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U.S. GENERAL ACCOUNTING OFFICE

STAFF STUDY

[PATROL FRIGATE]

DEPARTMENT OF THE NAVY

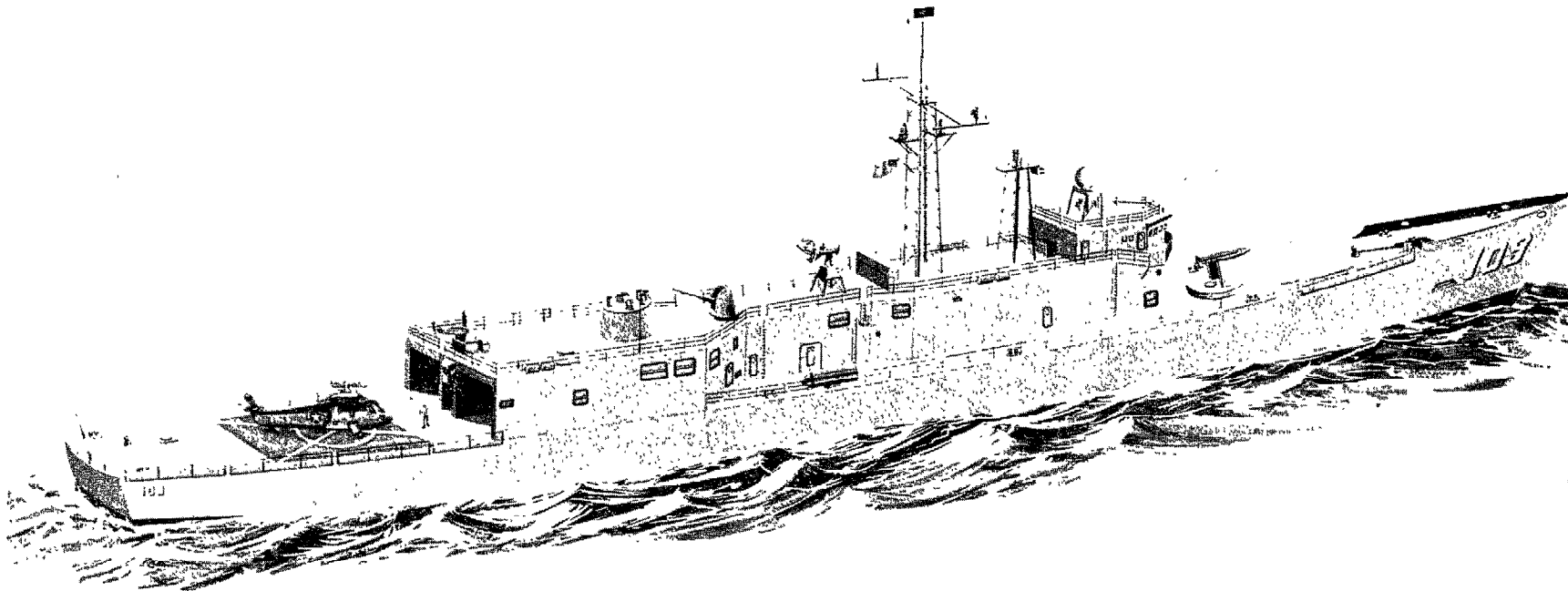
FEBRUARY 1975

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ARTIST'S CONCEPTION OF THE PATROL FRIGATE



C o n t e n t s

	<u>Page</u>
SUMMARY	1
RECOMMENDATIONS	6
MATTERS FOR CONSIDERATION	6
QUESTIONS	7
SYSTEM DESCRIPTION AND STATUS	10
RELATIONSHIP TO OTHER SYSTEMS	11
COMING EVENTS	12
COST	13
Provision For Escalation	15
Possible Additional Program Costs	16
SCHEDULE	17
PERFORMANCE	18
SELECTED ACQUISITION REPORTING	18
ACQUISITION STRATEGY	19
Design-To-Cost	20
Procurement Plan	24
Lead Ship Contractor Purchasing Performance	27
RESPONSIBILITY FOR PERFORMANCE	29
INTEGRATED LOGISTIC SUPPORT	31
TESTING	35
APPENDIX I	38

ABBREVIATIONS

ASW	Anti-Submarine Warfare
BIW	Bath Iron Works
DSARC	Defense Systems Acquisition Review Council
DTC	Design To Cost
GFE	Government Furnished Equipment
GFI	Government Furnished Information
ILS	Integrated Logistic Support
LAMPS	Light Airborne Multi-purpose System
LBTS	Land Based Test Site
NAVSEA	Naval Sea Systems Command
PF	Patrol Frigate
R/M/A	Reliability/Maintainability/Availability
SAR	Selected Acquisition Report
SSDS	Ship System Design Support

PATROL FRIGATE

SUMMARY

SYSTEM DESCRIPTION AND STATUS

The Patrol Frigate (PF) is a missile equipped surface combatant ship, in the detailed design phase, for the protection of underway replenishment groups, amphibious forces and military and mercantile shipping against subsurface, air and surface threats. It is one of the first new construction ships designed to accommodate the HARPOON missile system. Bath Iron Works is the lead ship construction contractor. Sperry Systems Management Division is the combat system (MK-92 fire control system and associated weapons) integration contractor.

RELATIONSHIP TO OTHER SYSTEMS

The PF weapons suite will consist of the HARPOON missile, STANDARD Missile (SM-1), MK-92 fire control system, the MK-75, 76mm gun, MK-46 torpedoes and is being designed to accommodate up to two LAMPS I or LAMPS III helicopters. The LAMPS III will not be available for use on the PF until after delivery of the lead PF.

Concerning the MK-92 fire control system the Congress has directed that contract for the three ships authorized in FY 1975 not be awarded until such time as the MK-92 system has satisfactorily completed the required test and evaluation. Upon completion of the test and evaluation, the Armed Services Committees of the House and Senate are to be advised of the results including all deficiencies, for review prior to contract award for the FY 1975 program.

