United States General Accounting Office

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Report to the Secretary of Defense

January 1990

NAVY SHIPBUILDING

Cost and Schedule Problems on the DDG-51 AEGIS Destroyer Program

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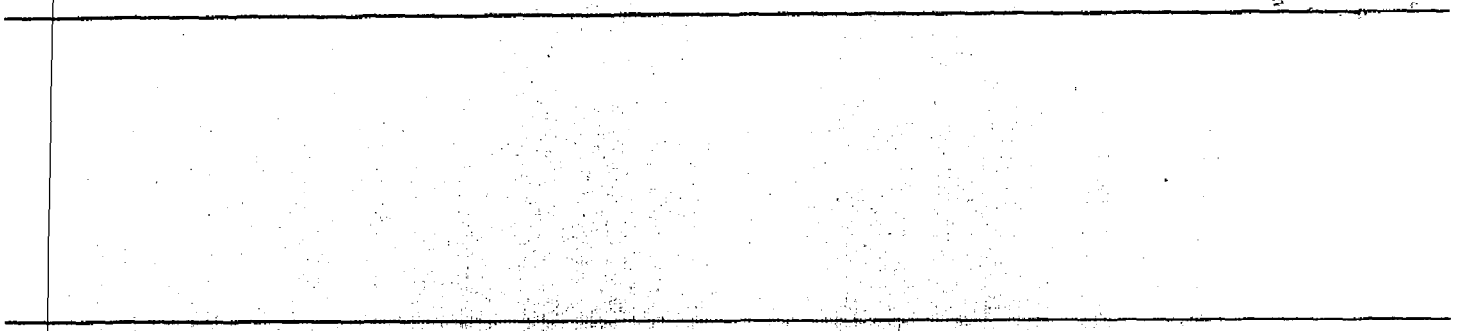

GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-228619

January 17, 1990

The Honorable Richard B. Cheney
The Secretary of Defense

Dear Mr. Secretary:

This report discusses our review of the DDG-51 AEGIS destroyer program, which is a 33-ship, $27 billion program that extends through 1999. Bath Iron Works, the lead yard, was awarded a contract to design and construct the lead ship. Ingalls Shipyard is the follow yard and shares the program with Bath.

Bath Iron Works has encountered problems in designing and constructing the lead ship. The contract costs have increased substantially, and the ship will be about 17 months late. Since the lead ship is only 50 percent complete, additional problems could surface and delay the follow ships.

The report recommends that you ensure that sufficient information exists to justify the award of contracts for follow ships beyond the seven now under contract. As you know, 31 U.S.C. 720 requires the head of a federal agency to submit a written statement on actions taken on this recommendation to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

Copies of this report are also being sent to the Secretary of the Navy.

Sincerely yours,

Frank C. Conahan
Assistant Comptroller General

Executive Summary

Purpose

The Navy currently plans to acquire at least 33 Arleigh Burke (DDG-51 class) guided missile destroyers at a total cost of about $27 billion. The ships will replace retiring battle-force destroyers and will be equipped with the AEGIS combat system. Originally, the Department of Defense (DOD) estimated the total cost of the lead ship at about $1.25 billion (in 1985 dollars) after design, construction, and outfitting with the AEGIS combat system.

The lead ship's complex design incorporates features to increase its ability to survive during battle. For example, it will have a seakeeping hull, which increases stability by reducing vertical motion; all-steel construction and extensive armor around vital spaces; and a collective protection system to protect the crew from contaminated air.

Because of the program's importance to the Navy mission and its significant costs, GAO assessed the status of the program.

Background

In April 1985, the Navy awarded Bath Iron Works a fixed-price incentive contract for the lead ship of the DDG-51 class destroyers. Bath Iron Works was responsible for designing the ship, which included integrating the AEGIS combat system and other government-furnished equipment. The contract called for ship construction to begin in May 1987, with delivery of the ship to the Navy in September 1989.

The Navy has awarded construction contracts for seven additional, or follow ships. The Navy awarded the contract for the second ship (DDG-52) in May 1987 to Ingalls Shipbuilding and the contract for the third ship (DDG-53) in September 1987 to Bath Iron Works. Contracts for five additional ships (DDGs 54 through 58) were awarded in December 1988—three to Bath Iron Works and two to Ingalls Shipbuilding.

Results in Brief

Bath Iron Works has encountered problems in designing and constructing the lead ship. As a result of these problems and Navy changes in the contract requirements, costs have increased substantially over the original contract estimate. Design and other problems contributed to two revisions to the ship's delivery schedule. The revisions, in January 1987 and February 1988, delayed the expected delivery by 17 months. Bath Iron Works is now accelerating construction to meet the planned delivery in February 1991.

While Bath Iron Works estimates that more than 50 percent of the lead ship is complete, the major part of outfitting the ship still has to be done. The combat system and certain other technical components have to be installed and integrated within the ship. Often in the development of new systems, it is these activities and the subsequent testing of the complete system that surface problems that could affect follow ships' schedule and cost. Therefore, GAO believes that DOD should ensure that sufficient information exists on program development and affordability before the award of contracts for follow ships beyond the seven awarded to date.

Principal Findings

Design Delays

Bath Iron Works planned to prepare production drawings using computer-aided design, but major problems arose. The computer equipment did not have adequate data storage capacity needed to design a complex warship. Design delays were also due to Navy changes in ship requirements, late government-furnished design data for the reduction gear, and difficulties with several developmental systems. As of November 1989, Bath Iron Works and Navy representatives believed that design problems had been resolved and production drawings were essentially complete. GAO believes that the installation and integration of the ship systems, which still has to be done, could surface additional design or performance problems.

Construction Problems

Design and other problems contributed to two revisions to the ship's scheduled delivery, totaling 17 months. The last revision to the delivery schedule was made in February 1988. The ship, originally scheduled to be completed in September 1989, is currently scheduled for delivery in February 1991. Bath Iron Works is accelerating construction to meet this date.

Bath Iron Works had not been able to perform as much construction in the fabrication buildings as planned because of delays in preparing production drawings. Therefore, more construction has been required in the production yard, which is more time-consuming and costly.

Bath Iron Works launched the lead ship in September 1989. According to Bath Iron Works representatives, the ship was more than 50 percent

complete in October 1989. However, to complete the ship requires incorporating and integrating the AEGIS combat system and demonstrating that other systems, such as the collective protection system, work as designed.

Cost Issues

According to the June 1989 cost performance report, the total cost for Bath Iron Works to design and construct the ship was estimated at about $500 million (in May 1984 dollars). Design costs were expected to more than double, from the original contract estimate of $111 million to about $247 million. Construction costs were expected to grow more than 60 percent, from $157 million to about $253 million. In September 1989, representatives of Bath Iron Works said that their estimate at completion had increased to $505 million and that costs could increase further. DOD believes that the total cost, after integrating the combat system, will still be under the original estimate of $1.25 billion (in 1985 dollars).

In September 1989, Bath Iron Works and the Navy modified the lead ship contract to resolve outstanding contractual issues. The issues were varied and included many technical matters. The modification provided for restructuring compensation to Bath Iron Works and, on the basis of information supplied by Bath Iron Works to the Navy, could increase Navy compensation as much as $71.7 million. Projected losses of about $41.5 million on design and construction would be eliminated.

GAO has reported that over 50 percent of competitively awarded fixed-price incentive shipbuilding contracts were experiencing overruns. Therefore, GAO was concerned that the contract modification for changing the lead ship contract terms could establish an inappropriate precedent. During the audit, GAO discussed this with Navy officials who said they expected the total cost of the ship to be under the original estimate and current shipbuilding appropriations were appropriate to cover the additional costs. DOD, in commenting on this report, stated that the restructuring will not set a precedent for future pricing of changes to Navy shipbuilding contracts because this instance presented a unique set of circumstances. GAO remains concerned about the modification in view of the high incidence of overruns on other fixed-price contracts.

Rescheduling of the First Two Follow Ships

In January 1989, the Navy modified the DDG-52 contract to provide for better helicopter support capabilities, which rescheduled the delivery date by 8 months. Also, the Navy has approved a proposal by Bath Iron Works to reschedule the DDG-53 construction schedule. The 7-month

rescheduling will allow Bath Iron Works to more efficiently schedule its work on other ships it is building for the government. These ships will be delivered earlier than expected.

Other Follow Ships

Contracts for seven follow ships, including the DDG-52 and DDG-53, have been awarded and will be under construction before the lead ship is completed. A major program milestone—approval for full-rate production — is scheduled for July 1990. Before then, contracts for five more follow ships could be awarded. Moreover, contracts for another five ships could be awarded before the scheduled February 1991 delivery of the lead ship. Thus, as many as 17 follow ships could be under construction or awarded before the lead ship has finished testing and has been delivered.

Although the Navy and Bath Iron Works believe the potential for lead ship problems is minimal, much work needs to be done to complete the ship. Unanticipated lead ship problems may increase costs and delay deliveries for many follow ships. Because of the technical advances being made in the destroyer program and because the lead ship is still only about 50 percent complete, putting a large number of ships in construction or under contract seems to be a risky procurement strategy. Before contracting for additional ships, the Secretary of Defense should review the status of the destroyer program. This is especially important in light of current deliberations on force structure and budget reductions.

Recommendations

GAO recommends that the Secretary of Defense ensure sufficient information exists to justify the award of contracts for follow ships beyond the seven now under contract.

