY ARGTS
FINISHED CONTRACT DESIGN
STABILITY & SUBDIVISION
HULL DIMENSIONS
SEAKEEPING
HULL FORM COEFFICIENTS
WEIGHT ANALYSIS
DISPLACEMENT
ELECTRONIC / COMBAT SYSTEMS
SHIP SYSTEMS
ENDURANCE
ELECTRICAL
RESISTANCE & PROPULSION
STRUCTURAL ARGTS
DESIGN PROCESS SPIRAL
LIFE COSTS
GEN ARGT & VOLUMES
STABILITY
HULL DIMENSIONS
SEAKEEPING
HULL FORM COEFFICIENTS
WEIGHT ANALYSIS
DISPLACEMENT
ENDURANCE
RESISTANCE & PROPULSION
CONCEPT DESIGN LOOP

Figure 1

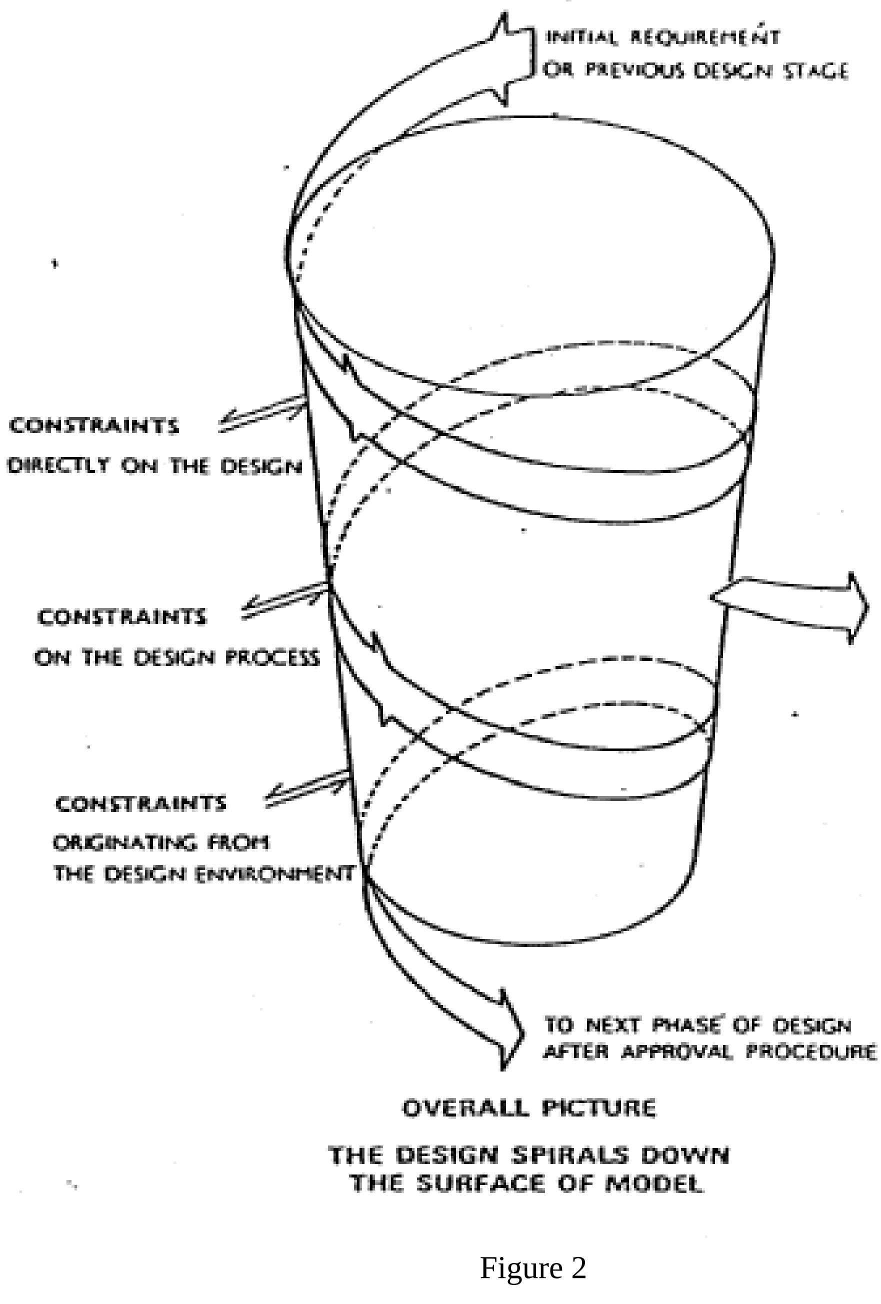

INITIAL REQUIREMENT
OR PREVIOUS DESIGN STAGE
CONSTRAINTS
DIRECTLY ON THE DESIGN
CONSTRAINTS
ON THE DESIGN PROCESS
CONSTRAINTS
ORIGINATING FROM
THE DESIGN ENVIRONMENT
TO NEXT PHASE OF DESIGN
AFTER APPROVAL PROCEDURE
OVERALL PICTURE
THE DESIGN SPIRALS DOWN
THE SURFACE OF MODEL

Figure 2

CONSTRAINTS IN SHIP DESIGN – TYPICAL EXAMPLES

Direct Constraints on the Design	Constraints on the Design Process	Constraints Originating from The Design Environment
Minimise Building Time	Structure of the Design Organisation	Physical and Natural environment. Political climate
Reduce manpower on the ship	Relationship of the designer with customer	Economic Climate
Reduce specialised manpower on the ship	Attitude of the design organisation to the latest design techniques	The exact manner in which money is funded
Minimise the maintenance load required at the ship	Past design type ship data available	The need to comply with new laws (eg health and safety during build)
Simplify production process in the shipyard	Countries of origin of designer or design methods	The strategic and political necessity to spread work round the shipyards
Fit up-to-date equipment which is being concurrently developed with the ship	The need or ability to buy-in talent to the design team	The decision to reduce direct government research
Minimise time in refit	Specialisation and training of design team	
Minimise time in port	State of the art in the various fields	
Comply with international rules existing or likely to come into force	Computer facilities directly on tap and their limitations	
Minimise training load to operate ship	Quality of general engineering data directly available	
	Research facilities directly under the designers' control	
	The idosyncracies, prejudices, rivalries, personalities of the design team	

NOTE: The above examples are not comprehensive. They serve to illustrate the difference in the three categories of 'constraints'.

Figure 3

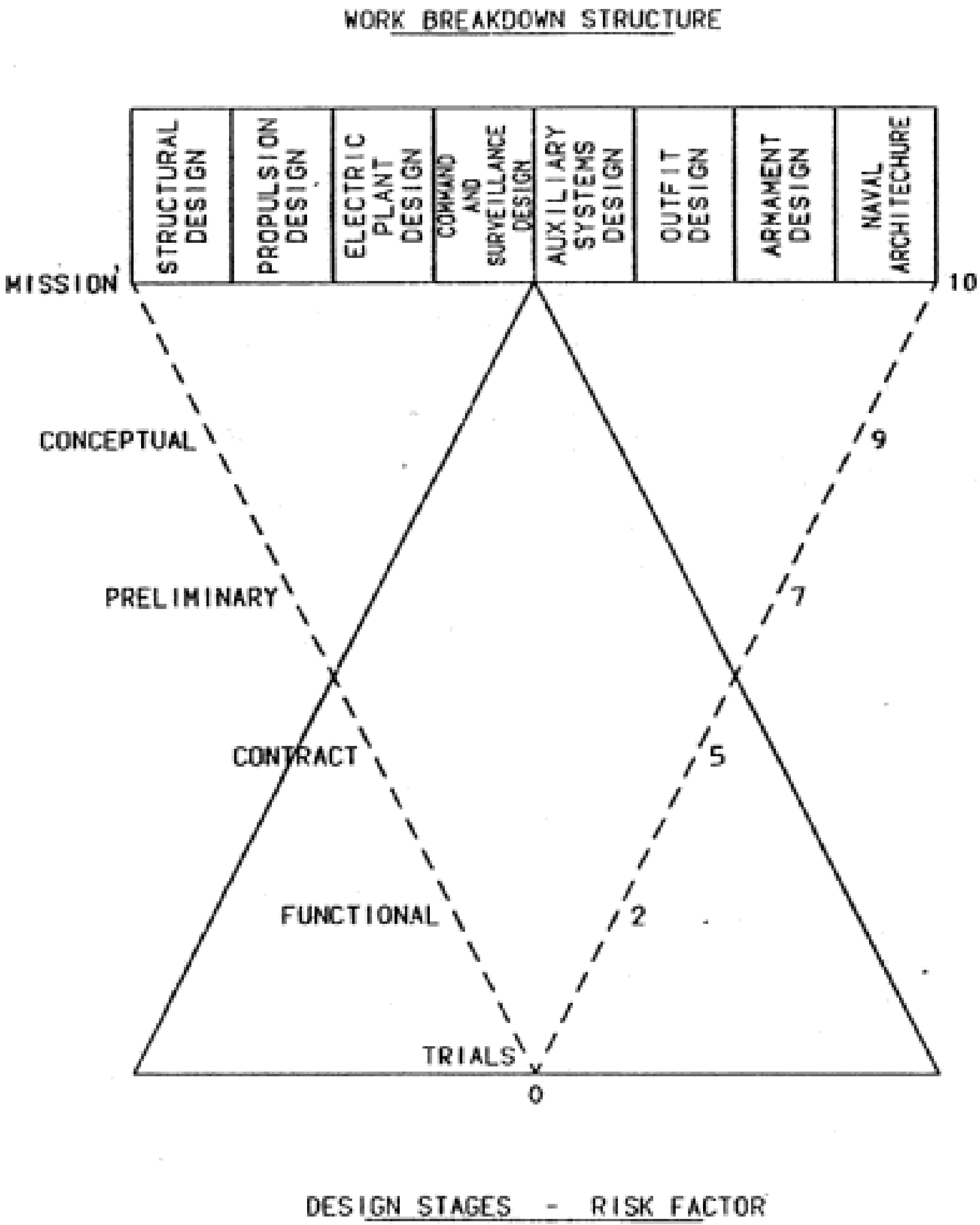

WORK BREAKDOWN STRUCTURE
STRUCTURAL DESIGN
PROPULSION DESIGN
ELECTRIC PLANT DESIGN
COMMAND AND SURVEILLANCE DESIGN
AUXILIARY SYSTEMS DESIGN
OUTFIT DESIGN
ARMAMENT DESIGN
NAVAL ARCHITECHURE
MISSION
10
CONCEPTUAL
9
PRELIMINARY
7
CONTRACT
5
FUNCTIONAL
2
TRIALS
0
DESIGN STAGES - RISK FACTOR

Figure 4

SECTION NO. 4 - WARSHIP DESIGN STAGES

Sub-Section B - Mission Profile

The Crown's Mission Profile for the proposed Warship is passed to the designer outlining the operational and performance requirements.