The PF is planned to operate in a complementary manner with the P-3 patrol aircraft, and DE-1052 in supporting underway replenishment groups,

amphibious forces, and convoys in low-threat areas. It will also be capable, under certain circumstances, of supporting high value forces (carrier task forces).

COMING EVENTS

The Navy's Interim Force Mix Study to determine the optimum mix of surface combatant forces is to be complete by May 1975.

As of September 30, 1974, a DSARC III review to consider production of follow ships is scheduled for June 1975. This decision is to be based on accomplishment of adequate test and evaluation (including IOT&E individually on systems, and collectively at land-based test sites [LBTS]) with satisfactory results.

COST

Estimated total program cost as of September 30, 1974, for the 50 ship PF program was \$5,274.6 million or \$2,030.1 million more than the June 30, 1973, estimate of \$3,244.5 million. \$1,842.7 million of the increase was attributed to economic escalation and \$187.4 million to program changes.

These program changes were due to:

- Characteristic changes and design changes due to the requirement for a fourth diesel generator
- One time start up costs at three follow shipyards
- Better estimating data
- Budget limitations
- Support costs

The PF is being constructed with several space and weight reservations for equipment which may be installed on the PF at a later date, however,

according to the Navy, the precise configuration of space and weight items by definition is not fully described. Therefore no cost estimate has been established for these equipments.

The Navy is going to use a maintenance concept emphasizing off-ship maintenance to maintain and support the PF ships. A program management office has been established within Naval Sea Systems Command (NAVSEA) to develop estimated cost and schedule for implementing it for the PF and other ships with similar concepts. Associated costs are not included in PF total program estimates. This is in accordance with SAR instructions.

As of September 30, 1974, the PF program had received funding totaling \$225.3 million; of which \$201.9 million was appropriated funds and \$23.4 million was reprogrammed from other Navy projects. At that time, \$170.8 million had been obligated and \$68.6 million expended.

SCHEDULE

The PF program has experienced several slippages in its testing schedules for major subsystems and operation of the combat and propulsion system land-based-test sites. These slippages have forced a 3 month delay (from March to June) in the DSARC III review.

TECHNICAL PERFORMANCE

The Full load displacement weight of the ship changed from 3500 to 3585 tons because of the addition of a fourth diesel generator. This generator was added when it was determined that the three originally planned would not supply sufficient electrical energy to the ship.

SELECTED ACQUISITION REPORTING (SAR)

The September 30, 1974, SAR shows that seven ships were funded by Congress in FY 1975. The Navy informed us that the December 31, 1974, SAR

will show that only three ships were funded to reflect Congressional action on the FY 1975 request.

There are several space and weight items for the PF which, because their precise configurations have not been determined, do not have cost estimates. We believe the total program cost put forth in the SAR is understated.

In this regard, the Navy advises that when the decision is made to equip specific ships with any of these items during the time limitations for SCN funding, estimated costs will be included in the SAR.

ACQUISITION STRATEGY

The Navy has initiated several changes to past strategies used in the procurement of ships. These changes include (1) the design-to-cost (DTC) concept, (2) a new approach to procurement of the ships, and (3) requiring lead ship contractor to obtain options for follow ship equipment.

Design-To-Cost (DTC)

The PF is the first ship to be built under the DTC concept. Since the CNO established the original constraints on full-load displacement, accommodations and cost, two, full-load displacement and cost, have changed.

When the PF project office attempted to track the present cost back to the original cost constraint, adjustments were made to reflect market place factors beyond the Navy's control which resulted in an average follow-ship cost below \$50 million in unescalated FY 1973 dollars.

We believe the \$50 million unescalated FY 1973 dollar threshold established in the DCP may have been breached since the attribution of \$3.7 million per follow ship is above and beyond the escalation figures used to update the PF program in the FYDP.

Procurement Plan

The original contracting schedules for follow-ships has been abandoned by the Navy because of Congressional action on the FY 1975 ship request. However, alternate contracting plans have been developed by the Navy and the FY 1976 appropriation for the PF will dictate to the Navy which alternate contracting plan they follow. The Navy is planning to use three separate shipyards to construct the PF ships.

Lead Ship Contractor Purchasing Performance

Under the lead ship contract, BIW is required to obtain options for equipment which will be standard on follow ships in order to achieve PF class standardization through lead ship competition. BIW is experiencing difficulty acquiring some of these options from vendors.

BIW believes the main reasons for the vendors unwillingness to bid on PF equipment items are (1) the extensive documentation requirements applicable to PF equipment, (2) material shortages, and (3) the rapid increase in inflation.

According to the Navy the documentation identified in number one above is essential in order to define escalation and option provisions. As a result, this one-time expenditure of lead ship effort is for the purpose of reducing follow ship cost.

RESPONSIBILITY FOR PERFORMANCE

The lines of authority between the Navy, BIW, and Sperry Systems Management Division appear to be overlapping concerning the installation of subsystems and construction of the lead ship. We believe the

responsibility for performance of these subsystems in the lead ship is not clear.

However, the Navy contends that the responsibilities of each are clear and distinct and that contractually the means are provided for controlling any difference between the ship and the prototype land based mockup which might occur by virtue of detail ship design development or construction exigency. The Navy further contends that, as for all GFE, the Government is responsible for its performance provided that the shipbuilder has properly installed it according to information provided by the Navy.

RECOMMENDATIONS

To provide more complete disclosure in the SAR, we recommend that the Navy include the estimated cost of all space and weight equipment in the SAR. If precise costs cannot be determined at this time that fact should be reported in the SAR.

MATTERS FOR CONSIDERATION

Listed below are the issues which we believe the Congress should consider during the hearings on the PF program.

--The instability of the U.S. economy is making it difficult for the lead ship contractor to acquire options on equipment to be standardized on all PF ships. Without such options the lack of standardization may have a serious impact on the overall PF program. Also various levels of FY 1976 appropriations (for 2, 3, 4, 12 and 13 ships) may have a monetary impact on the program. The impact of each level of funding should be understood before a commitment is made to the PF program.

--The testing and evaluation of the major subsystems of the PF may not be available until after the hearings on the PF are over. The obligation authority on the FY 1976 appropriations for the PF could be withheld until this information can be presented to the Congress.