Agency and Contractor Comments

DOD commented that the probability of a major problem affecting follow ships is minimal and did not concur in our recommendation in the report draft. DOD said that it had complied with existing federal statute regarding the adequacy and the evaluation of tests necessary to proceed beyond limited production. It stated that the adequacy and results of testing would continue to be evaluated and would be an important factor in the deliberation and decision to award contracts for additional follow ships.

GAO maintains the thrust of its recommendation because the program risks are significant; however, GAO reworded the recommendation to emphasize the need for high-level assurance on the overall program development and affordability. If DOD is not able to provide the assurances, it should delay contract award for additional follow ships.

Bath Iron Works commented that the report did not assess the validity of the Navy's acquisition process—most importantly, the fixed-price incentive type of contract. Bath Iron Works commented that it has become widely recognized that the use of a fixed-priced contract is not workable or compatible with the developmental nature of a highly complex warship.

GAO did not review the appropriateness of a fixed-price incentive contract for the DDG-51 acquisition. However, in commenting on this report, DOD did not agree with Bath Iron Works that, at the time of contract award, a fixed-price incentive contract was inappropriate. DOD said the contract terms at the time of award were appropriate to balance the risk between the Navy and Bath Iron Works. It also said that while Bath Iron Works' bid was aggressive, it was not unreasonably low.

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Abbreviations

DOD	Department of Defense
GAO	General Accounting Office
BIW	Bath Iron Works Corporation

Introduction

The Arleigh Burke is the Navy's newest class of guided missile equipped destroyers. The Navy currently plans to acquire at least 33 destroyers at a total acquisition cost of about $27 billion, or about $820 million per ship. The ships will replace retiring battle force destroyers and perform simultaneous missions in antiair, strike, antisurface, and antisubmarine warfare.

Bath Iron Works Awarded Lead Ship Contract

In April 1985, the Navy awarded Bath Iron Works Corporation (BIW) of Bath, Maine, a fixed-price incentive contract for about $322 million; it included about $268 million to design and construct the first, or lead, ship of the class (DDG-51). The remaining $54 million included $31 million in profits to BIW and $23 million for other program support costs. Originally, the Department of Defense (DOD) estimated the total cost of the lead ship at about $1.25 billion (in 1985 dollars), which included government-furnished equipment—primarily the AEGIS weapon system—and other program costs.

Ship construction was to begin in May 1987, with delivery to the Navy in September 1989, a contract allowance of 54 months for design and construction. Construction actually began in July 1987, and the ship was launched in September 1989. According to BIW representatives, the ship was more than 50 percent complete in October 1989. Delivery has been rescheduled to February 1991.

BIW subcontracted with Gibbs & Cox Inc., a marine engineering firm, to help it design the lead ship. Using the Navy's specifications, Gibbs developed the initial engineering design for the various ship systems. BIW then transformed this design into production drawings, which provide the detailed instructions and techniques needed to construct the ship.

The ship's complex design incorporates features to increase its ability to survive during battle. For example, it will have a seakeeping hull, which increases stability by reducing vertical motion. The ship will have all-steel construction and extensive topside armor in vital command, electronic, and machinery spaces. Better and redundant fire-fighting equipment will allow the ship to withstand damage. Noise and infrared suppression systems, in combination with other electronic gear, will make the ship difficult to detect or target. The collective protection system will protect the crew against contaminated air from nuclear, biological, and chemical agents.

BIW and Ingalls Shipbuilding Awarded Follow Ship Contracts

In May 1987, the Navy awarded Ingalls Shipbuilding of Pascagoula, Mississippi, a $162-million fixed-price incentive contract to construct the second ship of the class—the DDG-52. In September 1987, BIW was awarded a contract for about $190 million to construct the third ship, the DDG-53. Contracts for five additional ships (DDG-54 to DDG-58) were awarded in December 1988—three to BIW and two to Ingalls—at a total price of about $1.2 billion.

Through fiscal year 1994, the Navy plans to award construction contracts for 25 more DDG-51 class destroyers. The Congress approved an authorization of 10 ships (5 ships each in fiscal years 1990 and 1991) and an appropriation for 5 ships in fiscal year 1990.

Objectives, Scope, and Methodology

We examined the status of the DDG-51 destroyer program because of the program's importance to the Navy mission and its significant costs. We focused on contracts for the lead ship of the class and on contracts for the first two follow ships. Our work did not include an evaluation of the ship's operational systems, such as the AEGIS combat system. Because the DOD Inspector General had reviewed the Navy's DDG-51 acquisition strategy and review process, we did not evaluate these areas.

We interviewed officials and obtained data at the Naval Sea Systems Command in Washington, D.C.; the Supervisor of Shipbuilding and Bath Iron Works Corporation in Bath, Maine; and at the Supervisor of Shipbuilding and Ingalls Shipbuilding in Pascagoula, Mississippi.

Cost data in this report (except as indicated) are shown in base month (May 1984) dollars. These amounts exclude adjustments in compensation (escalation) that BIW receives under the contract based on certain labor, material, and other indexes from the Bureau of Labor Statistics. We relied on data in BIW and Navy cost reports.

In March 1989, we briefed staff of the House and Senate Appropriations Committees to provide information and analysis in time to be of use to the Congress in deliberations concerning the fiscal year 1990 budget.

As we were finalizing our review at BIW in September 1989, the Navy and BIW modified the lead ship contract, which included restructuring BIW's compensation under the contract. Although we did not perform a

detailed review of the justification supporting the contract restructuring, we have provided information on the modification because it is integral to discussing BIW's costs under the contract.

We provided a draft of this report to both DOD and BIW for comments. We revised the report to consider their comments where appropriate. DOD's comments appear in appendix II and BIW's appear in appendix III.

Our review was performed in accordance with generally accepted government auditing standards. The review was performed between April 1988 and December 1989.

Delivery Delays and Cost Growth With the Lead Ship of the DDG-51 Program

Design delays with the lead ship contributed to revisions in the lead ship delivery schedule and also created inefficiencies in constructing the ship. The design delays and construction inefficiencies have caused substantial cost growth under the lead ship contract. As a result of these problems and Navy changes in the contract requirements, costs have increased substantially over the original contract estimate. Design and other problems contributed to two revisions to the ship's delivery schedule, totaling 17 months.

In March 1989, BIW submitted a proposal for resolving outstanding contractual issues, which included provisions for major changes to the contract terms for calculating Navy compensation to BIW. The proposal was negotiated in September 1989 and will substantially increase Navy compensation to BIW.

Lead Ship Delivery Delays

Scheduled delivery of the lead ship was delayed twice earlier in the program because of design and other problems. In January 1987, the Navy and BIW revised the construction milestone dates, which included a 9-month delay in the delivery to July 1990. The extension was the result of changes to the ship's specifications, corrections to government-furnished information, and modifications to the duration and the phasing of testing requirements of the AEGIS combat system.

In February 1988, the Navy and BIW agreed to a second delay of 8 months, from July 1990 to February 1991. BIW had experienced production inefficiencies and capacity limitations for CG-47 class cruisers within its fabrication buildings. Because of scheduling and space limitations, delays with the cruisers also created delays for the destroyer units. Although the Navy and BIW attributed the delay to the cruiser production problems, design issues remained a major problem affecting the lead ship delivery schedule.

Design Delays

BIW encountered major delays in designing the lead ship. The design delays were mainly the result of (1) problems with computer-aided design, (2) changes in design requirements, (3) late government-furnished design data for the reduction gear, and (4) difficulties in designing several developmental ship systems.

Computer-Aided Design

BIW planned to prepare the lead ship production drawings using a computer-aided design system. This involves the storing of ship dimensions,

material information, equipment arrangements, and specifications in a 3-dimensional computer model. Draftsmen use computer-aided design to arrange ship zones and verify that all the systems interface properly without any interferences. BIW was convinced that the computer-aided design would reduce significantly the hours and elapsed time in developing the production drawings for the lead ship.

The computer-aided design for shipbuilding was planned for development in parallel with the design of the lead ship. The engineering concept of the computer-aided design had been tested in smaller pilot projects but had never been used to develop the entire design of a complex surface combatant ship.

BIW experienced problems using the computer-aided design to develop the production drawings. BIW's computer equipment did not have the capacity to handle the extensive level of data required for the ship's various systems (such as piping, electrical, and structural systems). Although BIW expanded the computer capability to store additional data, problems remained. The subcontractor, responsible for assisting in the system development, did not meet its required dates for delivering the software that was critically important to support the computer-aided design. Because of these problems, BIW scaled down significantly the use of computer-aided design and, with the assistance of other subcontractors, prepared a significant amount of the production drawings manually. BIW was able to use computer-aided design in developing the structural drawings.

Changes in Design Requirements

BIW representatives cited changes in design requirements as a major cause for the design delays. These changes have caused an increase in the original target cost for the design portion of the contract by about $37 million, from about $111 million to about $148 million as of June 1989. In conjunction with the approval for the second delivery delay in February 1988, BIW agreed to incorporate a series of changes in the lead ship, many related to the AEGIS combat system. These lead ship changes, according to Navy representatives, included 47 modifications to the original ship design and required revision of about 30 to 40 percent of the drawings. The Navy eventually agreed to increase the estimated price by about $14 million to make these changes.