The Mission Profile indicates a "wish list" of requirements from which feasibility studies will be carried out during the sequential design stages.

Warships, unlike aircraft are built without preliminary prototype work and the R&D element tends to be overlooked.

Unless the Crown specifies an existing design variation, the design at this point is nothing but a Blank Piece of Paper.

Unlike commercial type ships which are designed to meet the rules of regulatory bodies, eg., Lloyds, warships are designed using both existing technical calculation methods and other methods still being developed to meet the specific requirements of a new warship design.

The product from this point on represents R&D and not the tasks or methods applied.

The risk factor at this stage of the design cycle is normally accepted as ten (10) on a rating of one (1) to ten (10).

SECTION NO. 4 - WARSHIP DESIGN STAGES

Sub-Section C - Conceptual Design

The Mission Profile and the Statement of Requirements is the baseline data used to undertake the Conceptual Design.

The following highlights the approach to the concept design process:

- After a review of the baseline data, an estimate will be made of volume and dimensional requirements based on general arrangement features. Design studies/parametric trade-offs will be initiated.

- A matrix of ship forms will be generated from first principles covering the anticipated range of displacement and principal hull dimensions. A resistance prediction method based on standard series will generate data on this matrix and determine good values for hull form coefficients to minimize fuel consumption and for good seakeeping.

- A parametric study will be conducted based on principal hull dimensions and selected coefficients to determine hull form limitations imposed by seakeeping criteria.

- Available hull volume will be calculated as a function of main hull parameters. When compared to the volume required, this will impose constraints on the selection of hull dimensions.

- An estimate will be made of ship displacement. The displacement line becomes an additional constraint on the hull form selection.

- From the assembled data, the design point may be chosen. The effect of moving to any other design point should also be apparent.

- As the Concept Design proceeds, results of other design studies will be fed into the design. Dimensional and form changes will be made as appropriate so that the design point stays within the bounds of limiting criteria.

The complexity and uniqueness of integrating the very stringent requirements of a warship design can only be controlled and progressed through the iteration process as described in Section No. 3, Sub-Section B - Spiral Design.

There will be Design Reviews with the Crown to monitor the Design Options. These Reviews will culminate with an agreed Conceptual Design Baseline.

The risk factor will have decreased to nine (9) on a scale of one (1) to ten (10).

SECTION NO. 4 - WARSHIP DESIGN STAGES

Sub-Section D - Preliminary Design

The Conceptual Design baseline is the data used to commence the Preliminary Design.

The Preliminary Design stage may be defined as that set of activities which will lead to one or more sets of definitive Warship Designs, each of which "satisfies the Customer's Statement of Requirements".

All major equipment options will be identified and assessed, and a recommended system incorporated into a set of hull options.

The hull options will be sufficiently broad so that all "Technically Feasible Combinations" of major equipments or systems are defined and the subsequent choice of supplier (of major equipment) will not cause major changes in weight, cost or layout.

All potential major system equipment options will be identified.

Recommended systems/equipment options will be proposed and supported by analysis in terms of operational capability, weight, maintenance and cost.

It is not intended that tenders for various equipments and systems be received during the Preliminary Design stage, therefore weight and cost estimates must be based on best available information.

The cooperative approach between the Crown and Designer is monitored with Design Reviews. These Reviews generate a confidence in the design process and establish a new Preliminary Design baseline.

The risk factor is decreasing as the design data begins to firm up.

The risk factor at the end of the Preliminary Design stage will be seven (7) on a scale of one (1) to ten (10).

SECTION NO. 4 - WARSHIP DESIGN STAGES

Sub-Section E - Contract Design

The Preliminary Design baseline is the data used to commence the Contract Design.

The Contract Design is the development of the design option(s) accepted by the Crown after the last Design Review of the Preliminary Design stage.

Preliminary Design addressed major features whereas Contract Design will address the entire ship in greater detail.

During this stage it may be necessary to process one or more loops around the design spiral (Section No. 3, Sub-Section B-Spiral Design) to advance features such as:

- hull form based on a faired set of lines and model tests
- powering based on model testing
- seakeeping and manoeuvring characteristics based on model testing and computer analysis
- structural details and materials
- general arrangements
- machinery, electrical and electronic/weapons systems

At this stage equipments and systems requirements will be progressed to a point where definitive selections can be considered.

Tenders will be raised for the equipment and systems allowing the weight and cost estimates to be updated.

The design will continue to be monitored by the Crown and designer during the ongoing design reviews. These reviews tend to become more frequent as financial commitments have to be made on hardware.

The risk factor is further decreasing as the design is developed into a package where builders may be asked to price for construction.

The risk factor at the end of the Contract Design stage will be five (5) on a scale of one (1) to ten (10).

SECTION NO. 4 - WARSHIP DESIGN STAGES

Sub-Section F - Functional Design for Construction

The Contract Design baseline is the data used to commence the Functional Design which defines the transition phase into construction data.

At this stage of the design cycle new methods and concepts of ship construction are probably the most underestimated stage in the whole design process. Modular construction is not new to the industry in Canada, however module construction for warships has only been attempted in the projects listed in Section No. 6.

The Japanese shipbuilding industry are the leaders in this method but have only perfected the procedures for their commercial vessels which are less sophisticated and do not have the space or operational restrictions of a warship.

Three (3)-way review meetings take place between the Crown, designer and shipyard to discuss and agree on proposed design changes to facilitate the requirements of the shipyard.

It is hoped that the changes will not effect the design and performance requirements of the vessel, however one more loop around the design spiral is necessary to decrease the risk factor and achieve agreement amongst the Crown, designer and builder of this warship.

The factor at the end of the functional design for construction will be two (2) on a scale of one (1) to ten (10).

The equivalent of the aircraft prototype can now start to be built.

SECTION NO. 4 - WARSHIP DESIGN STAGES

Sub-Section G - Production Design and Trials

The Functional Design data is used to commence the Production Design.

During the construction stage of the project, the normal day to day problems are resolved through direct communication between the designer and the shipyard tradesmen.

There does however remain risk that new technology introduced at earlier phases cannot be accommodated as planned leading to rework and in some cases a revisiting of the design spiral.

The remaining design risk can only be removed at the successful completion of the systems and ship trials.

At this point in time the ship should successfully meet all of the State of Requirements and have a capability to perform to the Mission Profile for the Crown.

Thousands of engineers, technicians, draftsmen and tradesmen have had their input into the design and build of the first ship- THE PROTOTYPE.

SECTION NO. 5 - DESIGN RISK QUANTIFICATION

Sub-Section A - Introduction

To quantify the risk involved with a warship design one must appreciate Section No's 3 and 4.

The initial blank pices of paper indicates a high risk to the completion of the trials with no risk.

The sub-section and figures included in this section identifies and quantifies the risk values through the whole design cycle.

SECTION NO. 5 - DESIGN RISK QUANTIFICATION

Sub-Section B - Risk Matrix

During the design stages of a warship, historically the risks are generally identified with the following areas:

- Hull Space and Weight Infraction
- Lines and Powering
- Propeller Design
- Stability, Damage Stability, Trim, Seakeeping
- Strength, Structural Design
- Machinery Selection
- Electrical Design
- Weapons Integration
- Signature, Noise, Vibration, Shock
- Vulnerability, Manning, Redundancy Considerations

The design problems associated with the risk areas interact with more than one discipline, i.e., the propeller design will effect the hull structure and lines.

The following matrices identifies this interaction and endeavours to quantify the risk value e.g., H - High; M - Medium; L - Low; N - Nil at the completion of each of the design stages.

The matrices are listed as follows:

Figure No. 5 - Mission Profile

Figure No. 6 - Conceptual Design

Figure No. 7 - Preliminary Design

Figure No. 8 - Contract Design

Figure No. 9 - Functional Design

Figure No. 10 - Production Design and Trials

"B"

RISK AREAS	STRUCTURAL DESIGN	PROPULSION DESIGN	ELECTRIC PLANT DESIGN	COMMAND & SURVEILLANCE DESIGN	AUXILIARY SYSTEMS DESIGN	OUTFIT DESIGN	ARMAMENT DESIGN	NAVAL ARCHITECTURE
HULL SPACE & WEIGHT INFRACTION	H	H	H	H	H	H	H	H
LINES & POWERING	H	H	H					H
PROPELLER DESIGN	H	H						H
STABILITY, DAMAGE STABILITY TRIM, SEAKEEPING	H							H
STRENGTH, STRUCTURAL DESIGN	H							H
MACHINERY SELECTION	H	H			H			H
ELECTRICAL DESIGN			H					H
WEAPONS INTEGRATION	H		H	H	H		H	H
SIGNATURE, NOISE, VIBRATION, SHOCK	H	H	H	H	H	H	H	H
VULNERABILITY, MANNING REDUNDANCY CONSIDERATIONS	H	H	H	H	H	H	H	H

"A"

RISK "A" ON "B"