--A program management office has been established within NAVSEA to develop estimated cost and schedule for implementing the maintenance concept for the PF and other ships with similar maintenance concepts. These estimates should be included in the PF program cost and earmarked specifically for the PF so that the integrity of the support program can be maintained throughout the life of the PF program.

Questions

Information on the questions that follow has not been developed in this study. They are provided for the Congressional committees' use during the FY 1976 hearings. They were included in the draft provided to DOD for review but we did not ask for a response.

1. The PF was designed for only organizational level helicopter maintenance support and relying on other facilities, such as a Sea Control Ship, for intermediate level helicopter maintenance.

How will the helicopters on board the PF be maintained since the Sea Control Ship will not be built?

3. The PF was designed to operate in low-threat areas, yet is being equipped with the HARPOON anti-ship missile system.

What is the probability of the PF fighting another surface ship?

How many HARPOON missiles will each PF carry?

The PF will also fire the SM-1 (Standard) missile for anti-air warfare from the same launcher as the HARPOON. What will be the mix of these missiles on a single PF? What is the estimated cost of the missile load for each PF?

3. Early in the PF program a change was made in the ship design to provide accommodations for two LAMPS helicopters instead of the one originally planned. This decision was made as a result of Navy recognition of the considerable potential for growth in ASW, as well as surface warfare, capabilities inherent in the LAMPS system. Additionally, the Navy concluded that the less expensive AN/SQS-56 sonar would be adequate for the PF mission application.

What effectiveness studies were performed to support this tradeoff?

What ASW capability does the PF now have without the SCS?

Will LAMPS III be too large for two to be put on a PF?

What ASW weapons does the PF have against a submarine? Will more be added in the near future?

4. Considering a ship life of 30 years the PF will be in the inventory after the year 2000. The PF was not designed to accommodate more or bigger weapons than originally planned. Are the weapons and sensors now being installed sufficient to meet the threat of the year 2000?

5. The MK-92 and Standard SM-1 provides the air defense capability on the PF. The Aegis is an air defense system in full scale development and is to be mounted on an as yet undesignated ship platform. How do the anticipated capabilities of the two systems compare and what justification does

the Navy have for developing two air defense systems? How many PFs could be procured for the estimated cost of one Aegis and its platform?

6. How will the relatively low speed PF keep up with high value forces?

7. Since the PF is considered, under certain circumstances, to be able to support high value forces and is multi-purpose in its capabilities is it a major combatant and subject to title VIII of Public Law 93-365 requiring it to be nuclear powered?

AGENCY REVIEW

A draft of this staff study was reviewed by DOD officials associated with the management of the program and their comments were incorporated as appropriate. As far as we know, there are no residual differences in fact.

PATROL FRIGATE

SYSTEM DESCRIPTION AND STATUS

The Patrol Frigate (PF) will be a new class of missile equipped surface combatant. Its mission is to supplement existing and planned surface combatants in protection of underway replenishment groups, amphibious forces and military and mercantile shipping against subsurface, air and surface threats. It is also expected to provide increased capability to defend against the anti-shipping missile. The Navy originally designated the PF to operate in areas where United States air superiority exists ("low-threat" areas).

Originally the Navy stated that although the PF must be capable of improving the support force capability to defend against a diverse threat, the objective is to provide improvement in the lower threat areas and the PF is not intended to serve as a carrier escort in high threat areas. However, the Navy has now stated that, although designed with the open ocean surface combatant role as the major consideration, the PF possesses sufficient multi-purpose capability and feasibility to be employed, under certain circumstances, in support of various high value forces.

The ship is to have an overall length of 445 feet, displace 3,585 tons in full-load condition and maintain a speed of 28 knots.

The PF's weapons will include the STANDARD missile and a 76mm gun. The STANDARD missile and 76mm gun are to be directed by the MK-92 fire control system. The PF is also one of the first ships designed to operate the HARPOON anti-ship missile system. The ship is to have hangar space for

two Light Airborne Multi-purpose Systems (LAMPS) helicopters. Present LAMPS program planning provides for one helicopter for each PF.

According to the Navy in wartime, the aircraft will be employed on those combatants for which there is an operational requirement; e.g., two on a deployed PF, one on a PF engaged in local operations, none on a PF undergoing overhaul.

The program is currently in the detail design phase of its acquisition process. The Navy awarded the lead ship construction contract to Bath Iron Works (BIW) on October 30, 1973, (See APPENDIX I for contract data). The detailed design portion is cost-plus-fixed-fee while the construction portion is cost-plus-incentive-fee.

RELATIONSHIP TO OTHER SYSTEMS

The PF is one element of the surface combatant force the Navy is planning to deploy. The ships, aircraft and associated weapons and sensors of the surface combatant force are intended to operate in a complementary manner. For example, in supporting a military convoy, the following forces and systems would interact with one another; P-3 patrol aircraft, PF, DE-1052 destroyer escort, LAMPS helicopter, sonars, MK-46 torpedo, and the HARPOON missile system.

The PF's weapons suite will consist of the HARPOON missile, Standard Missile (SM-1), MK-75, 76mm gun, MK-92 fire control system, MK-46 torpedo and is being designed to accommodate up to two LAMPS I or LAMPS III helicopters.

Concerning the MK-92 fire control system, the Congress has directed that the contract for the three ships authorized in FY 1975 not be awarded

until such time as the MK-92 system has satisfactorily completed the required test and evaluation. Upon completion of the test and evaluation, the Armed Services Committees of the Senate and House are to be advised of the results, including all deficiencies, for review prior to contract award for the FY 1975 program.

The PF when in company of a suitable type support ship, will receive intermediate maintenance support for the LAMPS helicopters. The PF will have organizational level helicopter maintenance capability.

The PF and the DE-1052 class destroyer were intended to operate with and in support of forces other than fast carrier forces. Compared with the DE-1052, which is currently operational, the PF will be comparable in length, about 500 tons lighter, one knot faster in sustained speed, identical in endurance speed and requires 75 fewer personnel. The Navy has stated that the PF will be superior in anti-air warfare because it is designed with the missile system (STANDARD SM-1) required to counter the Soviet anti-shipping cruise missile. Also the Navy states that the STANDARD missiles will provide the PF with the most significant portion of the advantage it will have over the DE-1052 ships. It is planned that the PF will complement the DE-1052 in the support role.