Government-Furnished Data for the Reduction Gear

One major design issue involved the reduction gear, which is a major component of the ship's propulsion system. Although the reduction gear is furnished to BIW by the government, BIW is responsible for designing the compartment for the ship's reduction gear, as well as the equipment—purifiers, coolers, and pumps—needed for its operation. BIW had to use preliminary data obtained from the Navy because the final design data were not available. The final requirements, which were 6 months late, necessitated increases to the size of coolers and design changes to the compartment. According to BIW representatives, this resulted in design rework, increased costs, and design delays.

Difficulties With Several Technical Systems

BIW representatives told us that they have encountered problems with designing several technical systems for the ship, which BIW considers developmental in nature. For example, the collective protective system[1] provides environmental protection from nuclear, biological, and chemical threats. This system uses sophisticated air filtration units, airtight compartments, and decontamination rooms. Problems occurred in designing high-pressure fans, pressure-relief valves, and ventilation systems. In another example, the system to protect the ship from damage by fragments during battle had to be modified.

BIW Actions

BIW has taken several actions to deal with the design delays and problems. BIW and Gibbs & Cox significantly increased the number of engineers and draftsmen working on the program. Further, in February 1988, BIW replaced several managers and reorganized the engineering division to strengthen BIW's ability to complete the drawings, incorporate engineering changes, and monitor the status of the drawings. In mid-1988, BIW subcontracted with several companies throughout the country to help complete the initial drawings. In March 1989, BIW again subcontracted with several engineering firms to help it incorporate revisions in the drawings. According to BIW and Navy representatives, the design problems have been resolved for the lead ship and the drawings were essentially complete as of September 1989.

BIW representatives have said they know of no significant design issues remaining to be resolved. While this may be true, much work remains to be done, which includes incorporating and integrating the AEGIS combat system and other components. Often in the development of new systems,

[1]Navy representatives told us that the collective protection system had been used on a smaller scale on other surface combatants and that therefore the Navy did not consider the system developmental.

it is these activities and the subsequent testing of the complete system that surface problems that could affect follow ships' schedule and cost.

Construction Inefficiencies

BIW's construction method calls for the modular, or unit, construction of portions of the ship's units inside fabrication buildings. This method, called preoutfitting, calls for structural, piping, and electrical work to be done to the extent possible inside the fabrication buildings under optimum conditions. The ship's structure is then formed by combining the modular units outside the buildings in the production yard until the ship is launched. Less construction, however, was performed during preoutfitting than planned because the drawings were not completed. As a result, more construction than planned has been done outside in the production yard, which is more time-consuming and costly than performing the work inside fabrication buildings.

Other Factors Cited by BIW as Contributing to Cost Problems

BIW representatives cited factors besides design problems and schedule delays that contributed to the cost problems with the lead ship contract.

The shipbuilding industry has declined significantly due to the virtual elimination of commercial U.S. shipbuilding. According to BIW representatives, the competitive award process forces shipbuilders to bid very aggressively to obtain any of the limited number of Navy contracts. BIW was in the final stages of completing ships in the FFG-7 Patrol Frigate program at the time of the lead ship contract award. The company had limited prospects for future work. Although BIW had been awarded contracts for CG-47 class cruisers, BIW believed that the company's survivability depended on the DDG-51 destroyer program. Therefore, according to BIW representatives, the firm bid very aggressively. BIW representatives said that they looked at many contract variables and calculated cost estimates on the basis of good performance. BIW anticipated cost savings through improved technology. They feel that it would be optimistic to think that excellent performance on individual variables is achievable, but excellent performance could be achieved on all variables concurrently. This results in an aggressive bid with the likelihood of a major cost overrun.

BIW representatives believe that having fixed-price contracts for prototype ships, such as the DDG-51 destroyer, is inappropriate because of the developmental nature of the lead ship design and construction. Thus, according to BIW representatives, the fixed-price incentive contract puts an unfair burden of risk on the firm. BIW had never designed a

collective protection system, for example, and thus the level of required design work was unknown. Navy representatives said that cost control was a prime factor in selecting the contract type and that the contract terms at the time of contract award were appropriate to balance the risk between the Navy and BIW.

Significant Cost Growth for Both Design and Construction

The cost estimate for completing the design and construction portions of the contract has increased substantially since the contract award. The original estimate (target cost) in the April 1985 contract was about $268 million. This estimate was increased to $324 million to incorporate approved Navy changes in the scope of the contract.

BIW's June 1989 cost performance report shows, however, estimates for completing design and construction of the lead ship at about $500 million.[2] Design costs are expected to more than double, from the original contract estimate of $111 million to about $247 million. Construction costs are expected to increase more than 60 percent, from $157 million to $253 million. In September 1989, however, BIW representatives told us that the estimate to complete the design and construction has increased to $505 million and that costs might increase further. Details on the cost increases are shown in appendix I.

Under the original contract terms, BIW would have incurred substantial losses on the lead ship contract. On the basis of estimates at completion in the cost performance report, BIW would have incurred losses of about $41.5 million—about $27.1 million on design and about $14.4 million on construction. The losses would have been offset to some degree by earnings under an incentive provision of the contract. However, a September 1989 modification to the lead ship contract eliminated BIW's losses under the contract. See appendix I for details on the contract modification.

[2]Cost data are shown in base month (May 1984) dollars. The amounts exclude adjustments in compensation (escalation) that BIW receives under the contract. BIW said that part of this cost growth had occurred because government escalation payments were less than forecasted.

BIW-Navy Agreement to Restructure Compensation Under the Lead Ship Contract

In March 1989, BIW submitted to the Navy a proposal to resolve outstanding contractual issues. The issues were varied and included matters related to technical areas, such as the collective protection system and other developmental systems. Also, according to the proposal, BIW would accelerate work to maintain the milestone schedule of the lead ship. In September 1989, BIW and the Navy reached agreement on modifying the lead ship contract.

The agreement provided for major restructuring of BIW's compensation under the contract. Among other things, the contract modification increased the maximum contract price and revised a ratio used to calculate BIW and Navy shares of certain cost increases. According to BIW representatives, the changes in contract terms diminished the risk of a financial loss and created a contractual environment more appropriate to a developmental program.

The modification could increase Navy compensation to BIW as much as $71.7 million, based on BIW information provided to the Navy during negotiations of the contract modification. Projected losses of about $41.5 million on design and construction would be eliminated.

Navy representatives believe that changing the contract terms was appropriate to compensate BIW for the technical issues and recognizes the appropriate risk sharing for a lead combatant ship. According to the Navy program manager, the additional Navy compensation can be absorbed within existing Navy appropriations. This may involve use of savings from other shipbuilding programs.

Given the number of competitively awarded fixed-price incentive contracts for shipbuilding that experience overruns, the contract modification could, in our opinion, establish an inappropriate precedent of significant importance in Navy shipbuilding programs. We discussed this with Navy officials, who said that (1) the total cost for the DDG-51 (which includes the government-furnished weapon systems and other equipment) was still under the original projection and (2) current shipbuilding appropriations were adequate to cover the additional costs.

Cost Growth on Shipbuilding Contracts

In August 1989, we issued a report[3] showing that many competitively awarded contracts are expected to have significant cost overruns. A cost overrun is the projected cost over the target cost for the contract. Of 46 shipbuilding fixed-price incentive contracts reviewed, 25 were experiencing cost overruns. The net cost overrun was projected at about $3 billion of about $26 billion worth of contracts. On the basis of then-existing contractual relationships, $1.8 billion represented the commercial shipyards' potential liability and $1.2 billion was the Navy's potential liability.

Included in the proprietary supplement to that report[4] were figures for the DDG-51 class destroyers showing the percentage of work completed on contracts and the cost estimate at completion. For the DDG-52, the report shows 5 percent of work under the contract complete and the estimated cost at completion already 9 percent above the contract's ceiling price. For the DDG-53, with only 1 percent of work under the contract complete, the cost estimate at completion was 1 percent above ceiling price.

Conclusion

Cost growth and schedule delays on the lead ship have resulted from both difficulties with the design process and inefficiencies with the construction process. Design delays have resulted from problems in the use of a computer-aided design system, Navy changes in design requirements, late government-furnished design data for the reduction gear, and difficulties with several technical systems. These design delays affected the construction by limiting the use of efficient modular construction.

In September 1989, BIW and the Navy modified the lead ship contract to resolve outstanding contractual issues. The modification, among other things, increased the maximum contract price and revised a ratio used to calculate BIW and Navy shares for certain cost increases. The modification, depending on the final costs for the lead ship, could increase the Navy compensation to BIW by as much as $71.7 million. Projected losses of about $41.5 million on design and construction would be eliminated. The modification could establish an inappropriate precedent of significant importance in Navy shipbuilding programs.

[3]Navy Contracting: Status of Cost Growth and Claims on Shipbuilding Contracts (GAO/NSIAD-89-189, Aug. 4, 1989).

[4]Navy Contracting: Cost Growth on Shipbuilding Contracts (GAO/NSIAD-89-189S, Aug. 4, 1989).

DOD Comments and Our Evaluation

DOD's comments on a draft of this report are provided in appendix II, and BIW's comments are in appendix III. Significant comments and our evaluations are shown below and in chapter 3.

DOD commented that the Navy expected to deliver the lead ship under the original congressional budget submission of $1.252 billion in fiscal year 1985 dollars. DOD stated that the portion of this congressional submission (made in 1983) related to the shipbuilder ($542.2 million) compared very favorably with the estimated end Navy cost for these items.