FIGURE #5 MISSION PROFILE

RISK AREAS	STRUCTURAL DESIGN	PROPULSION DESIGN	ELECTRIC PLANT DESIGN	COMMAND & SURVEILLANCE DESIGN	AUXILIARY SYSTEMS DESIGN	OUTFIT DESIGN	ARMAMENT DESIGN	NAVAL ARCHITECTURE
HULL SPACE & WEIGHT INFRACTION	H	M	M	H	M	M	H	H
LINES & POWERING	H	H	H					H
PROPELLER DESIGN	H	H						H
STABILITY, DAMAGE STABILITY TRIM, SEAKEEPING	H							H
STRENGTH, STRUCTURAL DESIGN	H							H
MACHINERY SELECTION	H	H			M			M
ELECTRICAL DESIGN			H					M
WEAPONS INTEGRATION	H		H	H	H		H	H
SIGNATURE, NOISE, VIBRATION, SHOCK	H	H	H	H	H	H	H	H
VULNERABILITY, MANNING REDUNDANCY CONSIDERATIONS	M	H	H	H	H	H	M	H

"A" (rows) "B" (columns)

RISK "A" ON "B"

FIGURE #6 CONCEPTUAL DESIGN

"B"

RISK AREAS	STRUCTURAL DESIGN	PROPULSION DESIGN	ELECTRIC PLANT DESIGN	COMMAND & SURVEILLANCE DESIGN	AUXILIARY SYSTEMS DESIGN	OUTFIT DESIGN	ARMAMENT DESIGN	NAVAL ARCHITECTURE
HULL SPACE & WEIGHT INFRACTION	M	M	M	M	M	M	M	M
LINES & POWERING	M	M	M					M
PROPELLER DESIGN	M	M						M
STABILITY, DAMAGE STABILITY TRIM, SEAKEEPING	H							H
STRENGTH, STRUCTURAL DESIGN	M							H
MACHINERY SELECTION	M	M			M			M
ELECTRICAL DESIGN			M					M
WEAPONS INTEGRATION	M		M	M	M		M	M
SIGNATURE, NOISE, VIBRATION, SHOCK	M	H	H	H	H	M	M	H
VULNERABILITY, MANNING REDUNDANCY CONSIDERATIONS	L	M	H	H	H	M	L	H

"A"

RISK "A" ON "B"

FIGURE #7 PRELIMINARY DESIGN

"B"

RISK AREAS	STRUCTURAL DESIGN	PROPULSION DESIGN	ELECTRIC PLANT DESIGN	COMMAND & SURVEILLANCE DESIGN	AUXILIARY SYSTEMS DESIGN	OUTFIT DESIGN	ARMAMENT DESIGN	NAVAL ARCHITECTURE
HULL SPACE & WEIGHT INFRACTION	M	L	L	M	L	L	M	M
LINES & POWERING	L	L	L					L
PROPELLER DESIGN	L	L						L
STABILITY, DAMAGE STSBILITY TRIM, SEAKEEPING	M							M
STRENGTH, STRUCURAL DESIGN	M							M
MACHINERY SELECTION	L	L			L			L
ELECTRICAL DESIGN			L					L
WEAPONS INTEGRATION	L,		M	M	L		L	L
SIGNATURE, NOISE, VIBRATION, SHOCK	M	M	M	M	M	M	M	M
VULNERABILITY, MANNING REDUNDANCY CONSIDERATIONS	L	L	L	L	L	L	L	L

"A"

RISK "A" ON "B"

FIGURE #8 CONTRACT DESIGN

"B"

RISK AREAS	STRUCTURAL DESIGN	PROPULSION DESIGN	ELECTRIC PLANT DESIGN	COMMAND & SURVEILLANCE DESIGN	AUXILIARY SYSTEMS DESIGN	OUTFIT DESIGN	ARMAMENT DESIGN	NAVAL ARCHITECTURE
HULL SPACE & WEIGHT INFRACTION	L	N	N	L	N	N	L	L
LINES & POWERING	N	L	N					L
PROPELLER DESIGN	N	L						L
STABILITY, DAMAGE STABILITY TRIM, SEAKEEPING	L							L
STRENGTH, STRUCTURAL DESIGN	L							L
MACHINERY SELECTION	N	N			N			N
ELECTRICAL DESIGN			N					N
WEAPONS INTEGRATION	N		L	L	N		N	N
SIGNATURE, NOISE, VIBRATION, SHOCK	L	L	L	L	L	L	L	L
VULNERABILITY, MANNING REDUNDANCY CONSIDERATIONS	L	L	L	L	L	L	L	L

"A"

RISK "A" ON "B"

FIGURE #9 FUNCTIONAL DESIGN

"B"

RISK AREAS	STRUCTURAL DESIGN	PROPULSION DESIGN	ELECTRIC PLANT DESIGN	COMMAND & SURVEILLANCE DESIGN	AUXILIARY SYSTEMS DESIGN	OUTFIT DESIGN	ARMAMENT DESIGN	NAVAL ARCHITECTURE
HULL SPACE & WEIGHT INFRACTION	N	N	N	N	N	N	N	N
LINES & POWERING	N	N	N					N
PROPELLER DESIGN	N	N						N
STABILITY, DAMAGE STABILITY TRIM, SEAKEEPING	N							N
STRENGTH, STRUCTURAL DESIGN	N							N
MACHINERY SELECTION	N	N			N			N
ELECTRICAL DESIGN			N					N
WEAPONS INTEGRATION	N		N	N	N		N	N
SIGNATURE, NOISE, VIBRATION, SHOCK	N	N	N	N	N	N	N	N
VULNERABILITY, MANNING REDUNDANCY CONSIDERATIONS	N	N	N	N	N	N	N	N

"A"

RISK "A" ON "B"

FIGURE #10 PRODUCTION DESIGN & TRIALS

4.2

DE's to DDH's SHIP CLASSES
Designs & Ship Upgrading

*All of the following warships were either designed and/or upgraded by the original Vickers Design Office staff under the NCDO/MDDO contract. The following data is prefaced in each case by extracts taken from "Jane's Fighting Ships 1991-92" edited for Jane's Information Group by Capt. Richard Sharpe RN **(13)**, and from "The Ships of Canada's Naval Forces 1910-1981" By MacPherson & Burgess **(17)**.*

DE 205 (St. Laurent Class)

Frigates / CANADA 85

4 ST LAURENT CLASS

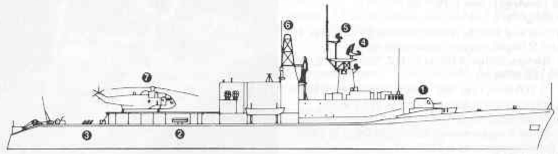
Name	*No*	*Builders*	*Laid down*	*Launched*	*Commissioned*
SKEENA	207	Burrard Dry Dock & Shipbuilding	1 June 1951	19 Aug 1952	30 Mar 1957
OTTAWA	229	Canadian Vickers Ltd, Montreal	8 June 1951	29 Apr 1953	10 Nov 1956
MARGAREE	230	Halifax Shipyards Ltd, Halifax	12 Sep 1951	29 Mar 1956	5 Oct 1957
FRASER	233	Yarrows Ltd, Esquimalt, BC	11 Dec 1951	19 Feb 1953	28 June1957

Displacement, tons: 2260 standard; 3051 full load (after conversion)
Dimensions, feet (metres): 366 × 42 × 14 (hull) *(111.6 × 12.8 × 4.3)*
Main machinery: 2 English Electric geared turbines; 30 000 shp; 2 shafts. 2 Babcock and Wilcox water tube boilers
Speed, knots: 28. **Range, miles:** 4570 at 12 kts
Complement: 213 (16 officers) plus 20 aircrew (7 officers)

Guns: 2 FMC 3 in *(76 mm)*/50 Mk 33 (twin) ❶; dual purpose; 85° elevation; 50 rounds/minute to 12.8 km *(7 nm)*; weight of shell 6 kg.
Torpedoes: 6—324 mm Mk 32 (2 triple) tubes ❷. Honeywell Mk 46; anti-submarine; active/passive homing to 11 km *(5.9 nm)* at 40 kts; warhead 44 kg. A few Mk 44 torpedoes are still in service.
A/S mortars: 1 Limbo Mk 10 (3 tubed) ❸; automatic loading; range 1000 m; warhead 92 kg (see *Structure*).
Countermeasures: ESM: WLR 1; radar warning.
Fire control: GFCS Mk 63.
Radars: Air search: RCA SPS 12 ❹; D band; range 119 km *(65 nm)*.
Surface search: Raytheon SPS 10 ❺; G band.
Fire control: Bell SPG 48; I/J band.
Navigation: Sperry Mk II; I band.
Tacan: URN 20 ❻.
Sonars: SQS 503; hull-mounted; active search and attack; medium frequency.
SQS 504; VDS; active search; medium frequency; or SQR 19 (wet end only in *Fraser*) towed array.
SQS 502; hull-mounted; active attack (mortar control); high frequency.
SQS 501; hull-mounted; bottom target classification; high frequency.

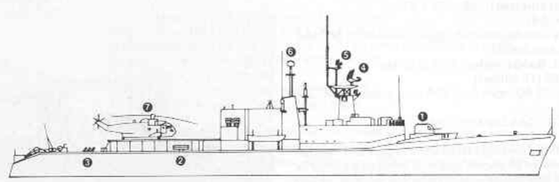
Helicopters: 1 CH-124A Sea King ASW ❼.

Programmes: Officially classified as DDH. The first major warships to be designed in Canada—much assistance was received from the Royal Navy (propelling machinery of British design) and the US Navy.
Modernisation: All modernised under Delex programme 1979-82 although no new sensors were included. Towed array sonar fitted to *Fraser* in 1988.
Structure: Twin funnels were fitted to permit fwd extension of the helicopter hangar. Fitted with fin stabilisers. Gunhouses are of glass fibre. In providing helicopter platforms and hangars it was possible to retain only one 3-barrelled Limbo mortar although this is inoperative when towed array is carried. *Fraser* has lattice radar-mast between the funnels for Tacan aerial. All other ships have this aerial on a pole mast.
Operational: *Assiniboine* paid off in 1989 and is used as a harbour training ship at Halifax. The four remaining ships of the class are planned to decommission in the early 1990s.