COMING EVENTS

The system land based test sites (LBTS) for the MK-92 fire control system and associated weapons and propulsion system are now expected to be operational in March 1975.

The Navy's interim Force Mix Study is to be completed by May 1975.

A DSARC III review is scheduled for June 1975 to consider whether the Navy is ready to proceed with construction of the follow-on ships. The

decision to proceed is to be based in part on successful test and evaluation at the LBTS. If follow-on production is approved, the Navy plans to have the ships built by three contractors and complete ship deliveries by April 1983, according to the September 30, 1974, SAR.

COST

Estimated total program costs for the 50 ship PF program as of September 30, 1974, was \$5,274.6 million. This is \$2,030.1 million more than the June 30, 1973, estimate of \$3,244.5 million.

Of the increase in total program cost, \$187.4 million resulted from program changes. These program changes were due to (1) refined distribution of ship's displacement, \$27.1 million; (2) design changes, \$74.2 million; (3) increased estimates for start up costs at follow-shipyards, \$13.6 million; (4) increase in ordnance estimate, \$40.1 million; (5) budgetary constraints on advanced procurement funds, \$20.6 million; and (6) increase support for technical manuals, MK-92 fire control system quality assurance and expanded R/M/A test and evaluation effort, \$11.8 million. The remaining amount, \$1,842.7 million, is attributable to an increase in the amount allowed for economic escalation. With this adjustment, allowance for escalation in the program cost estimate is \$2,466.8 million or 47 percent of the total program cost estimate.

The estimated cost for the PF lead ship was \$239.6 million (excluding outfitting and post delivery costs) as of September 30, 1974. This represents a \$33.3 million increase since the June 30, 1974, estimate of \$206.3 million. Of this increase, \$15.7 million is for additional escalation. The remaining \$17.6 million is attributable to the following:

- (1) New technical manuals to comply with a Chief of Naval Material

request that manuals be written at a ninth grade level

(\$2.0 million)

(2) Expansion of the Patrol Frigate Reliability, Maintainability, and Availability (R/M/A) Program (\$4.9 million)

(3) Expanded R/M/A testing for the MK-92 fire control system (\$1.5 million)

(4) Additional start-up costs for the MK-75, 76 millimeter gun (\$2.0 million)

(5) MK-92 fire control system costs for royalties, spare parts, and allowance for contingencies (\$1.3 million)

(6) Changes in lead ship design to include a fourth diesel generator (\$1.0 million)

(7) Cost growth associated with MK-92 fire control system and expansion of quality assurance testing for the fire control system (\$4.9 million)

The estimated average cost of the 49 follow ships in the PF program including escalation (but excluding outfitting and post delivery) was \$94.92 million as of September 30, 1974. This is an increase of \$37.72 million since the June 30, 1973, estimate of \$57.20 million. The increase was due primarily to escalation based on Navy projections from Bureau of Labor Statistics indices for material and labor costs.

As of September 30, 1974, the PF program had received funding totaling \$225.3 million; of which \$201.9 million was appropriated funds and \$23.4 million was reprogrammed from other Navy projects. At that time, \$170.8 million had been obligated and \$68.6 million expended.

Provision For Economic Escalation

For the PF program the Navy is now using an 11.0 percent weighted average annual inflation factor for the part of the program subject to future escalation. The 4.25 percentage rate published by OSD and used in the past has proven to be very understated.

The \$2,466.8 million shown as provision for economic escalation in the September 1974 SAR was derived by personnel in the PF Project Office through a process of eliminating all program costs considered within the control of the Navy. The amount remaining was deemed escalation.

According to a PF Project Office official, the amount reported as provision for economic escalation in the September 1974 SAR was not obtained by applying an escalation factor to any basic costs. Rather, it was developed from an estimate of PF follow ship costs prepared by Naval Sea Systems Command (NAVSEA) in then year dollars. This estimate reflected changes in estimated program cost given in the January 1974 Five Year Defense Plan.

The inflation factors used by NAVSEA were projected from Bureau of Labor Statistics' (BLS) actuals for material and labor through March 1974 and November 1973, respectively. The lag time for reporting of BLS actuals is generally one month for material and four to six months for labor. The labor lag tends to increase as the end of the fiscal year approaches. Other key elements considered in developing a projection include price changes in the steel and coal industries, industry trends, labor movement, and shipyard wage agreements which generally operate on a three year cycle.

The update of inflation and shipbuilder contract escalation calculations are made in accordance with the budget cycle. Latest BLS actuals available

at the time of a budget submit are used. New forecasts or projections are produced annually and are submitted either with or ahead of the budget and require OSD/OMB approval.

Due to the fact that the actuals used in determining escalation in NAVSEA's follow ship program cost estimate have become outdated, we question the realism of the "provision for economic change" reported in the SAR. Further, we question the validity of that provision in view of the questionable procedure used in its determination.

Possible additional program costs

In our 1974 staff study we reported that an additional program cost of \$118 million could result from inclusion of three space and weight items, i.e. close-in-weapon-system, digital data link systems, and space for mechanical stabilizers after ship construction is complete. During this review we found additional space and weight items which are not included in the program cost estimates. These are:

- LAMPS III Shipboard Electronics
- Type B Quality Monitoring System
- Helicopter Handling System
- T/SEC/KY-75 Security Equipment
- T/SEC/(?) Security Equipment
- C-7594A Security Equipment
- Escort Towed Array Sensor (ETAS) [space only]

We were unable to obtain from the Navy a current estimated cost for these items because the Navy said that they could not put any reliance on these cost figures, unless precise configuration and the time of procurement and installation are known.

Other space and weight items are included in the program cost estimate.

These are:

- Passive ESM Suite	\$40,417,000.00
- AN/URT-7D Transmitter	133,900.00
- AN/GRR-23 Receiver	100,500.00
- AN/URD-(?) UHF Radio Direction Finder	3,327,000.00

We believe that the estimated cost of the PF program should include all space and weight items. By omitting items the total program cost is understated.