We question DOD's rationale for comparing the current estimates at completion with the original congressional submission made in 1983. For example, the original estimate of $542 million was updated and reduced in fiscal year 1987 to about $357 million, or a reduction of about $185 million. However, whatever comparisons are used, BIW has experienced significant cost problems on the design and the construction of the lead ship.

DOD commented that the restructuring "equitably adjusted" the contract to recognize a number of changes and that the contract in its new form provided an effective incentive arrangement and reflected the current Navy position on risk and uncertainty for a lead combatant ship contract. The report points out the potential cost impact of the contract modification, as well as BIW and Navy positions on the contract restructuring.

We did not assess the justification supporting the contract modification, including whether the modification equitably adjusted the contract. The modification was completed in mid-September 1989, near the end of our review. However, given the number of fixed-price incentive contracts experiencing overruns, we were concerned that the modification could establish an inappropriate precedent within the shipbuilding industry. Navy officials were not concerned because they felt the total costs of the program would be under the original estimate and funds were available to cover the additional costs. DOD said that the contract restructuring would not set a precedent for pricing of changes to Navy shipbuilding contracts because the changes in this instance presented a unique set of circumstances. We remain concerned about the modification in view of the high incidence of overruns on other fixed-price contracts.

BIW Comments and Our Evaluation

BIW commented that the report did not assess the validity of the Navy acquisition process—including the type of contract (fixed-price incentive) and the tight 54-month delivery schedule. BIW commented that it has become widely recognized that the fixed-priced form of contract is not workable or compatible with the developmental nature of a highly complex warship.

We did not review the appropriateness of a fixed-price incentive contract for the DDG-51 acquisition. However, in commenting on this report, DOD did not agree with Bath Iron Works that, at the time of contract award, a fixed-price incentive contract was inappropriate. DOD said that the contract terms at the time of contract award were appropriate to balance the risk between the Navy and BIW. DOD also said that, while BIW's bid was aggressive, it was not determined to be unreasonably low.

BIW commented that recent policy guidance from the Congress and DOD supplied more than adequate rationale for the restructuring of the contract but that the report created the impression that BIW alone contended that fixed-price contracts were inappropriate for designing and constructing highly sophisticated warships. BIW commented that it was convinced the modification had been negotiated because (1) BIW proved entitlement, (2) actual experience has shown that several original contract terms required adjustment, (3) the revised structure provided a better form to efficiently complete the lead ship, (4) restructuring will prove beneficial to follow ships, and (5) BIW gave additional consideration such as extended warranties.

As discussed above, the scope of our review did not assess the appropriateness of the contract modification, including whether the modification equitably adjusted the contract. However, we did obtain a legal analysis on the contract restructuring performed in August 1989 by the Naval Sea Systems Command at the request of the Navy contracting officer. According to the analysis, the submissions by BIW were less than specific regarding the basis for its request to modify the contract sharing ratios and ceiling prices. The vagueness was attributable to a number of causes, including the difficulties created by the classified nature of the subject matter and BIW's general laxity in generating proposal support. The analysis further pointed out that the Navy had a difficult time in quantifying the adjustment due BIW. The analysis concluded that the contract restructuring was highly unusual, but not improper, provided that the ultimate impact is fully assessed and judged reasonable. The contract was restructured in September 1989.

Lead Ship Delays Create Potential Problems for Follow Ship Production

Technical and other problems related to the lead ship must be identified and resolved as early as possible before they affect the construction of follow ships. The impact of lead ship design and construction delays on follow ships to date has been minimal because of major changes in the delivery schedules of both the DDG-52 and DDG-53 for other reasons. Although the Navy and BIW believe that the potential for future lead ship problems is minimal, much work needs to be done to complete the ship. Unanticipated lead ship problems may increase costs and delay deliveries of many follow ships in the program. With force structure and defense budget reductions being deliberated, it is important that the status of major programs, such as the DDG-51, be reviewed before major increases are authorized.

Impact of Lead Ship Delays on the DDG-52

The Navy is responsible for supplying the lead ship drawings to Ingalls Shipbuilding for use in constructing the DDG-52. BIW is contractually responsible for supplying the drawings to Ingalls Shipbuilding on behalf of the Navy. The start of construction was delayed due to serious problems with incomplete drawings provided by BIW. For example, an Ingalls review of 388 pipe drawings in January 1989 disclosed that 129 (or about 33 percent) were less than 51 percent complete. Another review of 112 ventilation drawings showed that 45 (or about 40 percent) had extensive data missing. Similar problems existed for drawings covering the first four ship assemblies that Ingalls planned to construct. For these four assemblies, 16 percent of the pipe and 12 percent of the ventilation drawings were incomplete.

In January 1989, the Navy modified the DDG-52 contract to provide for better helicopter support capabilities. The modification called for a reschedule of the DDG-52 delivery by 8 months and a maximum cost increase of about $12.7 million. Although the 8-month delay is attributed to the helicopter modification, Ingalls representatives told us that incomplete drawings would have significantly delayed the DDG-52 schedule.

In March 1989, Ingalls began to construct the DDG-52. When we discussed the lead ship design problems with Ingalls representatives in June 1989, they said that many changes had been made in the drawings affecting construction but that the major problems with the drawings had been resolved. Although there was some uncertainty, Ingalls representatives were optimistic about meeting the revised delivery date.

Lack of Drawing Verification Could Result in Additional Ingalls Compensation

The DDG-52 contract between the Navy and Ingalls specifies that the Navy will provide warranted drawings. The contract provides Ingalls with a guarantee from the Navy that about 1,950 drawings are accurate as of a certain warranty date (the warranty dates are contractually established and staggered primarily over an 18-month period). If the contractor identifies a problem with a drawing after the warranty date, the Navy is at risk for additional compensation to Ingalls for any additional costs to correct the problem.

The Navy planned considerable work to ensure that Ingalls received accurate drawings. The DDG-51 contract required BIW to develop a plan to ensure the accuracy and the completeness of DDG-51 drawings. This plan was to include BIW's methodology for (1) revising drawings on the basis of problems identified during construction of the lead ship, (2) validating drawings through the review and acceptance of drawings by engineers, and (3) verifying drawings through comparison of drawings with actual lead ship construction. In addition, the Navy contracted with another marine engineering firm to review and comment on the drawings.

Delays in designing and constructing the lead ship, however, may significantly diminish the amount of verification that can be accomplished in time to benefit the DDG-52, which is already under construction. Under the process, the drawings for a compartment of the lead ship would be physically matched against the actual ship construction, and the drawing would be updated for any identified interferences or problems. Insufficient time exists between the physical check (and drawing update) of the actual construction of the lead ship and the warranty dates for many drawings. The Navy is considering a limited verification effort that would examine the lead ship after the foundations, piping, and ventilation work have been installed.

According to BIW representatives, every effort is being made to provide complete and accurate drawings. BIW is providing updated information to Ingalls daily.

Rescheduling of the DDG-53

In February 1989, BIW proposed to the Navy a realignment of construction schedules for cruisers and destroyers. According to BIW representatives, the proposed sequencing of ships would maximize production efficiencies for both the cruiser and destroyer programs at BIW. Further, BIW representatives said that the revised approach would give them additional time to resolve design and construction problems identified

during lead ship construction. The Navy approved the change in April 1989, and the DDG-53 contract was formally modified in September 1989.

Under the proposal, BIW would begin to construct the last cruiser in the CG-47 class of ships before beginning to construct the DDG-53 and later destroyers. Using this proposal, the DDG-53 delivery would be rescheduled from July 1992 to February 1993. BIW also planned to deliver other ships earlier than contractually required. One CG-47 class cruiser would be delivered 7 months earlier, and a second cruiser would be delivered 1 month earlier. Three other DDG-51 class destroyers under contract to BIW would each be delivered 2 months early.

Potential for Major Problems With Follow Ships

The completion of design, construction, and testing of the lead ship of any class of ship is important to the success of the entire program. Technical and other problems need to be identified and resolved as early as possible in order to minimize the impact of any identified problems on follow ships. Although the Navy has test facilities for the propulsion system and the AEGIS combat system, it is important to integrate the various systems by building and testing the lead ship.

The lead DDG-51 ship delay may increase costs and delay deliveries of follow ships to be built in the program. Because of design and delivery delays with the lead ship, limited time exists to identify and resolve problems that may adversely affect these follow ships. At the current rate, contracts for 17 follow ships, or more than 50 percent of the ships in the program, could be awarded before the lead ship has finished its at-sea trials and has been delivered to the Navy. Any further delays in the construction of the lead ship could further increase the possibility of adversely affecting follow ships by compressing the time between the completion of the lead ship and the construction of follow ships.

Although the scope of our review did not include a review of combat systems, we did note potential problems with the ship's antisubmarine warfare combat system. A Navy operational evaluation completed in January 1989 of the sonar to be used concluded that it was only potentially operationally effective and suitable. The report recommended that fleet introduction for the system be limited and that full fleet introduction not take place until the Navy corrects specific deficiencies noted in the report. In April 1989, DOD performed an operational system assessment on the sonar. The resulting report identified limitations in the

scope of the testing and some potential problems. Nevertheless, DOD determined the sonar to be operationally effective and suitable.