FRASER (Scale 1 : 1 200), Ian Sturton

FRASER 10/1988, Maritime Photographic



ST. LAURENT Class (except *Fraser*) (Scale 1 : 1 200) Ian Sturton

There were actually 7 ships in this class, viz:

St. Laurent DE 205
Saguenay DE 206
Assiniboine DE 234

Destroyer Escorts

St. Laurent Class

HMCS St. Laurent, launched in 1951, was the first A/S vessel designed and built in Canada. She and her six sisters, classed as destroyer escorts (DDEs), were originally armed with two twin 3-inch guns and two Limbo A/S mortar mounts, the latter located in a well beneath the quarterdeck. From 1962 to 1966 all seven were extensively rebuilt as destroyer helicopter escorts (DDHs), emerging with a hangar and flight deck. Space for the hanger was made by twinning the original single stack, while the flight deck necessitated the removal of one gun and one Limbo mount. The stern was rebuilt to accommodate equipment for handling variable depth sonar, a Canadian development that overcomes the problem of water layers at varying depths, which confuse fixed sonar systems.

Restigouche Class

A second class of seven DDEs, the Restigouche class, entered service between 1958 and 1959. They approximated very closely the original *St. Laurent* design, but four of them were rebuilt, from 1967 to 1972, with an A/S rocket (ASROC) launcher aft in place of the after turret, a disproportionately tall mast, and a stern re-designed to accommodate VDS. None of the four rebuilt carries a helicopter. The three not rebuilt, *Chaudière*, *Columbia*, and *St. Croix*, were reduced to Category 'C' reserve in 1974. *St. Croix* serves as a harbour training ship at Halifax; the other two lie at Esquimalt.

DE 235 (Improved Restigouche Class)

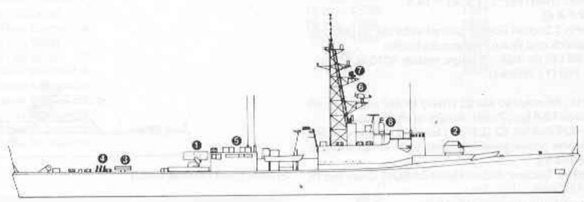
4 IMPROVED RESTIGOUCHE CLASS

Name	No	Builders	Laid down	Launched	Commissioned
GATINEAU	236	Davie Shipbuilding & Repairing	30 Apr 1953	3 June 1957	17 Feb 1959
RESTIGOUCHE	257	Canadian Vickers, Montreal	15 July 1953	22 Nov 1954	7 June 1958
KOOTENAY	258	Burrard Dry Dock & Shipbuilding	21 Aug 1952	15 June 1954	7 Mar 1959
TERRA NOVA	259	Victoria Machinery Depot Co	14 Nov 1952	21 June 1955	6 June 1959

Displacement, tons: 2390 standard; 2900 full load
Dimensions, feet (metres): 371 × 42 × 14.1 *(113.1 × 12.8 × 4.3)*
Main machinery: 2 English Electric geared turbines; 30 000 shp; 2 shafts. 2 Babcock and Wilcox water tube boilers
Speed, knots: 28. **Range, miles:** 4750 at 14 kts
Complement: 214 (13 officers)

Missiles: SSM: 8 McDonnell Douglas Harpoon during Gulf deployments in 1990-91.
A/S: Honeywell ASROC Mk 112 octuple launcher ❶; 8 reloads; inertial guidance to 1.6-10 km *(1-5.4 nm)*; payload Mk 46 torpedo. Replaced by 8 Harpoon during Gulf deployments.
Guns: 2 Vickers 3 in *(76 mm)*/70 (twin) Mk 6 ❷; dual purpose; 90° elevation; 90 rounds/minute to 17 km *(9 nm)*; weight of shell 7 kg.
1 Vulcan Phalanx and 2 Bofors 40 mm/60 during Gulf deployments.
Torpedoes: 6—324 mm Mk 32 (2 triple) tubes ❸. Honeywell Mk 46; anti-submarine; active/passive homing to 11 km *(5.9 nm)* at 40 kts; warhead 44 kg.
A/S mortars: 1 Limbo Mk 10 (3 tubed) ❹; automatic loading; range 1000 m; warhead 92 kg. Replaced by Phalanx during Gulf deployments in 1990-91.
Countermeasures: Decoys: 4 Loral Hycor SRBOC Mk 36 ❺; 4 launchers with 4 fixed barrels firing Chaff decoys and IR flares to 4 km *(2.2 nm)*. Plessey Shield Chaff launchers during Gulf deployments in 1990-91.
ESM: Canews; radar warning.
ECM: ULQ-6; jammer.
Combat data systems: Litton ADLIPS; automated data handling; Links 11 and 14. SATCOM for Gulf deployments.
Fire control: GFCS Mk 69.
Radars: Air search: Marconi SPS 503 (CMR 1820) ❻; E/F band; range 128 km *(70 nm)*.
Surface search: Raytheon SPS 10 ❼; G band.
Navigation: Decca 127E; I band.
Fire control: Bell SPG 48 ❽; I/J band.
Tacan: URN 25.
Sonars: Westinghouse SQS 505; combined VDS and hull-mounted; active search and attack; 7 kHz.
C-Tech mine avoidance active (for Gulf deployments).
SQS 501; hull-mounted; bottom target classification; high frequency.

Programmes: Officially classified as DD.
Modernisation: These four ships were first refitted with ASROC aft and lattice foremast. Work included removing the after 3 in/50 twin gun mounting and one Limbo A/S Mk 10 triple mortar, to make way for ASROC and variable depth sonar. Refits also included improvements to communications fit and completed 1968-73. Three other ships of the class were paid off without being refitted. All four modernised again under Delex programme 1983-86 with new air radar, GFCS, communications and EW equipment. The Bofors rocket launcher replaced by Super RBOC and Tacan fitted on a pole mast replacing the top section of the lattice mast. Triple Mark 32 torpedo tubes fitted. Extension until 1991-94.



GATINEAU (Scale 1 : 1 200), *Ian Sturton*

TERRA NOVA (with Gulf fit) *9/1990, Photo Sami*

Operational: All based in the Pacific Fleet. *Columbia* (paid off in 1974) is used as a harbour training ship at Esquimalt. *Terra Nova* deploying to the Gulf in September 1990 had the ASROC launcher replaced by 8 Harpoon SSM, the Limbo Mk 10 by Phalanx, and the ships boats by two single Bofors 40 mm/60. Additional 12.7 mm MGs can be carried plus Blowpipe and Javelin shoulder-launched SAM. *Restigouche* similarly modified in early 1991.

Actually, there were 7 ships in this class, viz:

Chaudiere DE 235
Colombia DE 260
St. Croix DE 256

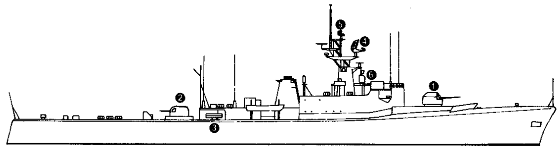
DE 261 (MacKenzie Class)

4 MACKENZIE CLASS

Name	*No*	*Builders*	*Laid down*	*Launched*	*Commissioned*
MACKENZIE	261	Canadian Vickers Ltd, Montreal	15 Dec 1958	25 May 1961	6 Oct 1962
SASKATCHEWAN	262	Victoria Machinery (and Yarrows Ltd)	16 July 1959	1 Feb 1961	16 Feb 1963
YUKON	263	Burrard Dry Dock & Shipbuilding	25 Oct 1959	27 July 1961	25 May 1963
QU'APPELLE	264	Davie Shipbuilding & Repairing	14 Jan 1960	2 May 1962	14 Sep 1963

Displacement, tons: 2380 standard; 2880 full load
Dimensions, feet (metres): 366 × 42 × 13.5 *(111.6 × 12.8 × 4.1)*
Main machinery: 2 English Electric geared turbines; 30 000 shp; 2 shafts. 2 Babcock and Wilcox water tube boilers
Speed, knots: 28. **Range, miles:** 4750 at 14 kts
Complement: 210 (11 officers)

Guns: 2 Vickers 3 in *(76 mm)*/70 Mk 6 mounting (twin) (not in *Qu'Appelle*) ❶; 90° elevation; 90 rounds/minute to 17 km *(9 nm)*; weight of shell 7 kg.
2 FMC 3 in *(76 mm)*/50 Mk 33 mounting (twin) (second mounting fwd in *Qu'Appelle*) ❷; 85° elevation; 50 rounds/minute to 12.8 km *(7 nm)*; weight of shell 6 kg.
Torpedoes: 6—324 mm Mk 32 (2 triple) tubes ❸. Honeywell Mk 46; anti-submarine; active/passive homing to 11 km *(5.9 nm)* at 40 kts; warhead 44 kg.
Countermeasures: ESM: WLR 1; radar warning.
Combat data systems: Litton ADLIPS; automated tactical data handling; Links 11 and 14.
Fire control: GFCS Mk 69. GFCS Mk 63.
Radars: Air search: RCA SPS 12 ❹; D band; range 119 km *(65 nm)*.



MACKENZIE *(Scale 1 : 1 200), Ian Sturton*

Surface search: Raytheon SPS 10 ❺; G band.
Fire control: SPG 48 ❻; I/J band.
SPG 34; I/J band.
Sonars: Westinghouse SQS 505; combined VDS and hull-mounted; active search and attack; medium frequency.
SQS 501; hull-mounted; bottom target classification; high frequency.

Programmes: Officially classified as DD.

Modernisation: All modernised at Esquimalt by Burrard/Yarrow Inc under Delex (Destroyer Life Extension Programme) 1982-85 including improved sonar and communications, and modifications to SPS 12 radar. Extension until 1991-93 but may be further extended.
Operational: All based in the Pacific Fleet.

Mackenzie, June, 1967

Mackenzie Class

The four Mackenzie class DDEs, which entered service between 1962 and 1963, essentially repeat the original *Restigouche* design, while the two Nipigon class DDHs of 1964 incorporated from their launching the design elements of the rebuilt *St. Laurents*, and carry helicopters.