The Navy advised that when the decision is made to equip specific ships with any of these items during the time limitation for SCN funding, estimated costs will be included in the SAR. This is substantiated according to the Navy by the fact that when it was recently decided by OSD to install CIWS in FY 76 and subsequent PF's, this fact was reported in the December 31, 1974, SAR with attendant cost implications.

SYSTEM SCHEDULE EXPERIENCE

According to the September 30, 1974, SAR the following schedule slippages have occurred in the PF program.

--Completion of the propulsion system LBTS slipped from December 1974 to February 1975 due to late delivery of the reduction gear.

--Initial operational evaluation of the SPS-49 radar has slipped from August 1974 to March 1975 so that additional testing at sea could be performed.

--IOT&E for the SQS-56 sonar slipped from October 1974 to March 1975 due to the correction of discrepancies discovered during

technical evaluation and expected limited availability of submarine services.

- Completion of Integration of Combat System LBTS slipped from November 1974 to February 1975 due to late delivery of MK-92 fire control system and late delivery of the SPS-49 radar.
- The DSARC III has slipped from March 1975 to June 1975 due to delays in completion of initial operational testing and evaluation efforts.
- Lead ship production start slipped from October to December 1974 due to the addition of a fourth diesel generator into the ship.

SYSTEM PERFORMANCE EXPERIENCE

One performance characteristic change occurred in the PF program during FY 1974. The full-load displacement of the ship was increased from 3,500 tons to 3,585 tons. The increase is attributed to the requirement for a fourth diesel generator. A detail design development of electrical loads revealed that the original design for only three generators would not supply sufficient electricity to the ship.

SELECTED ACQUISITION REPORTING (SAR)

The Congress deleted funds from the Navy's FY 1975 request for seven follow ships and provided funding for only three ships. However, the Navy submitted the September 30, 1974, SAR indicating the request for seven ships since the FY 75 Appropriations Bill had not yet been passed. The Navy has indicated that the December 31, 1974, SAR will reflect the FY 75 Appropriation Act.

Also there are no cost estimates for several space and weight items which may be put on the PFs at a later date. The Navy states that these costs cannot be estimated unless precise configuration and time of procurement and installation are known.

According to the Navy, when the decision is made to equip specific ships with any of these items during the time limitations for SCN funding, estimated costs will be included in the SAR.

We believe the SAR should show the expected cost of the space and weight items in order to project a more realistic total program cost estimate.

ACQUISITION STRATEGY

The Navy has initiated several changes to past strategies used in the procurement of ships. These changes include (1) the design-to-cost (DTC) concept, (2) a new approach to procurement of the ships, and (3) requiring the lead ship contractor to obtain options for follow ship equipment. These changes in the acquisition strategy are discussed in detail below.

Design-to-cost

The Department of Defense has directed that all major systems be developed under the Design-to-Cost (DTC) concept. The DTC concept, according to the Navy, is difficult to implement for ship construction because a ship contains many important subsystems and weapons which must be integrated into a large platform. Also the construction period of a single ship is in excess of three years once started. This long construction period makes it difficult to plan weapons and sensors for the ship because improvements to these systems can develop during the construction period. However, the Navy has developed an approach in the PF program which they believe complies with DTC concepts.

The PF program is the Navy's first attempt to implement the design-to-cost (DTC) concept in shipbuilding. The DTC goal is stated in unescalated fiscal year (FY) 1973 dollars. The Chief of Naval Operations (CNO) established an original DTC goal for the Navy of \$45 million in FY 1973 unescalated dollars. The CNO also established original goals on full-load displacement (3400 tons) and accommodations for 185 persons.

Since the CNO established the above three goals on the PF, two have changed. The dollar cost goal has changed two times to the present level of \$47.7 million in FY 1973 unescalated dollars. The full load displacement goal has changed from 3400 to 3585 tons.

The DTC goal rose to \$45.7 million (in unescalated FY 1973 dollars) on August 24, 1972. This increase was essentially due to the addition of the capability to accommodate a second LAMPS helicopter. The substitution

of a smaller, less capable and less costly sonar was also made at that time to partially offset the cost impact of the added helicopter capability.

The December 1973 SAR indicated that the average follow ship cost goal had risen to \$47.7 million in FY 1973 unescalated dollars. The major part of this increase was due to "marketplace factors" (those factors over which the Navy has no control and/or which are impossible to predict--such as decrease in shipyard productivity). CNO subsequently determined that such market place factors should be excluded from the DTC goal and the estimate for follow ships was adjusted to \$46.3 million as shown in the March 1974 SAR.

The June 1974 SAR indicated that the average follow ship cost had risen to \$48.0 million, mainly due to the addition of a fourth diesel generator and increases in Government-Furnished Equipment cost estimates.

According to PF officials, the CNO has not yet officially recognized the \$48.0 million estimate as a new DTC goal. Therefore, the PF average follow ship cost has exceeded the last CNO-approved goal.

The Navy has stated, however, that the Top Level Requirement for PF will probably use the term "less than \$50 million" which would correct this deficiency.

In our March 1974 PF study we expressed our concern about the use of DTC as implemented by the Navy as a management tool as the program progressed through its acquisition cycle. In discussing our concerns with the Navy, they stated that they had established a method for relating the unescalated "average" cost constraint and unit cost effect of any changes in the program to escalated dollars and that this relationship would be reflected in the

variance analysis of successive Selected Acquisition Reports (SAR). However, during the present review of the PF program we were informed that there was no formally documented process for de-escalating current estimated costs back to the FY 1973 unescalated dollar constraints. Although, according to the Navy, the rationale for all estimates and procedures for developing those estimates are documented after the fact, and adjustments consistently applied.