Although we did not evaluate this specific operational assessment, we have reported[1] on the quality of DOD operational testing and reporting. Our report pointed out that (1) DOD operational testing reports contained incomplete and inaccurate statements and (2) the majority of favorable overall assessments of testing adequacy and of system effectiveness and suitability were not supported by the evidence. If the sonar does need to be modified, it could result in redesign and reconstruction work on the lead ship and other follow ships.

The Navy has constructed a land-based engineering test site for the propulsion system for the DDG-51 in Philadelphia. This facility, which became fully operational in the spring of 1989, is to test the engines, reduction gear, electrical generators, and shaft for the ship. Through this facility, as well as the combat system testing, the Navy believes it has significantly reduced the risks in the performance of the lead ship and thus the risks for the follow ships.

BIW representatives stated that they believed the risks to follow ships are low because design problems have been minimized. Although BIW representatives believe there are always some modest design risks with a lead ship, they are confident that the risks are manageable. Further, they believe that further delays in contract awards could delay the start of follow ship construction. This would increase the costs of follow ships because production would be interrupted. The higher costs would be attributed to loss of learning in production trades, loss of skilled labor, material procurement, and other costs associated with delay.

Full-Scale Production Without Milestone IIIB Approval

The management of major acquisition programs, like the DDG-51, is normally divided into phases to provide effective oversight during development and procurement. These phases include concept definition, full-scale engineering development, limited production, and full-rate production. Both DOD and Navy approval is normally required at key decision points, or milestones, before the program can proceed to the next phase. In October 1986, the DDG-51 program received approval to proceed with limited production (milestone IIIA). A total of seven follow ships were authorized in fiscal years 1987, 1988, and 1989. In August

[1]Weapons Testing: Quality of DOD Operational Testing and Reporting (GAO/PEMD-88-32BR, July 26, 1988).

1989, the program received extended approval for limited production through the award of ships in fiscal year 1990. According to Navy regulations, approval for limited production signifies that the system is potentially operationally effective. It also signifies that the system has undergone initial developmental and initial operational test and evaluation.

The next major milestone for the DDG-51 program is approval for full rate production (milestone IIIB), which is scheduled for July 1990. Although a milestone IIIB decision normally requires successful completion of technical and operational testing, the Navy recognizes the unique character of ship construction, including the 3 to 4 years necessary to build a ship. While there are some differences in documentation and decision reviews, the Navy's management of ship programs is consistent with overall DOD and Navy requirements for managing major acquisitions.

As discussed above, contracts for seven follow ships have been awarded. A total of 12 ships—the 7 ships awarded to date plus 5 additional ships authorized in fiscal year 1990—could be awarded before the milestone IIIB decision in July 1990. Thus, 12 follow ships, or more than one-third of the ships in the program, could be either under construction or under contract with approval for only limited production. Moreover, as many as 17 ships could be under construction or awarded (which includes 5 ships in fiscal year 1991) before the lead ship has finished testing and been delivered to the Navy.

Conclusions

In view of the problems encountered with the lead ship of the class and the potential impact on follow ships, the Navy should tailor the DDG-51 acquisition strategy to provide for a full-rate production decision meeting as soon as possible. Such a meeting would provide information to decisionmakers to assess the risks of the current acquisition strategy and to make any necessary changes if the risks are unacceptable. Unanticipated problems with the lead ship may increase costs and delay deliveries for many follow ships in the program.

Because of the technical advances being made in the destroyer program and because the lead ship is still only about 50 percent complete, putting a large number of ships in construction or under contract seems a risky procurement strategy. Before contracting for additional ships, the Secretary of Defense should review the status of the destroyer program. This

is especially important in light of current deliberations on force structure and budget reductions.

Recommendation

We recommend that the Secretary of Defense ensure sufficient information exists to justify the award of contracts for follow ships beyond the seven now under contract.

DOD and BIW Comments and Our Evaluation

DOD commented that while any problem may affect follow ships, the probability of a major problem with the DDG-51 affecting follow ships is minimal. The design has been supported by the construction of two land-based engineering sites—one for the propulsion system and another for the AEGIS combat system. The basic AEGIS combat system for the destroyer has been proven at sea with the AEGIS cruiser program. Many elements of the propulsion system have operated successfully at sea or have been successfully tested.

We maintain that the program risks are significant because the Navy will not actually know whether major problems exist with the lead ship until testing at sea trials have actually been completed. At the current rate, 17 follow ships, or more than 50 percent of the ships in the program, could be under construction or could be awarded before the lead ship has finished the sea trials and been delivered to the Navy.

Although DOD agrees that it is desirable to have a full-rate production decision as soon as possible, DOD did not concur in our proposal in a draft of this report. We had proposed that DOD ensure that the DDG-51 lead ship schedule provide for completion of the task and test necessary to support an informed full-rate production decision before award of contracts for additional follow ships. DOD said that it had complied with existing federal statute regarding the adequacy and the evaluation of tests necessary to proceed beyond limited production. It stated that the adequacy and the results of testing would continue to be evaluated and would be an important factor in the deliberation and decision to award contracts for additional follow ships.

We maintain the thrust of our proposal because the program risks are significant and it is timely to review the status of major acquisitions because of likely force structure and budget reductions. However, we have reworded the recommendation to emphasize the need for high-level assurance on the overall program development and affordability. If DOD

is not able to provide the assurances, it should delay the award of additional follow ships.

Overview of Contract Costs for Lead Ship of DDG-51 Destroyer Class

In April 1985, the Navy awarded a fixed-price incentive contract to BIW for about $322 million. This included about $268 million to design and construct the lead ship. The remaining $54 million included $31 million in profits for design and construction and $23 million for other program support costs (including special studies, spares and repair parts, certain engineering services, and design and development of the machinery control system). In June 1989, the BIW estimate to design and construct the lead ship had increased to $499.6 million.

In September 1989, BIW and the Navy modified the lead ship contract to resolve outstanding contractual issues. The modification provided for major restructuring of BIW's compensation under the contract. This appendix discusses (1) contract cost elements, (2) cost data before the contract modification, and (3) an analysis of the cost impact of the modification.

Contract Cost Elements

Under the contract terms, the ultimate costs to the Navy and BIW are determined on the basis of final BIW costs relative to certain contractual elements—target costs, target profits, sharing ratios, and ceiling prices. Costs are accumulated separately for design, construction, and other requirements.

A target cost was established separately for design and construction. The target cost is the negotiated dollar value (an estimate excluding profits) to complete the requirements in the original contract, plus the cumulative cost applicable to contract changes since the beginning of the contract. The target price consists of the target cost plus profits.

The contract incentives were established through separate sharing ratios established in the contract for design and construction. The Navy and BIW share costs above the target costs up to the specified ceiling prices, which are the maximum contract prices the Navy will pay (including profits) under the contract. All costs above the ceiling are paid by the contractor. For example, the 90-to-10 sharing ratio for design meant that the government was responsible for 90 percent of costs above the target cost up to the ceiling price and that BIW was responsible for 10 percent of the costs above the target cost. The ceiling prices were specified in the contract as percentages of the target costs.

Contract amounts are shown in base month (May 1984) dollars. The contract amounts exclude adjustments in compensation (escalation) that BIW receives in accordance with the contract provisions. The escalation

is computed on the basis of certain labor, material, and other indexes from the Bureau of Labor Statistics.

Cost Data Before the Contract Modification

Lead ship contract cost data based on the cost performance report (June 1989) are shown in table I.1.

Table I.1 Estimated Design and Construction Cost Data Before Contract Modification

Dollars in millions

	Design	Construction
BIW cost estimates at completion (EAC)	$247.1	$252.5
Target costs	147.6	176.4
Target profits	10.5	26.1
Target prices	158.1	202.5
Costs over targets (EACs less target costs)	99.5	76.1
Sharing ratios	90/10 ratio	50/50 ratio
Ceiling prices	220.0	238.1
Ceiling prices—percentages of target costs	149 percent[a]	135 percent

[a]The contract established a ceiling ratio of 145 percent for the design portion of the contract. The ceiling price for certain engineering changes in the contract was negotiated at 175 percent. The combination of these results is a revised ceiling at about 149 percent.

On the basis of the above data, the contract price to the Navy for design and construction, as well as BIW's profit or losses, could be estimated. The Navy would be responsible for paying the ceiling price for design ($220 million) and construction ($238.1 million) because of the level of BIW's costs. Any additional costs incurred over the ceiling price would have been BIW's responsibility. BIW would have incurred about a $41.5 million loss. The computations derived from a cost analysis prepared by the Navy are shown in table I.2.

Table I.2 Computation of Estimated Navy Prices and Estimated BIW Net Losses Before Contract Modification

Dollars in millions

Navy price	Design	Construction
Target costs	$147.6	$176.4
Navy share of costs over targets up to ceiling price[a]	61.9	35.6
Target profits	10.5	26.1
Estimated Navy prices	$220.0	$238.1
BIW profit (loss)		
Target profits	10.5	26.1
BIW share of costs over targets up to ceiling price	(10.5)	(26.1)
BIW costs over ceiling	(27.1)	(14.4)
BIW net profits (losses)	($27.1)	($14.4)

[a]These amounts are derived from a formula in the contract. When the costs approach the ceiling price, the amounts do not mathmatically equate directly to the sharing ratio percentage.