DE 265 (Annapolis Class)

2 ANNAPOLIS CLASS

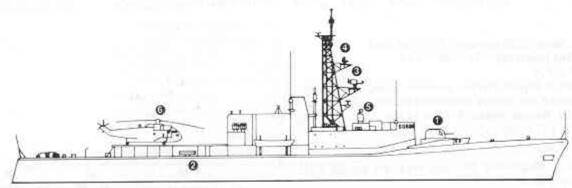
Name	*No*	*Builders*	*Laid down*	*Launched*	*Commissioned*
ANNAPOLIS	265	Halifax Shipyards Ltd, Halifax	July 1960	27 Apr 1963	19 Dec 1964
NIPIGON	266	Marine Industries Ltd, Sorel	Apr 1960	10 Dec 1961	30 May 1964

Displacement, tons: 2400 standard; 2930 full load
Dimensions, feet (metres): 371 × 42 × 14.4 *(113.1 × 12.8 × 4.4)*
Main machinery: 2 English Electric geared turbines; 30 000 shp; 2 shafts. 2 Babcock and Wilcox water tube boilers
Speed, knots: 28 (30 on trials). **Range, miles:** 4570 at 14 kts
Complement: 210 (11 officers)

Guns: 2 FMC 3 in *(76 mm)*/50 Mk 33 (twin) ❶; 85° elevation; 50 rounds/minute to 12.8 km *(7 nm)*; weight of shell 6 kg.
Torpedoes: 6—324 mm Mk 32 (2 triple) tubes ❷. Honeywell Mk 46; anti-submarine; active/passive homing to 11 km *(5.9 nm)* at 40 kts; warhead 44 kg.
Countermeasures: Decoys: 4 Loral Hycor SRBOC; Chaff and IR flares to 4 km *(2.2 nm)*.
ESM: MEL Canews; radar warning; 0.5-18 GHz.
Combat data systems: Litton ADLIPS automated tactical data handling; Links 11 and 14.
Fire control: GFCS Mk 60.
Radars: Air/surface search: Marconi SPS 503 (CMR 1820) ❸; E/F band; range 128 km *(70 nm)*.
Surface search: Raytheon/Sylvania SPS 10 ❹; G band.
Fire control: Bell SPG 48 ❺; I/J band.
Tacan: URN 25.
Sonars: Westinghouse SQS 505; hull-mounted; active search and attack; 7 kHz.
SQS 501; hull-mounted; bottom target classification; high frequency.
CDC SQR 501 CANTASS; trials towed array; passive; very low frequency. Uses part of SQR-19.

Helicopters: 1 CH-124A Sea King ASW ❻.

Programmes: Officially classified as DDH. These two ships represented the logical development of the original St Laurent class, through the Restigouche and Mackenzie designs.
Modernisation: A full Delex (Destroyer Life Extension Programme) took place in 1982-85 including new air radar, GFC, communications, sonar and EW equipment. Extension until 1994-96. Both ships fitted with a trials CANTASS vice VDS in 1987/88; in service date is expected to be 1991.
Operational: *Annapolis* is based in the Pacific Fleet.



ANNAPOLIS (Towed Array) *(Scale 1 : 1 200), Ian Sturton*

ANNAPOLIS *9/1989, Giorgio Arra*

Iroquois Class

The four much larger "280," or Iroquois, class DDHs carry two helicopters and are armed with a 5-inch gun, a Mark X A/S mortar, and a Sea Sparrow A/S missile launcher. The last of these was commissioned in 1973. Apart from the hydrofoil *Bras d'Or* they are the only Canadian warships to be powered by gas turbine engines.

DELEX

With a view to prolonging the lives of the 16 older destroyers, the Destroyer Life Extension Project (DELEX) was introduced in December, 1979. The procedure, which will be carried out by civilian ship repairers, is expected to take about 10 months per ship. In this way it is hoped, by 1987, that 12 years will have been added to the life expectancy of the Nipigon class and 8 years to that of the others.

The following page contains DELEX data as supplied by Alex Patterson, and is repeated herein from Chapter 3.4.

3

DELEX PROGRAM

The following vessels underwent the Destroyer Life Extension (DELEX) Program to varying degrees for various budgets and different planned life extensions

		COST/SHIP	PLANNED EXTEN
DDH 265	ANNAPOLIS	$ 24 M	→ 94
DDH 264	NIPIGON	$ 24 M	→ 94
DDE 261	MACKENZIE	$ 12 M	→ 90 - 93
DDE 262	SASKATCHEWAN	$ 12 M	→ 90 - 93
DDE 263	YUKON	$ 12 M	→ 90 - 93
DDE 264	QU'APPELLE	$ 12 M	→ 90 - 93
DDE 236	GATINEAU	$ 22 M	→ 91 - 94
DDE 257	RESTIGOUCHE	$ 22 M	→ 91 - 94
DDE 258	KOOTENAY	$ 22 M	→ 91 - 94
DDE 259	TERRANOVA .	$ 22 M	→ 91 - 94

Conversion included:

- Removal of
  - Plotting System
  - HM Sonar
  - A/S Mortar - Bofors Rocket launcher
  - VDS
  - VDS Handling Gear.
  - FW System
  - 3"/50 Gun Control System
  - Mast.
- Installation of
  - ADLIPS
  - New HM Sonar
  - Anti-ship Missile System - Super RBOC
  - New VDS
  - New VDS Handling Gear
  - Air Search Radar
  - New E.W System & GFC System
  - New Mast
- Relocation of
  - Sewage Collection & Disposal Plant.

AP
18-4-94

DDH 280 (Iroquois Class)

DESTROYERS

4 TRIBAL CLASS

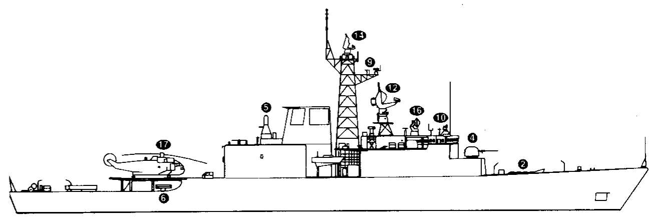
Name	*No*	*Builders*	*Laid down*	*Launched*	*Commissioned*
IROQUOIS	280	Marine Industries Ltd, Sorel	15 Jan 1969	28 Nov 1970	29 July 1972
HURON	281	Marine Industries Ltd, Sorel	15 Jan 1969	3 Apr 1971	16 Dec 1972
ATHABASKAN	282	Davie S B Co, Lauzon	1 June 1969	27 Nov 1970	30 Nov 1972
ALGONQUIN	283	Davie S B Co, Lauzon	1 Sep 1969	23 Apr 1971	30 Sep 1973

Displacement, tons: 4700 full load (5100 modified)
Dimensions, feet (metres): 398 wl; 426 oa × 50 × 15.5 keel/21.5 screws *(121.4; 129.8 × 15.2 × 4.7/6.6)*
Main machinery: COGOG; 2 Pratt & Whitney FT4A2 gas turbines; 50 000 shp; 2 Pratt & Whitney FT12AH3 (unmodified); 7400 shp; 2 GM Allison 570 KF gas turbines (modified); 12 800 shp for cruising; 2 shafts; 5-bladed cp propellers
Speed, knots: 29+. **Range, miles:** 4500 at 20 kts
Complement: 255 (modified) (23 officers) plus aircrew 30 (11 officers); 245 (unmodified) (20 officers) plus aircrew 40 (7 officers)

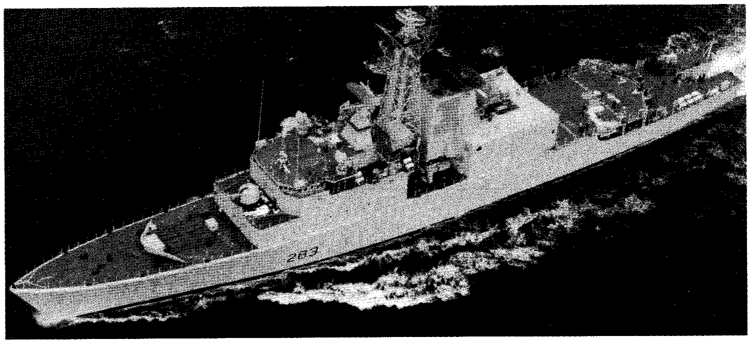
Missiles: SAM: 2 Raytheon Sea Sparrow quad launchers (unmodified) ❶; semi-active radar homing to 14.6 km *(8 nm)* at 2.5 Mach; warhead 30 kg; 32 missiles.
1 Martin Marietta Mk 41 VLS ❷ for 29 GDC Standard SM-2MR (modified); command/inertial guidance; semi active radar homing to 73 km *(40 nm)* at 2 Mach.
Guns: 1 OTO Melara 5 in *(127 mm)*/54 (unmodified) ❸; 85° elevation; 45 rounds/minute to 16 km *(8.7 nm)*; weight of shell 32 kg.
1 OTO Melara 3 in *(76 mm)*/62 Super Rapid (modified) ❹; 85° elevation; 120 rounds/minute to 16 km *(8.7 nm)*; weight of shell 6 kg.
1 General Electric/General Dynamics 20 mm/76 6-barrelled Vulcan Phalanx Mk 15 (modified) ❺; 3000 rounds/minute combined to 1.5 km. Also fitted in place of Limbo during Gulf deployment in 1990-91.
Torpedoes: 6—324 mm Mk 32 (2 triple) tubes ❻. Honeywell Mk 46; anti-submarine; active/passive homing to 11 km *(5.9 nm)* at 40 kts; warhead 44 kg.
A/S mortars: 1 Limbo Mk 10 (3-tubed) (unmodified) ❼; automatic loading; range 1000 m; warhead 92 kg. Replaced by Phalanx during Gulf deployments in 1990-91.
Countermeasures: Decoys: 2 Vickers Knebworth Corvus 8-tubed trainable launchers (unmodified). Plessey P4 Chaff rockets fired in distraction or centroid modes.
2 Plessey Shield 6-tubed trainable launchers (modified) ❽ and for Gulf deployment.
SLQ 25 Nixie; torpedo decoy.
ESM: MEL SLQ 504 Canews ❾; radar warning.
ECM: ULQ-6; jammer.
Combat data systems: Litton CCS 280 (unmodified). SHINPADS (modified), automated data handling with UYQ-504 and UYK-505 processors. Links 11 and 14. WSC-IV and SSR-1 SATCOM.
Fire control: GFCS Mk 60 (unmodified). Signaal WM 25 (modified) including LIROD 8 ❿ optronic director. SAR-8 IRSTD may be fitted in due course.
Radars: Air search: SPS 501 (LW 03 antenna) (unmodified) ⓫; D band.
Signaal LW 08 (modified) ⓬; D band.
Surface search/navigation: SMA SPQ 2D (unmodified) ⓭; I band.
Signaal DA 08 (modified) ⓮; E/F band.
Fire control: Two Signaal WM 22 (unmodified) ⓯; I/J band.
Two Signaal STIR 1.8 (modified) ⓰; I/J band.
Tacan: URN 25.
Sonars: Westinghouse SQS 505; combined VDS and hull-mounted; active search and attack; 7 kHz.
Westinghouse SQS 501; hull-mounted; bottom target classification; high frequency.