In preparing the June 1974 SAR, NAVSEA prepared two estimates of the average follow ship cost, in FY 73 dollars unescalated, to determine compliance against the DTC goal. The first estimate, conducted in accordance with procedures defined when the goal was established, yielded an estimate of \$48.0 million. In effect, this estimate was a "from the ground-up" type of estimate, using previous DTC cost estimates as a base, and using the procurement plan presented during DSARC II. As a gross check against this cost estimate, a second estimate was developed, using the updated costs over that included in the January 1974 Five Year Defense Program (FYDP). This estimate was a regressive type of estimate in that "then-year" dollars were de-escalated to account for differences since FY 73, so that an estimate in "FY 73 dollars, unescalated", could result. For this method, NAVSEA compensated for understated inflation estimates in the FYDP by generating NAVSEA factors based on BLS indices, and also developed estimates for other events that were known to have occurred during the period from FY 73 to FY 75, were not reflected by the indices, and were beyond the control of the Navy. The effect of these other events had surfaced in

part during lead ship contract negotiations and were subsequently quantified as:

- \$1M increased material costs
- \$.4M decreased shipyard productivity
- \$1.6M market place factors such as high demand coupled with
 shortages and reduced competition

Using this regressive analysis resulted in an average follow ship cost estimate, in FY 73 dollars unescalated, of within \$700,000 of the basic \$48.0 million estimate that had been developed in accordance with DTC procedures. The Navy views this second estimate as confirmation that the more rigorously developed \$48.0 million figure is valid.

The real discipline for the PF program is the threshold established by the Navy and approved by OSD in the Development Concept Paper (DCP) as \$50 million in FY 73 unescalated dollars. In addition, a DTC goal below this DCP threshold was established, as noted above, to improve the probability of meeting the threshold level, and to provide, according to the Navy, an early warning that the threshold may be breached. Since the breach of a DCP threshold requires approval by OSD, the Navy uses continued cost estimates against the goal as an early warning to provide assessment of program cost trends against the threshold.

We believe the DCP threshold may have been breached since the attribution of \$3.7 million per follow ship to inflation by the Navy is above and beyond the 11 percent weighted average escalation which NAVSEA estimators used in updating the PF program in the FYDP.

Procurement Plan

The original procurement plan for the PF program was formulated after serious study was performed on past programs such as the DE-1052 and DD-963. According to the Navy the desirable parts of these programs were incorporated into the PF plan and new approaches were formulated to avoid concurrency and specifications that are impossible or costly to perform, thereby minimizing the undesirable parts, such as design changes, engineering changes, increases in controllable costs, contractor claims and time delays for introduction into the fleet.

The procurement plan for the PF was designed to obtain a working relationship between prospective contractors and the Navy. To achieve this, contractor participation was instigated early in the acquisition cycle. After the Navy had completed the PF Preliminary Design, two contractors, Bath Iron Work (BIW) and Todd Shipyard (Todd), were awarded Ship Systems Design Support (SSDS) contracts with one of the contractors, BIW, being designated as lead ship contractor. The functions of the two contractors under the SSDS contracts were to review, study, and make recommendations to the Navy concerning the preliminary design of the ship.

After the designated lead ship contractor (BIW) was awarded a detail design and construction contract, the responsibilities of the second contractor (Todd) were to review the detail design drawings to insure that the follow ships could be constructed in shipyards other than BIW and to make recommendations to the Navy for improvement of ship production.

The original plan called for the 49 follow ships to be constructed in three separate shipyards. The award of the follow ship contracts were to

begin about two years after the award of the lead ship construction contract. This two year time period (about one year longer than usual) was to allow the lead ship design and construction and the PF test and evaluation program to progress far enough to validate the accuracy, correctness, and desirability of overall ship design. The follow ship contracts according to the Navy would then be based on more detailed, validated specifications than usual, and were expected to result in more accurate bids, fewer misunderstandings, fewer changes and reduction of claims.

The Navy had planned to award the follow ship as multi year contracts in two blocks of 24 and 25 respectively and achieve a delivery rate of one ship per month. The funding plan and delivery schedule including the lead ship were as follows:

FY Funded	73	74	75	76	77	78	79	80	81	82	83
First Block	1	0	7	11	6						
Second Block						4	10	11			
Delivery					1	0	9	12	10	12	6

In accordance with the original funding plan, the Navy requested long lead time funds in FY 1974 and authorization of seven PFs in FY 1975 at an end cost of \$436.5 million. Congressional action on the FY 1974 request was to deny advanced procurement funding; Congressional action on the FY 1975 military procurement bill was to deny four of the seven ships because the Congress believed the Navy was proceeding to fast with the program. Authorized funding for the construction of the three ships was \$186.0 million. The Project Officials stated that the Congress did not take

economy of larger quantities into consideration and now estimates that about \$109 million more will be required to build the three approved ships.

Because of these funding changes ship procurement schedules had to be changed and the Navy has developed alternative plans based on anticipated FY 76 funding.

The Navy is still planning to use three shipyards to construct the follow ships if at all possible, because this is the only way, according to the Navy, to maintain a rate of construction high enough to support economical production rates for ship components. Reduction of this rate of ship construction would invalidate component procurement options. Thus causing component cost increases and loss of standardization.

Shown below are the two contracting plans developed by the Navy. These plans are based on possible authorization from the Congress in the FY 1976 budget. The number of follow ships authorized will dictate which plan will be followed; in particular, the number of ships in FY 1976 governs the number of shipyards to be awarded contracts in FY 1975.

PLAN A

	<u>Funding Year</u>	<u>Shipyard A</u>	<u>Shipyard B</u>	<u>Shipyard C</u>	<u>Total</u>
(optional quantity)	FY 75	2	1	0	3
	FY 76	4	5	0	9

PLAN B

	FY 75	1	1	1	3
(optional quantity)	FY 76	5	4	4	13

The Navy considers that a minimum commitment from the Congress of nine ships in FY 76, plus indications of future authorizations, is necessary to maintain vendor options and shipbuilder interest. This commitment has not been congressional practice in the recent past. As shown in the following section, the lead ship contractor is experiencing difficulty in obtaining options for necessary equipment to be installed on the lead ship and also on follow ships even though escalation protection is provided. We believe the main reason for this difficulty is the instability of today's economy. Without some assurance of long term work contractors or vendors are reluctant to offer bids.