Analysis of the Estimated Cost Impact of the Contract Modification

In September 1989, BIW and the Navy modified the lead ship contract to resolve outstanding contractual issues. The modification provided for a major restructuring of BIW's compensation under the contract. The modification called for (1) increasing the target cost by $31 million and target profit by about $3.7 million, (2) combining the design and construction portions of the contract, (3) revising the sharing ratio to 80-to-20 for combined design and construction costs, and (4) increasing the ceiling ratio to 151 percent of target cost for design and construction.

Table I.3 compares estimated costs before the contract modification with estimated costs after the modification. The first column represents the total of design and construction data in the June 1989 cost performance report. (See table I.1.) The second column represents an estimate after the modification, based on the provisions of the contract modification and information as of September 1989 provided by BIW to the Navy during negotiations of the modification. The estimate is also based on the revised ceiling price for design and construction.

Table I.3: Comparison of Estimated Cost Data Before and After Contract Modification

Dollars in millions

	Design and construction estimates	
	Before modification	**After modification**
Cost estimates at completion (EAC)	$499.6	$529.8
Target costs	324.0	350.9
Target profits	36.6	40.0
Target prices	360.6	390.9
Costs over targets (EACs less target costs)	175.6	178.9
Sharing ratios		
design	90/10 ratio	
construction	50/50 ratio	
combined design and construction		80/20 ratio
Ceiling prices	458.1	529.8
Ceiling prices—percentages of target costs		
design	149 percent	
construction	135 percent	
combined design and construction		151 percent
Share of costs over target		
Navy costs up to ceiling	97.5	138.9
BIW costs up to ceiling	36.6	40.0
BIW costs over ceiling	41.5	-0-
Total BIW costs over target	78.1	40.0

On the basis of the data, a comparison of the Navy's prices and BIW's net profit or losses can be estimated. On the basis of the estimates, the contract modification could increase compensation to BIW by as much as $71.7 million. The estimated Navy price would increase from $458.1 million to $529.8 million. At the revised ceiling, BIW's estimated loss of $41.5 million for design and construction is eliminated. If costs increase beyond the ceiling price, BIW would absorb them all and incur them as losses. The computations are shown in table I.4.

Table I.4: Comparison of Estimated Navy Prices and BIW Profits (Losses) Before and After Contract Modification

Dollars in millions

	Design and construction estimates	
Navy price	**Before modification**	**After modification**
Target costs	$324.0	$350.9
Navy share of costs over target up to ceiling price	97.5	138.9
Target profits	36.6	40.0
Estimated Navy prices	$458.1	$529.8
BIW profits (losses)		
Target profits	36.6	40.0
BIW share of costs over target up to ceiling price	(36.6)	(40.0)
BIW costs over ceiling	(41.5)	
BIW net profits (losses)	($41.5)	$0.0

The contract also provides an incentive pool of $19 million to reward BIW performance for design and construction. Each 6-month period, the Navy assesses BIW performance in certain areas and awards funds from the incentive pool. The Navy assesses technical matters such as the quality of the engineering and workmanship, as well as management matters such as BIW's resolution of problems. BIW has earned incentives to date of about $11.3 million of a potential of about $13.9 million.

Comments From the Department of Defense

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

WASHINGTON, DC 20301-3010

Mr. Frank C. Conahan
Assistant Comptroller General
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "NAVY SHIPBUILDING: Cost and Schedule Problems on the DDG-51 Destroyer Program," dated October 13, 1989 (GAO Code 394265/OSD Case 8149). The Department agrees in part with the report findings, but disagrees with the recommendation.

The DoD does not agree with the recommendation to delay the scheduled award of contracts for additional follow ships, pending completion of operational tests for a Milestone IIIB full rate production decision. In the DDG-51 program DoD has complied with the existing Federal statute regarding the adequacy and evaluation of the tests necessary to proceed beyond low-rate initial production--a decision made in October 1986. That testing was based on key component tests, as allowed under Title 10, U.S.C., Section 138. Additional operational testing has taken place since then and will continue to be evaluated by the DoD, in accordance with the existing Federal statute. The additional operational testing will be an important factor in the deliberation and decision to award contracts for additional follow ships.

The basic report is a balanced presentation of the facts, data and rationale on the DDG-51 program. The Executive Summary, however, conveys a more negative message than the body of the report, because balancing and clarifying statements are not present. Unfortunately, many readers will only scan the Executive Summary. It is the Department's position that the problems cited in this report, which was initiated by the GAO approximately two years earlier, have been largely overcome. The shipyards participating in the DDG-51 program are meeting the revised design and construction schedules and the lead ship end cost compares favorably with the original estimate provided the Congress.

The detailed DoD comments on each finding and the recommendation are provided in the enclosure. The DoD appreciates the opportunity to comment on the draft report.

Sincerely,

Robert C. Duncan

Enclosure

GAO DRAFT REPORT - DATED OCTOBER 13, 1989
(GAO CODE 394265) OSD CASE 8149

"NAVY SHIPBUILDING: COST AND SCHEDULE PROBLEMS ON THE DDG-51 DESTROYER PROGRAM"

FINDINGS AND RECOMMENDATION TO BE ADDRESSED IN THE DOD RESPONSE TO THE GAO DRAFT REPORT

DEPARTMENT OF DEFENSE COMMENTS

* * * * *

FINDINGS

- **FINDING A: Navy Acquisition of the DDG-51 Destroyer.** The GAO reported that the Navy plans to acquire at least 33 Arleigh Burke class guided-missile destroyers (DDG-51 class) at a total cost of about $27 billion. The GAO noted that, in 1983, the Navy estimated the lead ship would cost a total of $1.25 billion after design, construction and outfitting with the AEGIS weapon system. The GAO observed that, in April 1985, the Navy awarded Bath Iron Works a fixed-price incentive contract for design and construction of the lead ship of the DDG-51 class destroyers. The GAO noted that this contract called for construction of the ship to begin in May 1987, with delivery of the ship to the Navy in October 1989. The GAO also found that the Navy has awarded construction contracts for seven additional, or follow ships, as follows:

  -in May 1987, the second ship contract (DDG-52) to Ingalls Shipbuilding;

  -in September 1987, the third ship contract (DDG-53) to Bath Iron Works; and

  -in December 1988, five additional ship contracts (DDG-54 through 58)--three to Bath Iron Works and two to Ingalls Shipbuilding. (pp. 1-3/GAO Draft Report)

  DOD RESPONSE: Concur.

- **FINDING B: Lead Ship Delivery Delays.** The GAO reported that, in January 1987, the Navy and Bath Iron Works revised the construction milestone dates, which included a 9-month delay in the delivery--until July 1990. The GAO found that the delay was

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attributed to design problems and additional time needed to test the AEGIS weapon system. The GAO also found that, in February 1988, the Navy and Bath Iron Works agreed to a second delay of eight months--from July 1990 to February 1991. The GAO observed that, although the Navy and the contractor attributed the second delay to cruiser construction problems, design issues remained a major problem impacting the lead ship delivery schedule. The GAO reported that as a result of design delays, changes in contract requirements and inefficiencies in construction, the cost of the contract will be almost double the original contract estimate. (pp. 5-6/GAO Draft Report)

DOD RESPONSE: Partially concur. The GAO has correctly identified the delivery extensions and the dates that delivery schedules were modified. The first extension was the result of changes to the ship specifications, corrections to Government furnished information, and modifications to the duration and phasing of testing requirements of the installed combat system. The test schedule revision resulted from experience gained on the AEGIS cruiser program. The second extension was attributable to production inefficiencies and capacity limitations at Bath Iron Works. It should be noted that the schedule revisions were based on bilateral Bath Iron Works and Navy agreement. The Bath Iron Works is currently on schedule with their contract requirements established 20 months ago. The DoD does not agree with the GAO statement (page 5), "As a result of these problems and Navy changes in the contract requirements, costs will be almost double the original contract estimate..." That statement appears to be based on a comparison of the original contract target price for Detail Design and Construction with the estimated cost at completion, and requires some clarification. The contract is a Fixed Price Incentive type. With this contract type, there is a target price and a ceiling price, with ceiling being above target. Between target and ceiling, costs are shared between the contractor and the Navy, based on a share ratio. Contractor costs above target reduce their profit. Bath Iron Work's proposed target price was aggressive and was likely to result in a cost above target. The DDG-51 original target price was $346.0 million for all contract line items--not just Detail Design and Construction. The current target price is $445.6 million for the same contract items. The difference is the result of authorized contract changes. The original Navy program estimate for all shipbuilder items, as shown on the Ship Construction, Navy, Congressional budget submission (Plans, Basic and Changes), was $542.2 million. The current estimated cost to the Navy at completion for these items, $564.5 million, reflects risk sharing in a Fixed Price Incentive contract. The current estimated end cost compares very favorably with the

original Navy estimate. The Navy expects to deliver the lead ship under the original Navy goal and budget request of $1.252 billion, in FY 1985 dollars.

- **FINDING C**: **Delays--Computer-Aided Design**. The GAO reported that Bath Iron Works had planned to prepare the lead ship production drawings using a computer-aided design system. The GAO observed that the computer-aided design for shipbuilding was planned for development in parallel with the design of the lead ship. The GAO found, however, that the Bath Iron Works computer equipment did not have the capacity to handle the extensive level of data required for the various ship systems and the subcontractor assisting in the system development missed dates for delivery of critical software. The GAO pointed out that, as a result of these problems, Bath Iron Works scaled down significantly the use of computer-aided design and, with the assistance of other subcontractors, prepared nearly all of the production drawings manually. The GAO concluded that design delays resulted from the use of a computer-aided design system. (pp. 7-8/GAO Draft Report)

Now on pp. 13-14.