Helicopters: 2 CH-124A Sea King ASW ⓱ (see *Operational*).

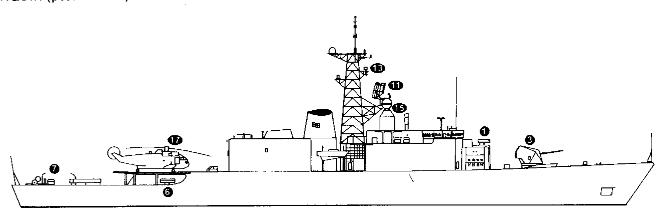
Modernisation: A contract for the Tribal Class Update and Modernisation Project (TRUMP) was awarded to Litton Systems Canada Limited in June 1986. The modernisation gives the ships an area air defence capability provided by Standard SM-2 (MR) missiles fired from a Mk 41 Vertical Launch System (VLS). Other equipment fitted includes: OTO Melara 76 mm Super Rapid gun; Phalanx CIWS; Signaal WM 25 FCS including LIROD 8 optronic director, ATMS automatic tracking and management system (SHINPADS) and two STIR tracking radars; LW-08 and DA-08 radars; inertial navigation; and, an infra-red suppression device fitted in the new single funnel. EW systems include new Plessey Shield Chaff and IR launch systems and MEL Canews ESM. The ASW capability provided by two helicopters and shipboard torpedoes is retained but towed arrays are not fitted. Some machinery noise suppression improvements are made. The new equipment reflects the changing role of the ship and replaces systems that did not meet the air defence requirement. *Algonquin* started modernisation in November 1987 at Mil Davie, Quebec, and completed in 1991 followed by *Iroquois* (started November 1988), and *Athabaskan* or *Huron*. All should be completed in 1993.



TRIBAL Class (modernised) *(Scale 1 : 1 200), Ian Sturton*



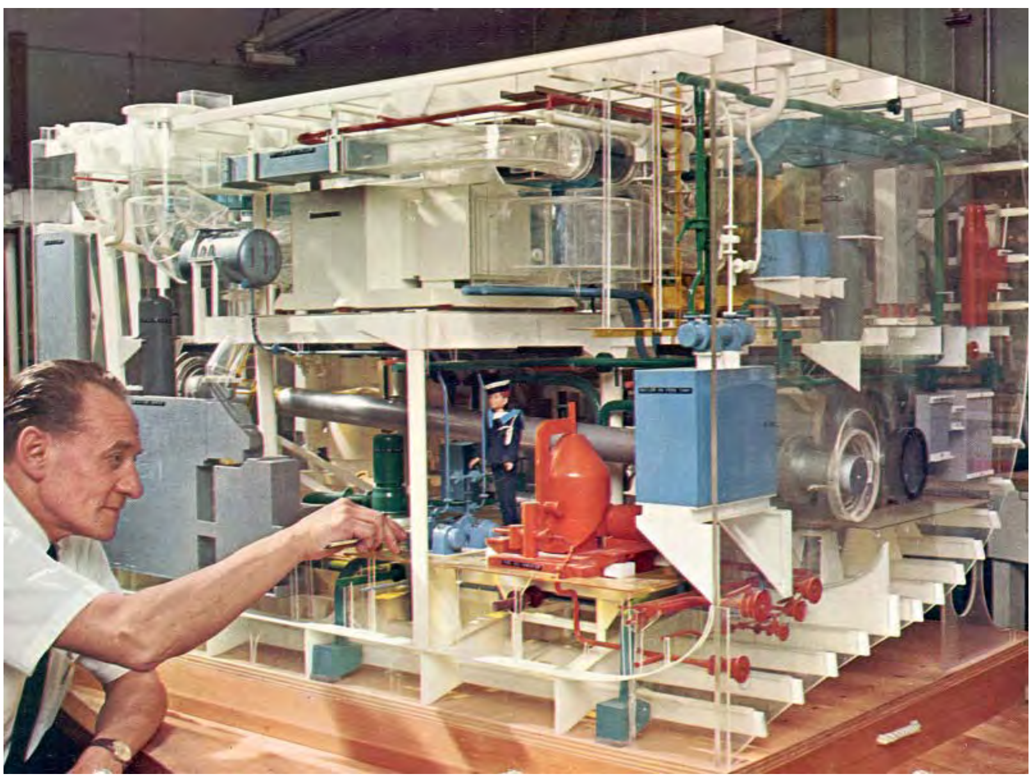
ALGONQUIN (post TRUMP) *12/1990, Canadian Forces*



TRIBAL Class (unmodernised) *(Scale 1 : 1 200), Ian Sturton*

Structure: These ships are also fitted with a landing deck equipped with double hauldown and Beartrap, flume type anti-rolling tanks to stabilise the ships at low speed, pre-wetting system to counter radio-active fallout, enclosed citadel, and bridge control of machinery. The flume type anti-roll tanks are replaced during modernisation with a water displaced fuel system.
Operational: *Athabaskan* deploying to the Gulf in September 1990 had the Limbo mortar replaced by Phalanx CIWS and also carried Blowpipe and Shorts Javelin SAM systems in both shoulder-launched and lightweight versions. Additionally both helicopters carried 12.7 mm MGs and ESM instead of ASW gear. *Huron* similarly modified in early 1991.

The beautifully clean lines of the DDH 280 class hull (MIL Sorel 1969)



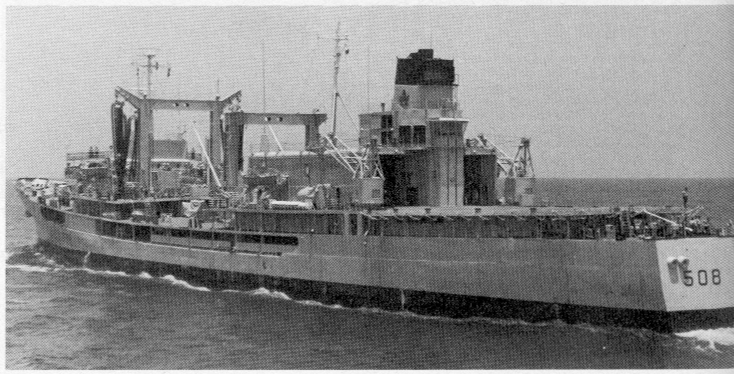
An example of ship space modelling of the engine room spaces for the DDH 280 class by Amie Bartien in Canadian Vickers before Computer Aided Design technology

AOR 508 (Provider Class)

Name	No	Builders	Laid down	Launched	Commissioned
PROVIDER	AOR 508	Davie Shipbuilding Ltd, Lauzon	1 May 1961	5 July 1962	28 Sep 1963

Displacement, tons: 7300 light; 22 000 full load
Dimensions, feet (metres): 555 × 76 × 32 *(169.2 × 23.2 × 9.8)*
Main machinery: Double reduction geared turbine; 21 000 shp; 1 shaft. 2 water tube boilers
Speed, knots: 21. **Range, miles:** 3600 at 20 kts
Complement: 166 (15 officers)
Cargo capacity: 12 000 tons fuel; 900 tons aviation fuel; 250 tons dry cargo
Helicopters: 3 CH-124A Sea King ASW.

Comment: The flight deck can receive the largest and heaviest helicopters. A total of 20 electro-hydraulic winches are fitted on deck for ship-to-ship movements of cargo and supplies, as well as shore-to-ship requirements when alongside. Based in the Pacific Fleet. If sent to the Gulf she is to be given the same fit as *Protecteur*.



PROVIDER *3/1988, G. Toremans*

AOR 509 (Protecteur Class)

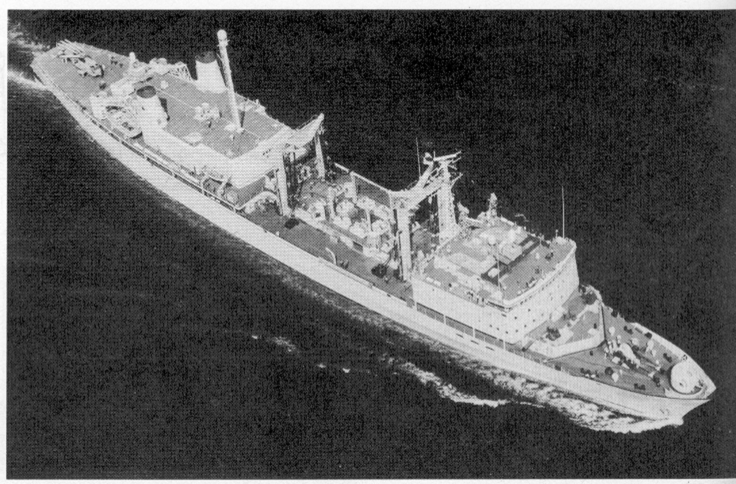
86 CANADA / Operational support ships

OPERATIONAL SUPPORT SHIPS

Name	No	Builders	Laid down	Launched	Commissioned
PROTECTEUR	AOR 509	St John Dry Dock Co Ltd, NB	17 Oct 1967	18 July 1968	30 Aug 1969
PRESERVER	AOR 510	St John Dry Dock Co Ltd, NB	17 Oct 1967	29 May 1969	30 July 1970

Displacement, tons: 8380 light; 24 700 full load
Dimensions, feet (metres): 564 × 76 × 30 *(171.9 × 23.2 × 9.1)*
Main machinery: General Electric steam turbine; 21 000 shp; 1 shaft; bow thruster. 2 forced draught water tube boilers
Speed, knots: 21. **Range, miles:** 4100 at 20 kts; 7500 at 11.5 kts
Complement: 290 (28 officers)
Cargo capacity: 13 700 tons fuel; 400 tons aviation fuel; 1048 tons dry cargo; 1250 tons ammunition; 2 cranes (15 ton lift)
Guns: 2 FMC 3 in *(76 mm)*/50 Mk 33 (twin). Mounted in the bow and under local control it was removed from both ships in 1983 but replaced for Gulf deployments in 1990-91.
2 Phalanx and 2 Bofors 40/60 for Gulf deployments in 1990-91.
Combat data systems: ADLIPS with Link 11; SATCOM WSC-3(V).
Radars: Surface search: SPS 502 with Mk XII IFF.
Navigation: Sperry Mk II. Racal Decca TM 969; I band.
Tacan: URN 20.
Sonars: Westinghouse SQS 505; hull-mounted; active search; 7 kHz.
C-Tech mine avoidance for Gulf.
Helicopters: 3 CH-124A Sea King ASW (see *Comment*).