Lead Ship Contractor Purchasing Performance

Bath Iron Works (BIW) was awarded the lead ship contract on October 30, 1973. One of the principal objectives in this contract is the achievement of intraclass standardization of equipment. Various equipment items were assigned to categories depending on levels of standardization desired throughout the class. The categories are: Category I items, by Government determination, are ones essential for PF construction, and standardization across the entire class is mandatory. Category II items are those for which the lead yard selects a vendor, competitively, to provide equipment that meet specified performance requirements. These items are further identified as category IIA items intended for use in all follow ships while category IIB items must be standard only within ships constructed at a given follow yard, although, standardization throughout the class is desired. Category

III equipment items are all items purchased by BIW for the lead ship other than category I and II items defined above.

BIW is required to contract to obtain options with its vendors to purchase additional ship sets of equipment for category I and IIA items, and attempt to obtain options for category IIB items. There are no requirements that options be obtained for category IIB or III items.

The fee BIW will receive for obtaining the options will depend on the price obtained for the options. This fee is determined by the difference between a Navy estimated option price set out in the contract and the actual option price BIW is able to negotiate with its vendors.

BIW has been successful in obtaining options on all category I and IIA items pertaining to the propulsion units. However, they have not been as successful in obtaining options on other required equipment. An analysis, at the time of our review, of 38 equipment items in categories IIA(11), IIB(8), and III(19) for which requests for proposals were solicited from 296 vendors BIW received only 63 responsive bids.

As an update to our information the Navy provided us with information as of January 17, 1975, which states that options have been obtained for 78.9 percent of category IIA and 52.2 percent of category IIB items. However two vendors of category IIA items and nine vendors of IIB items have refused to grant options on the equipment.

BIW believes that the major reasons for vendors unwillingness to bid on PF equipment items (this unwillingness to bid has not been experienced by BIW in commercial work) are (1) the extensive documentation requirements

applicable to PF equipment, (2) material shortages, and (3) the rapid increase in inflation. Also, there is currently a considerable amount of commercial work available for vendors.

According to the Navy, the documentation identified in (1) above is essential in order to define escalation and option provisions, and, as a result, follow ship procurement cost and documentation requirements will be considerably reduced.

We also found that there have been major slippages of from 3 to 8 months in the procurement of several items needed for installation in the lead ship. BIW does not believe that these slippages will affect the lead ships delivery date because work-around procedures will be implemented during construction for late delivered items.

Although BIW has received poor bidder response from vendors for some PF equipment items and has experienced 3 to 8 month schedule delays or slippages for required equipment they are optimistic that they will meet the ships' scheduled delivery date.

RESPONSIBILITY FOR PERFORMANCE

As in past Navy programs the Navy has accepted the responsibility for the performance of Government Furnished Equipment (GFE) subsystems to be installed aboard the PF. One of these subsystems is the MK-92 Fire Control system.

The MK-92 Fire Control System is being produced by Sperry Gyroscope Division and Sperry Systems Management Division is responsible to the Navy for combat system integration and performance. Sperry Systems is to furnish

functional diagrams to the lead shipbuilder who is responsible for the installation of the system aboard the lead ship. Also Sperry is to furnish consultant engineers to BIW to inspect and assist with the installation of the MK-92 into the lead ship. The Navy has told the lead shipbuilder (BIW) that if the MK-92 is installed according to the drawings furnished by Sperry Systems, the Navy will be responsible for the MK-92 performance aboard ship.

The Navy's use of a combat system land based test site is intended to reduce the possibility of integration problems aboard the lead ship, nevertheless, based on the responsibilities as stated above it appears that complications could arise if problems should be experienced with the MK-92 or other GFE when the lead ship is tested at sea. It may be difficult to determine who would be responsible for correcting deficiencies concerned with GFE subsystems. However, according to the Navy, the potential for disputes in this program has been reduced through careful configuration management planning and by virtue of the physical replication at the land based test site.

Also with regard to performance responsibility the Navy has designated the LM-2500 gas turbine engine to be used in the PF propulsion system. Since they have designated which engine to use they have accepted the responsibility for the ship's engine performance of the ship.

The lead ship contractor (BIW) has responsibility for integrating all such systems into the lead ship. He also has responsibility for dock side testing and overall performance of the lead ship.

We believe that the interaction of two contractors, Sperry and BIW, concerning the installation of the MK-92 aboard the lead PF may cause problems for the Navy, concerning the apparent overlap of responsibility between these two contractors.

However, the Navy contends that the responsibilities of each are clear and distinct and that contractually the means are provided for controlling any differences between the ship and the prototype land-based mockup which might occur by virtue of detail ship design development or construction exigency.

INTEGRATED LOGISTICS SUPPORT (ILS)

The PF is being designed to a concept of logistic support that emphasizes reduced shipboard manning and off-ship maintenance.

The PF has incorporated into the design of the ship new and innovative procedures which will enhance the accomplishment of the principal maintenance concept goals of reduced shipboard manning for maintenance and minimizing ship off-line time for maintenance. These procedures center around the design criteria for logistic elements and the accessibility and removability programs.

To reduce manning levels the ships equipment will be accessible for maintenance and will be spared at the unit, module or component basis to ease replacement of failed parts.

To replace large equipment items such as the LM-2500 gas turbine engine, the ship is being designed for accessibility to these equipments so that a

ship tender could remove the failed item and replace it with a repaired one in a short period of time. A contract requirement is that an LM-2500 engine can be removed and replaced in a 48 hour time period.

To minimize off-line time of the ship a reliability and maintainability program will be implemented on all critical equipment to establish operational and support criteria. To the extent possible off-the-shelf equipment or equipment nearing completion of development will be used in the PF.

To support the ILS for the PF the Navy will be maintaining an inventory of repairable material at module level. This inventory called "rotating spares", will be maintained aboard the PF on destroyer tenders and at shore base facilities to support maintenance actions. Those equipments to be stored on-board or at tenders and land-based facilities have not yet been determined. However, it will be based on an analysis to determine if the man-hours saved by transferring the refurbishment task off-ship will result in reduction of shipboard personnel.