DOD RESPONSE: Concur.

- **FINDING D**: **Delays--Changes in Design Requirements**. The GAO reported that contractor representatives cited changes in design requirements as a major cause for the design delays. The GAO found that changes have caused about a $36 million increase in the estimated cost for the design portion of the contract--from about $111 million to about $148 million, as of July 1989. The GAO noted that, in addition, according to Navy representatives, 44 changes in the lead ship design-- many related to the AEGIS weapon system--required revision of 30 to 40 percent of the ship drawings. The GAO found that the Navy agreed to increase payments to the contractor by $16.8 million to make these changes.

  The GAO also reported that, for the reduction gear, which is Government-furnished, Bath Iron Works had to use preliminary data because the final design data was not available. The GAO noted that the final requirements, which were six months late, called for changes that resulted in (1) design rework, (2) increased cost, and (3) delay. The GAO also reported that contractor representatives cited problems designing technical systems such as those for nuclear, biological and chemical protection, and for prevention of damage from fragments during battle--which they considered developmental. The GAO observed that Bath Iron Works has taken several management actions to deal with the design delays and problems, including signifi-

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cantly increasing the number of engineers and draftsmen working on the program. The GAO noted that contractor and Navy representatives believe the design problems have been resolved for the lead ship--that the drawings are essentially complete as of September 1989. The GAO concluded that design delays have resulted from (1) Navy changes in design requirements, (2) late government furnished design data for the reduction gear, and (3) difficulties with several developmental systems. (pp. 8-10/GAO Draft Report)

DOD RESPONSE: Partially concur. This is the first time Bath Iron Works has designed and constructed a Collective Protection System for an entire ship. The system has, however, been used on a smaller scale on other surface combatants and, therefore, the Navy does not consider it developmental. The DoD recognizes that there is risk in designing and constructing such systems on a lead ship. For this reason it is appropriate for the contract to provide for risk sharing between the Navy and the contractor.

The Navy is confident with the lead ship design. Ship design has been supported by construction of two land-based engineering sites--one for the propulsion system and a second for the Aegis Combat System. The propulsion plant land-based engineering site, built to the Bath Iron Works design at the Naval Ship Systems Engineering Station, Philadelphia, was lit off in April 1989 and completed a Navy standard full power trial in August. The AEGIS Combat System, a follow on to the AEGIS Combat System at sea on the TICONDEROGA Class (CG 47) cruisers, has a land-based engineering site at the Combat System Engineering Development Site at Moorestown, New Jersey. It has completed the initial operational evaluation. These two sites have demonstrated the design and operability of the two principal ship systems. Consequently, the Navy is confident that these actions have greatly reduced the potential for further design problems.

- **FINDING E: Construction Inefficiencies.** The GAO reported that the contractor's construction method called for modular construction of portions of the ship's units inside fabrication buildings. The GAO found, however, that less construction was performed this way than planned because the drawings were not completed. The GAO observed that, as a result, more construction has been done outside in the production yard, which is more time consuming and costly. The GAO concluded that schedule delays on the lead ship have limited the use of efficient modular construction, resulting in inefficiencies in the construction process. The GAO also concluded that these design delays affected the construction by limiting the use of efficient modular construction. (pp. 10-16/GAO Draft Report)

Now on p. 16.

DOD RESPONSE: Concur.

- **FINDING F**: **Other Problems Contribute To Cost Problems**. The GAO reported that Bath Iron Works representatives stated that, because of limited prospects for work in the U.S. shipbuilding industry, the company bid on an unfavorable form of contract (fixed-price incentive) at a highly competitive price. The GAO further reported that company officials believed that the survivability of the company was dependent on the DDG-51 destroyer program. The GAO noted that the company looked at a large number of contract variables and calculated its cost estimates based on good performance and improved technology--resulting in a bid with the likelihood of a major cost overrun. The GAO also reported that company representatives believe having fixed price contracts for prototype ships, such as the DDG-51 Destroyer, is inappropriate because of the developmental nature of the lead ship design and construction. The GAO noted that, on the other hand, Navy representatives said that potential cost savings was a prime factor in selecting the contract type and that the contract terms, at the time of contract award, were appropriate to balance the risk between the Navy and the contractor. (pp. 11-12/GAO Draft Report)

Now on pp. 16-17.

DOD RESPONSE: Partially concur. The DoD cannot comment on statements by contractor representatives on business strategies. Prior to award of the lead ship contract, the Navy evaluated all offerors' proposed prices. While the Bath Iron Works bid was aggressive, it was determined to not be unreasonably low. The DoD does not agree that at the time of award, a Fixed Price Incentive contract type was inappropriate. At the time of award, the Navy considered the contract form, including the share ratios and ceiling percentages, appropriate to the expected risk for both the contractor and the Navy.

- **FINDING G**: **Increases in Cost Growth**. The GAO reported that the cost estimate for completing the design and construction portions of the contract has increased substantially since the contract award. The GAO noted that design costs were expected to double and construction costs to increase by more than 60 percent from original estimates. The GAO found that cost estimates have increased from the original April 1985 estimate of $268 million to $505 million in September 1989--with a possible further increase to $525 million. The GAO concluded that there is significant cost growth for both design and construction. (pp. 11-13/ GAO Draft Report)

Now on p. 17.

DOD RESPONSE: Partially concur. As clarified in the DoD response to Finding B, the original Navy program estimate for

shipbuilder items was $542.2 million and the current estimated cost to the Navy at completion for these items is $564.5 million. The difference between the current target price and the estimated Navy cost at completion is the effect of risk sharing on the contract shareline. This shareline effect was anticipated when the lead ship acquisition strategy was formulated and is typical for a lead ship. As noted in the GAO report, development problems with computer-aided design was one of the factors that drove costs on the shareline. The Navy expects to deliver the lead ship under the original Navy goal and budget request of $1.252 billion, in FY 1985 dollars. The DoD does not agree with the GAO assessment that, under the original contract terms, Bath Iron Works would have incurred substantial losses because this ignores the effect of changes in explaining cost increases.

- **FINDING H**: **Agreement to Restructure Compensation Under the Lead Ship Contract**. The GAO reported that, in March 1989, Bath Iron Works submitted a proposal to the Navy for a major restructuring of compensation under the contract. The GAO found that the contract modification (1) increased the maximum contract price and (2) revised the ratio for sharing certain costs. The GAO noted that, according to Bath Iron Works representatives, the changes created a contractual environment more appropriate to a development contract.

  Based on its analysis, the GAO found that Navy payments to Bath would increase by about $53 million and, if costs rise to the maximum contract price, Navy payments would increase by another $29 million. The GAO also found that the contract modification could result in a Bath Iron Works profit of about $11.4 million, rather than the previously projected loss of about $41.5 million.

  The GAO noted that Navy representatives believe that changing the terms of the contract was appropriate to compensate the contractor for the technical issues and the risk for a prototype lead ship. The GAO noted that the Navy program manager believes the additional compensation required can be absorbed within existing Navy appropriations.

  The GAO also referenced its August 4, 1989, report "NAVY CONTRACTING: Status of Cost Growth and Claims on Shipbuilding Contracts" (OSD Case 8046), which found that of the 46 shipbuilding fixed-price incentive contracts it reviewed, 25 were experiencing cost overruns--projected to total about $3 billion (of which $1.2 billion was the potential Navy liability). The GAO also referenced the supplement to that report (OSD

Now on p. 18.

Case 8046-A), which showed that, for the DDG-52, with only five percent of the work under the contract complete, the estimated cost at completion is already 9 percent above the contract ceiling price and, for the DDG-53, with only one percent of the work completethe cost at completion is now estimated at 1 percent above the ceiling price. The GAO concluded that, given the number of competitively awarded fixed-price incentive contracts for shipbuilding, which have experienced overruns--the DDG-51 contract modification could establish an inappropriate precedent of significant importance for Navy shipbuilding programs. (pp. 13-17/GAO Draft Report)

DOD RESPONSE: Partially concur. The agreement to restructure the contract in September 1989, equitably adjusted the contract to recognize a number of changes. As a result of the incorporation of these changes, the original sharing ratio and ceiling percentage no longer reflected an appropriate sharing of risk between the Navy and Bath Iron Works, based on the nature of the work. The contract, in its present form, provides an effective incentive arrangement and reflects the current Navy position on risk and uncertainty for a lead combatant ship contract. The DoD does not agree with the GAO projection of Bath Iron Work's losses and Navy payments because this projection ignores the increases in work scope reflected by the modification. The Bath Iron Works projected loss of $41.5 million (page 13) included work authorized, but not formally in the contract scope and price. That work was formally incorporated in the contract by the restructuring modification. Similiarly, the projection (page 14) that the Navy could pay up to $82 million, as a result of the agreement, is overstated. Consistent with the incentive structure, the Bath Iron Work profit or loss will depend on their ability to manage costs. The restructuring will not set a precedent for future pricing of changes to Navy shipbuilding contracts because the changes in this instance presented a unique set of circumstances. These changes had significant and widespread repercussions on other work and altered the risk of total contract performance considerably.