Comment: An improved design based on the prototype *Provider*. Four replenishment positions. Both have been used as Flagships and troop carriers. They can carry anti-submarine helicopters, military vehicles and bulk equipment for sealift purposes; also four LCVPs. For the Gulf deployment, the 76 mm gun was replaced, two Vulcan Phalanx and two Bofors 40/60 guns fitted and 4 Plessey Shield Chaff launchers and ALR-76 ESM equipment provided. Additionally all helicopters carried 12.7 mm MGs and ESM equipment instead of ASW gear.



PROTECTEUR (with Gulf fit) *8/1990, D. C. Milroy RCN*

Operational Support Ships

PROVIDER (2nd)
PRESERVER (2nd)
PROTECTEUR

The first of this type, *Provider*, was commissioned on September 28, 1963, at Lauzon, Que. Originally designated as a fleet replenishment ship, she was the largest ship ever built in Canada for the RCN. She enabled RCN ships to remain at sea for extended periods, as well as greatly increasing their mobility and range. She has stowage space for some 12,000 tons of fuel oil, diesel oil, and aviation gas, in addition to spare parts, ammunition and missiles, general stores and food.

Experience with *Provider* led to significant changes in the design of the next two operational support ships, *Protecteur* and *Preserver*, commissioned at Saint John, N.B., on August 30, 1969 and July 30, 1970, respectively. Though similar in size to the tanker-like *Provider*, they have a higher freeboard, massive bridges, and paired funnels that make possible a single, much wider hangar door. Unlike *Provider*, the newer pair are also armed with a twin 3-inch "bow chaser" gun.

All three ships can refuel other fleet units at 20 knots, with automatic tensioning equipment to compensate for the ships' motion as fuel oil is transferred at 25 tons per minute. Each can carry three A/S helicopters as spares for the fleet or for transferring pallet loads of solid stores.

22 Class

Work on this ship had stopped three months after her launching in February, 1945, with the result that when construction resumed in 1952, improvements could be built into her. The most notable of these was the angled flight deck, which provided a longer landing run without sacrificing forward parking space, and permitted the removal of the unpopular crash barrier. Also noteworthy were a steam catapult and a mirror landing sight, the latter going far toward eliminating human error in landing.

"Bonnie" was commissioned at Belfast on January 17, 1957, and arrived at Halifax on June 26, carrying on deck an experimental hydrofoil craft that was to serve in the development of HMCS *Bras d'Or*. Unlike her predecessors, *Bonaventure* had Banshee jet fighters and Tracker A/S aircraft as her complement. Like them, she enjoyed a busy career of flying training and participation in A/S and tactical exercises with ships of other NATO nations. What was expected to be her mid-life refit, carried out from 1966 to 1967, took 16 months and cost over $11 million. Incomprehensibly, she was paid off on July 1, 1970, and sold for scrap.

Bonaventure, 1968

Aircraft Carriers

Of the three light fleet carriers that were operated by the Canadian Navy, viz. HMCS Warrior, Magnificent and Bonaventure, only one underwent major retrofit design and subsequent upgrading in a Canadian shipyard. HMCS Bonaventure never re-entered service with the fleet subsequent to that major refit.

4.3 Halifax Class FFH 330

The following is an extract from "Jane's Fighting Ships 1991-92" edited for Jane's Information Group by Captain Richard Sharpe RN **(13).**

FFH 330 (Halifax Class)

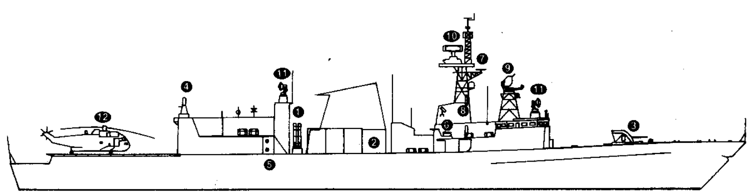
82 CANADA / Frigates

FRIGATES

1 + 11 HALIFAX CLASS (FFH)

Name	*No*	*Builders*	*Laid down*	*Launched*	*Commissioned*
HALIFAX	330	St John S B Ltd, New Brunswick	19 Mar 1987	19 May 1988	1991
VANCOUVER	331	St John S B Ltd, New Brunswick	19 May 1988	8 July 1989	1991
VILLE DE QUÉBEC	332	Marine Industries Ltd, Sorel	16 Dec 1988	1991	1992
TORONTO	333	St John S B Ltd, New Brunswick	15 Apr 1989	1991	1992
REGINA	334	Marine Industries Ltd, Sorel	6 Oct 1989	1992	1993
CALGARY	335	Marine Industries Ltd, Sorel	1990	1993	1994
MONTREAL	336	St John S B Ltd, New Brunswick	1990	1992	1993
FREDERICTON	337	St John S B Ltd, New Brunswick	—	—	1993
WINNIPEG	338	St John S B Ltd, New Brunswick	—	—	1994
CHARLOTTETOWN	339	St John S B Ltd, New Brunswick	—	—	1995
ST JOHN'S	340	St John S B Ltd, New Brunswick	—	—	1996
OTTAWA	341	St John S B Ltd, New Brunswick	—	—	1997

Displacement, tons: 4750 full load
Dimensions, feet (metres): 440 oa; 408.5 pp × 53.8 × 16.1 *(134.1; 124.5 × 16.4 × 4.9)*
Main machinery: 2 General Electric LM 2500 twin gas turbines; 46 000 shp
1 SEMT-Pielstick 20 PA6-V280 diesel; 8800 shp at 1000 rpm (cruise); 2 shafts; cp propellers
Speed, knots: 28. **Range, miles:** 7100 at 15 kts (diesel); 4500 at 15 kts (gas)
Complement: 225 war; 185 peace



HALIFAX *(Scale 1 : 1 200), Ian Sturton*

Missiles: SSM: 8 McDonnell Douglas Harpoon Block 1C (2 quad) launchers ❶; active radar homing to 130 km *(70 nm)* at 0.9 Mach; warhead 227 kg.
SAM: 2 Raytheon Sea Sparrow Mk 48 octuple vertical launchers ❷; semi-active radar homing to 14.6 km *(8 nm)* at 2.5 Mach; warhead 30 kg; 28 missiles (16 normally carried).

Guns: 1 Bofors 57 mm Mk 2 ❸; 77° elevation; 220 rounds/minute to 17 km *(9 nm)*; weight of shell 2.4 kg.
1 GE/GDC 20 mm Vulcan Phalanx Mk 15 ❹; anti-missile; 3000 rounds/minute (6 barrels combined) to 1.5 km.
8—12.7 mm MGs.

Torpedoes: 4—324 mm Mk 32 Mod 9 (2 twin) tubes ❺. 24 Honeywell Mk 46 Mod I or Mod 5; anti-submarine; active/passive homing to 11 km *(5.9 nm)* at 40 kts; warhead 44 kg.

Countermeasures: Decoys: 2 Plessey Shield decoy launchers ❻; triple mountings; fires P8 Chaff and P6 IR flares in distraction, decoy or centroid modes.
Nixie SLQ 25; towed acoustic decoy.
ESM: MEL Canews SLQ 504 ❼; radar intercept; (0.5-18 GHz).
ECM: MEL Ramses SLQ 503 ❽; jammer.

Combat data systems: SHINPADS action data automation with UYQ-504 and UYK-505 or 507 processors. Links 11 and 14.
Fire control: Spar Aerospace SAR 8 IRSTD (infra red search and target designation) to be fitted in due course. SWG-1(V) for Harpoon.
Radars: Air search: Raytheon SPS 49(V)5 ❾; C/D band; range 457 km *(250 nm)*.
Air/surface search: Ericsson Sea Giraffe HC 150 ❿; G band; range 40 km *(21.6 nm)* against missiles in clear conditions.
Fire control: Two Signaal VM 25 STIR ⓫; K/I band; range 140 km *(76 nm)* for 1 m^2 target.
Navigation: Sperry Mk 340; I band.
Tacan: URN 501.
Sonars: Westinghouse SQS 505(V)6; hull-mounted; active search and attack; medium frequency.
CDC SQR 501 CANTASS towed array (uses part of Martin Marietta SQR 19 TACTASS).
CDC UYS 503(V); sonobuoy processing system.

Helicopters: 1 CH 124A Sea King ASW ⓬ or 1 EH 101.

Programmes: On 29 June 1983 St John Shipbuilding Ltd won the long running competition for the first six of a new class of patrol frigates to be assisted by Paramax Electronics Inc of Montreal, a subsidiary of Unisys Co (formerly Sperry). Three were subcontracted to Marine Industries Ltd in Lauzon and Sorel. On 18 December 1987 six additional ships of the same design were ordered from St John S.B. Ltd with delivery by 1997. Sometimes referred to as the City class. *Halifax* started sea trials 6 August 1990.
Structure: Plans to lengthen some of the class to increase SAM capacity and improve accommodation have been shelved. Much effort has gone into stealth technology. Gas turbine engines are raft mounted. Female accomodation is provided.
Opinion: These were the first new warships ordered in Canada since 1973 and should be good general purpose vessels with an emphasis on ASW. There have been delays in the original published programme but this is not unusual particularly for the first of class of a complex new design. In due course some variation of this design may be needed for the next generation of air defence ships.