A study is in process to assess the cumulative effect of modular repair for different equipment instead of piece-part repair. This effort develops the requirements of onboard allowances for rotating repairable stock components, and determines the inventory required in system stocks to support the repair program.

To effectively implement this maintenance concept at least cost the rotating spares must be standardized throughout the class of PF ships. In support of this, the lead ship contractor is required to obtain options for equipment procured for the lead ship. If these options for future

purchases of the same equipment cannot be obtained, then the repairable/exchange program will become more expensive.

The implementation of the maintenance concept will require expansion of support facilities to accommodate progressive overhauls. To ensure that the support facilities are available another program management office has been established to plan for, budget, and implement the support requirements of the PF and ships with similar maintenance concepts. Included in this effort are rework facilities for Hull, Mechanical and Electrical and electronics repairable equipment, budgeting, management of shore spares, maintenance engineering analyses, and transportation management planning.

Improvement of intermediate maintenance facilities to accommodate PF requirements is currently being incorporated into a surface force tender/intermediate maintenance activity (IMA) improvement program.

A program management office has been established within NAVSEA to provide for the planning to identify and budget for the maintenance concept to be utilized to support and maintain the Patrol Hydrofoil Guided Missile Ship (PHM) and the PF.

The funding estimate for this concept is as follows:

Project Management Funds (\$ in millions)

<u>FY 75</u>	<u>FY 76</u>	<u>FY 77^{a/}</u>	<u>FY 77</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>	<u>FY 81</u>	<u>FY 82</u>
\$2.1	\$2.0	\$0.5	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0

Other Procurement Navy

<u>PF</u>	1.5	3.7	9.2	14.6	15.1	12.8
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<u>PHM</u>	4.8	10.8	10.6	9.4	6.1	3.4
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<u>Operation and Maintenance Navy</u>	5.2	10.2	15.9	26.6	26.8	35.6
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<u>Number of Additional Civilian Personnel</u>	16	41	81	180	259	338
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a/ Transition to different budget years

The maintenance concept as it is now planned will consolidate the machinery and electrical component rework effort at Long Beach Naval Shipyard. This facility is expected to begin operation in FY 1979 and be fully operational in FY 1983.

There will be Maintenance Engineering Analysis (MEA) coupled with progressive overhaul work package studies and the system PMS studies will establish the maintenance plan for systems and components used on PHM/PF ships. The analysis contains component data identification, failure mode effects and analysis, corrective maintenance, planned maintenance, and task analysis. Historically the preparation of MEAs has taken too long, cost too much, were not completely accurate, and were clumsy to load/update. The PHM/PF MEA approach will identify and establish a method to provide an initial maintenance concept package identity of preparing quick,

low cost MEAs. Dollars saved initially can be better spent on a data feed-back loop and will use initial ships experienced to observe, record, and refine the MEAs.

Tailored documentation will be used to provide specific Technical Data required by PHM/PF introduction, that is either unmodified, modified, rewritten, or new. The approach is to identify the documentation requiring change, and where necessary indicate type of documentation which requires development. The objectives of the PF R/M/A program are to influence and control the design of equipment for requisite reliability and maintainability, and to track and analyze failure data for remedial purposes. In addition the realities of PHM/PF maintenance can be observed and used beginning with first ship introduction. The Navy's approach is a continued analysis of INSURV and 3M reports of similar ships, compare trouble equipment to LO-MIX ship equipment and advise SHAPMS and develop detailed plans to alter Material, Maintenance Management/Maintenance Data System for PHM/PF ships.

TESTING

The testing program established for the PF was designed to meet the fly-before-you-buy approach outlined in Department of Defense Instruction (DODI) 5000.1. According to the Navy the intent is complied with by the establishment and operation of two complete LBTSS; one for the combat systems operated by Sperry Systems Management Division in Long Island, New York, and one for the propulsion system operated by the Naval Ship Engineering Center, Philadelphia, Pennsylvania, plus extensive at sea testing.

The Combat System test site combines the major elements of the combat system (the MK-92 fire control system, the SPS-49 radar, the SPS-55 radar, and the tactical data system computers, displays, and interface equipment) in spaces that duplicate actual installation aboard ship. Other equipment, for which ashore testing is not normally conclusive (such as the MK-75 gun, and SQS-56 sonar) are simulated at the land based test site and tested more extensively at sea. The SQS-56, for example, is undergoing Tech Eval and OPEVAL aboard the USS GLENNON, and the MK-75 gun is being tested aboard the USS TALBOT with the MK-92 fire control system. In addition, the SPS-49 is undergoing a Tech Eval and OP Appraisal aboard the USS DALE, to complement integrated tests at the LBTS with other PF combat system equipments. The PF MODs of the MK-13 missile launcher will be extensively tested at the factory.

The propulsion LBTS system is a duplicate of the propulsion system to be used on the PF, including the propeller hub, and it can be operated up to full power to demonstrate the PF system prior to actual lead ship installation.

The LBTs also serve as installation mock-ups so that lead and follow ship installation is simplified, and after initial tests are complete the LBTS can be used for evaluation of engineering changes and for training. Further, the results of these and other tests will be presented at the DSARC III review which is to determine if the Navy is ready to proceed into production.

Although this effort represents the most extensive testing program yet applied to a shipbuilding program by the Navy, only major systems of the ship (the LBTS systems) are tested together prior to ship construction.

PF CONTRACT DATA

<u>DATE</u>	<u>CONTRACTOR</u>	<u>CONTRACT FOR</u>	<u>INITIAL AMOUNT</u> (\$ In Millions)	<u>NUMBER CHANGES</u>	<u>JUNE 1974 AMOUNT</u> (\$ In Millions)
APRIL '72	BATH IRON WORKS	Ship System Design Support	\$3.15	14	\$3.6
APRIL '72	TODD SHIPYARD	Ship System Design Support	1.8	8	2.0
MARCH '73	SPERRY SYSTEMS MANAGEMENT	Combat System Integration	11.9	14	13.8
OCTOBER '73	BATH IRON WORKS	Lead Ship/Detail Design	92.5	68	98.1