The largest warship designed and built in Canada (pre 2003)

There was an open competition for the design and build of 6 Canadian Patrol Frigates - later 6 more were added (the CPF Program), which was won by Saint John Shipbuilding Ltd (SJSL). However, the Crown preferred the Concept Design that Versatile Vickers had submitted as an integral part of its bid for the Prime Contract, and directed SJSL to use that design rather than the Concept Design by Gibson & Cox of the USA included in the SJSL submission. Versatile Vickers design unit was Versatile Vickers Systems Inc. (VVSI)), which in 1987 became MIL Systems Engineering Inc. (MSEI) and the Detail Design was subsequently carried out by that company. However, some of the design requirement was kept by SJSL itself (see Chapter 7.2 for some of the ramifications of this decision). SJSL held the Prime Contract for the design, but sub-contracted the majority of the work to MSEI, as directed by the Crown. It kept to itself such aspects as the main machinery spaces and the rafting thereof, as well as the radar cross section signature of the overall ship. It contracted out this work to offshore companies, viz: Scotland and the USA. Hence that work does not qualify as Canadian Content, the objective of the CANDIB Study that prompted this publication. The Saint John Shipyard is currently closed down (2003) and no response to our enquiries for information for the CANDIB Study was forthcoming.

The following reproduced marketing pamphlet issued by MIL Systems Engineering summarises its role in the CPF Program. The MDDO Contract was invariably used by the Navy to carry out technical and feasibility studies for future warships, and the CPF Program was one example of this policy, and utilized the MDDO contract to a high degree in this regard starting as early as 1978. The subsequent technical requirement was then issued as part of the Bid Set for Industry to bid against. MIL Systems Engineering was, prior to the CPF Prime Contract Award, part of the Versatile Vickers Group as stated above and carried out the various studies to define the eventual requirement under the NCDO/MDDO contract.

MIL Systems

THE DESIGN OF THE HALIFAX CLASS FRIGATE

The acquisition of the Halifax Class Frigate through the Canadian Patrol Frigate (CPF) program, represents the cornerstone of the Canadian Navy's material modernization program and has been the most significant Canadian naval ship design activity since the Tribal Class (DDH 280). As with the Tribal Class, **MIL Systems** was involved with the CPF program from its outset. Starting in 1978 with the preparation of Contract Definition proposals, **MIL Systems** played a key role in the design of the ship and its systems.

The Halifax Class represents the state-of-the-art in Anti-Submarine Warfare vessels. The 134 metre vessel is powered by two LM2500 gas turbines and for superior range at cruise speed a medium speed diesel engine is also fitted. The vessel incorporates an extensive suite of above water and underwater sensors and countermeasures and is equipped to counter surface, air and underwater threats.

In support of the CPF Program, from 1978 to 1988, **MIL Systems** undertook feasibility studies and Concept Design of the ship platform and subsequently the Preliminary Design, Contract Design, and Functional Design of the ship platform, propulsion and service systems. In addition to providing 70% of the Production Drawings **MIL Systems** was also responsible for the integration of the combat system into the ship platform.

MIL Systems is proud to have been a leader in the design of this vessel

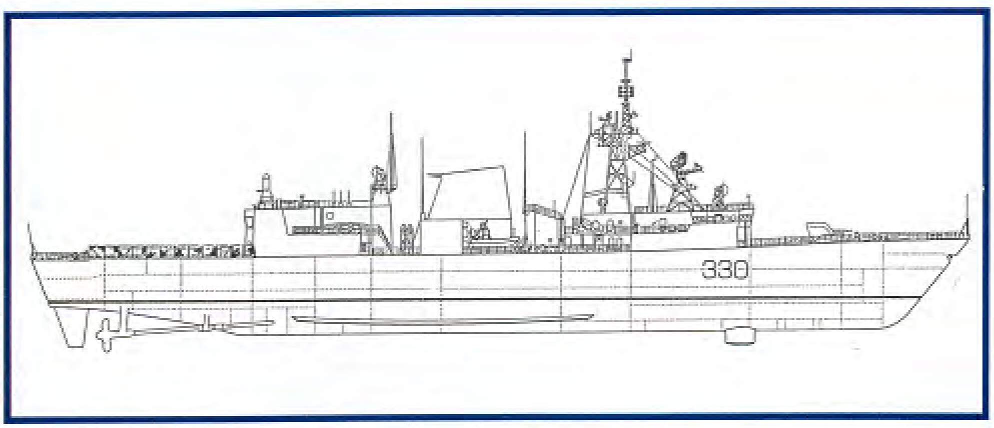
MIL Systems Engineering, 200-1150 Morrison Drive, Ottawa, Ontario, CANADA K2H 8S9 tel. (613)726-0600 fax. (613)726-0252

MIL Systems

DESIGN SERVICES PERFORMED IN THE CPF PROGRAM

In support of the CPF Program, **MIL Systems** provided an extensive range of design Services:-

- Feasibility Studies and Concept Design
- Preliminary Design
- Contract Design
- Functional Design
- Structural Design
- Propulsion System Design
- Vibration, Noise, Shock & Blast Engineering Analysis
- Electrical Generation & Distribution Systems Design
- Auxiliary & Outfit Systems Design
- Combat Systems/Platform Integration
- Equipment and Systems Specifications and Evaluation
- Production Drawings Preparation



The next reproduction is from the DND website and provides more definition of some of the equipment designed into the Halifax Class frigates by MIL Systems Engineering.

HALIFAX CLASS FRIGATES, CANADA

Saint John Shipbuilding Ltd is the prime contractor for the Halifax class frigate or Canadian Patrol Frigate programme. Nine of the twelve ships were constructed at the Saint John shipyards in Saint John, New Brunswick and three ships at Marine Industries Shipyards in Sorel. The multi-purpose frigates were commissioned between 1992 and 1997.

Halifax Class frigates, HMCS Regina and Fredericton, have been conducting maritime interdiction operations in the Persian Gulf in support of the international campaign against terrorism.

COMMAND AND CONTROL

The SHINPADS integrated processing and display system, supplied by Lockheed Martin Canada, provides a distributed architecture command and weapon control capability. The system uses about 15 AN/UYK-501 workstations manufactured by Computing Devices Canada.

The ship's Communications Control and Monitoring System (CCMS) was supplied by SED Systems of Saskatoon. Lockheed Martin Electronic Systems Canada supplied the message processing system.

MISSILES

The ship's surface-to-surface missile is the Boeing Harpoon Block 1C. The two quadruple launch tubes are installed at the main deck level between the ship's funnel and the helicopter hangar. The Harpoon missile uses active radar homing to deliver a 227kg warhead to a range in excess of 130km.

The Sea Sparrow vertical launch surface-to-air missile uses semi-active radar homing to deliver a 39kg warhead at speed Mach 1.6 to a range of 15km. The eight-cell launchers are installed port and starboard of the funnel.

GUNS

The main gun on the bow deck is a 57mm 70 Mark 2 gun from Bofors. The gun is capable of firing 2.4kg shells at a rate of 220 rounds/min at a range of more than 17km.

One Raytheon/General Dynamics Phalanx Mark 15 Mod 1 close-in weapon system is mounted on the roof of the helicopter hangar. The six barrels of the Phalanx provide a firing rate of 3000 rounds/min. The Canadian Navy has ordered upgrade kits to convert to the Phalanx Block 1B. The Block 1B upgrade includes a Thales Optronics HDTI5-2F thermal imager, improved Ku-band radar and longer gun barrel with a dual firing rate of 3000 or 4500 rounds/min. Deliveries of the kits began in September 2002.

TORPEDOES

The ship's two twin 324mm Mark 32 Mod 9 torpedo tubes are installed at the bow end of the helicopter hangar. The torpedoes are the ATK (Alliant TechSystems) Mark 46 lightweight anti-submarine torpedo. The torpedo has a speed of 45 knots and is equipped with active and passive homing and a 44.5kg warhead. /p>

HELICOPTER

The ship has a helicopter deck with a single landing spot. The deck is fitted with a RAST (Recovery, Assist, Securing and Traversing) system supplied by Indal Technologies of Ontario, allowing the launch and recovery of helicopters in up to Sea State 6. The hangar can accommodate a 15t helicopter such as the Sikorsky CH-124A Sea King.

COUNTERMEASURES

The ship's decoy system comprises four BAE SYSTEMS Shield Mark 2 decoy launchers which fire chaff to 2km and infra-red rockets to 169m, in distraction, confusion and centroid seduction modes. The torpedo decoy is the AN/SLQ-25A Nixie towed acoustic decoy from Sensytech Inc of Newington, Virginia.

The ship's radar warning receiver, the Canews (Canadian Electronic Warfare System), SLQ-501, and the radar jammer, SLQ-505, were developed by Thorn (now Thales) and Lockheed Martin Canada.

SENSORS

Two Thales Nederland (formerly Signaal) SPG-503 (STIR 1.8) fire control radars are installed one on the roof of the bridge and one on the raised radar platform immediately forward of the helicopter hangar. The ship is also fitted with Raytheon SPS-49(V)5 long-range active air search radar operating at C and D bands, Ericsson HC150 Sea Giraffe medium-range air and surface search radar operating at G and H bands, and Kelvin Hughes Type 1007 I-band navigation radar.

The sonar suite includes the CANTASS Canadian Towed Array supplied by Computing Devices of Canada (CDC) and CDC AN/SQS-510 hull mounted sonar and incorporates an acoustic range prediction system. The sonobuoy processing system is the CDC AN/UYS-503.

PROPULSION

The Halifax is powered by a CODOG (combined diesel or gas) system with two GE LM2500 gas turbines and one SEMT-Pielstick 20PA6 V280 diesel engine. CAE provide the Integrated Machinery Control System, which is being upgraded with flat screen monitors by December 2003.