- **FINDING I**: **Impact of Lead Ship Delays on the DDG-52 and DDG-53**. The GAO found that the impact of lead ship delays on followon ships to date has been minimal because of changes in the delivery schedules of both the DDG-52 and the DDG-53. The GAO noted, however, that further Navy design changes or construction problems with the lead ship have the potential to increase costs and delay deliveries of many followon ships in the program. The GAO found that Ingalls Shipbuilding delayed the start of construction by 3 months because drawings were not complete. The GAO reported that, in March 1989, when Ingalls

began to construct the DDG-52, officials indicated that while many changes had been made which affected the drawings--all major problems with the drawings had been resolved and they were optimistic about meeting the revised delivery date.

The GAO noted that the DDG-51 contract required Bath Iron Works to develop a plan to assure the accuracy and completeness of the DDG-51 drawings. The GAO found, however, that delays in designing and constructing the lead ship may significantly diminish the amount of verification that can be accomplished in time to benefit the DDG-52, which is already under construction. The GAO concluded that insufficient time exists between the physical check of the completed lead ship and the warranty dates for many drawings. The GAO reported that, according to Bath Iron Works officials, every effort is being made to provide complete and accurate drawings--including daily updates to Ingalls Shipbuilding.

The GAO also reported a February 1989 Bath Iron Works proposal to realign the construction schedules for cruisers and destroyers, which would result in the following:

-the last cruiser being constructed before beginning construction of the DDG-53;

-push back delivery of the DDG-53 by 7 months;

-deliver one cruiser 7 months early;

-deliver a second cruiser one month early; and

-deliver three other DDG-51-class destroyers 2 months early. (pp. 18-22/GAO Draft Report)

Now on pp. 22-24.

DOD RESPONSE: Partially concur. While it is true that any problem has the potential of affecting the follow ships, the Navy is confident with the ship design. The two land-based engineering sites (see DoD response to Finding D) have demonstrated the operability of the two principal ship systems. As lead shipbuilder, Bath Iron Works is required to provide Ingalls Shipbuilding, the follow shipbuilder, with construction drawings. As of the end of September, Bath Iron Works was to have shipped 3005 of 3162 construction drawings to Ingalls. At that time, a total of 3063 had been shipped, with fifty-nine ahead of schedule and one overdue. Initially (June 1988-March 1989) some drawings were released out of sequence and Ingalls had to develop work-around plans to maintain its schedule. Ingalls started construction on the DDG-52 on March 13, 1989, and

achieved their first contract milestone (cutting of the first 100 tons of steel) on schedule, on May 15, 1989. Ingalls has advised the Navy they expect to meet all contract milestones.

- **FINDING J: Potential for Major Problems With Follow Ships.** The GAO found that the lead DDG-51 ship delay has the potential to increase costs and delay deliveries of followon ships. The GAO found that, at the current rate, 5 followon ships could be under construction and 12 more under contract before the lead ship finishes its at-sea trials and is delivered to the Navy. The GAO noted that any further delays in the construction of the lead ship could further increase the possibility of adversely affecting followon ships by compressing the time between completion of the lead ship and the construction of the follow ships.

  The GAO also found a January 1989 Navy operational evaluation concluded that the DDG-51 sonar system is only potentially operationally effective and suitable--and recommended that the deficiencies noted be corrected before full fleet introduction. The GAO reported that the Navy has constructed a land based engineering test site in Philadelphia for the DDG-51 propulsion system. The GAO noted that, with this facility and the combat system testing, it is the Navy view that it has significantly reduced the risks in the performance of the lead ship and, thus, the risks for the followon ships under the program. The GAO reported that Bath Iron Works officials indicated that the risks to follow ships are low because design problems have been minimized. The GAO also reported that, according to the Bath Iron Works officials, further delays in contract award could delay the start of followon ship construction and such delays would increase costs--due to (1) the loss of learning in the production trades, (2) the loss of skilled labor, (3) delayed material procurement, and (4) other costs. (pp. 22-24/GAO Draft Report)

Now on pp. 24-25.

  DOD RESPONSE: Partially concur. While it is true that any problem has the potential of affecting follow ships, it is the DoD position that, in the case of DDG-51, the probability of a major problem affecting the follow ships is minimal. This conclusion is supported by the current stage of construction on the DDG-51 and the extensive testing of the two principal ship systems at the land-based engineering sites. The statement by the GAO (page 23) that the sonar system is "... only potentially operationally effective and suitable ..." is not current. As of April 1989, based on an operational system assessment, the DoD found the sonar to be operationally effective and suitable. Therefore, little or no potential impact on the design and construction of DDG-51 from the sonar is anticipated.

- **FINDING K: Full Scale Production Without Milestone IIIB approval.** The GAO reported that, in October 1986, the DDG-51 program received approval to proceed with limited production (milestone IIIA) for seven followon ships. The GAO noted that the program received extended approval for limited production through award of the ships in FY 1990. The GAO reported that the next major milestone for the DDG-51 program is approval for full rate production (Milestone IIIB)--which is scheduled for July 1990. The GAO observed that, as a result of approval for only limited production, the Navy could still have 17 followon ships (or more than 50 percent of the ships in the program) either under construction, under contract, or authorized. The GAO concluded that program risks are significant because of the technical nature of the destroyer and the large number of ships under construction or contract before the lead ship has been constructed. The GAO also concluded that the Navy management of the ship programs is consistent with overall DoD and Navy requirements for managing major acquisitions. In summary, however, the GAO concluded that, because of the problems encountered with the lead ship and the potential impact on followon ships, the Navy should tailor the DDG-51 acquisition strategy to provide for a full rate production decision meeting as soon as possible. (pp. 24-26/GAO Draft Report)

Now on pp. 25-26.

DOD RESPONSE: Partially concur. The DoD agrees with the GAO on the desirability of providing for a full rate production meeting as soon as possible. The DDG-51 Class acquisition plan is designed to meet the Department of Defense requirements with minimum technical risk. While system development and testing rely heavily on land-based engineering sites, the AEGIS program has the advantage of developing the DDG-51 Class as an evolution of the three AEGIS baselines already at sea with the fleet. The basic AEGIS destroyer system elements are virtually the same as those proven in the AEGIS cruiser. The same pertains to the ship's systems. Although the hull design is new, it underwent extensive model testing at David Taylor Research Center prior to design incorporation. Many elements of the propulsion system have already operated successfully at sea in the DD-963 and CG-47 classes. New propulsion system elements, principally the reduction gear and machinery control system, have successfully completed full factory acceptance testing and are undergoing full system testing at the land-based engineering site. The propulsion system successfully completed a standard Navy four hour full power trial in August 1989. The DoD does not agree with the GAO statement that the program risks are significant because of the technical nature of the ship. In September 1986,

in a report prepared in accordance with Title 10, USC, Section 138, the Director, Operational Test and Evaluation certified through an operational assessment of the DDG-51 that testing was adequate and the DDG-51 combat systems were operationally effective and suitable and, based on operational testing, "a number of deficiencies were identified but none was considered severe enough to pose any significant risk to the overall operational effectiveness and suitability of the DDG-51." Milestone IIIA, Approval for Limited Production (ALP), was based on a Navy Program Decision Meeting in October 1986. Subsequent reviews were held by the Navy Acquisition Executive in September 198, and August 1989, prior to extending the Approval for Limited Production decision for the annual acquisition. The DDG-51 program, based on the successful AEGIS cruiser program and supported by extensive land-based engineering site testing, has been reviewed annually prior to extending the Approval for Limited Production.

However, in the future, should there me a mission change for the DDG class ship, a significant modification/product improvement program, and/or a major change in configuration of the ship to respond to the evolving threat, before contracts would be awarded including such changes, the program would be subject to a Defense Acquisition Board Milestone V review (or a Milestone IV review, as proposed in the Defense Management Review).

RECOMMENDATION

- **RECOMMENDATION 1**: The GAO recommended that the Secretary of Defense assure that the DDG-51 lead ship schedule provides for completion of those tasks and tests necessary to support an informed full rate production decision prior to the scheduled award of contracts for additional follow-on ships. (p. 26/GAO Draft Report)

Now on p. 27.

DOD RESPONSE: Nonconcur. As the GAO observed, "the Navy's management of ship programs is consistent with overall Department of Defense and Navy requirements for managing major acquisitions." In the DDG-51 program, the DoD has complied with the existing Federal statute regarding the adequacy and evaluation of the tests necessary to proceed beyond low-rate initial production--a decision made in October 1986. Additional operational testing has taken place since then and will continue well into the future. The adequacy and results of testing will be evaluated by DoD, in accordance with the existing Federal statute, and will be an important factor in the deliberation and decision to award contracts for additional follow ships.

As indicated in the DoD response to Finding K--if, in the future, there is a mission change for the DDG class ship, a significant modification/product improvement program, and/or a major change in the configuration of the ship to respond to the evolving threat, before contracts would be awarded including such changes, the program would be subjected to a Defense Acquisition Board Milestone V review (or a Milestone IV review, as proposed in the Defense Management Review).

Comments From Bath Iron Works

Bath Iron Works Corporation

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WILLIAM E. HAGGETT
Chairman and
Chief Executive Officer

November 9, 1989

Mr. Frank C. Conahan
Assistant Controller/General Director
National Security and International
Affairs Division
General Accounting Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Conahan:

This is in response to your request of October 13, 1989, for comments on the GAO draft report entitled "Navy Shipbuilding - Cost and Schedule Problems on the DDG-51 Destroyer Program." Attached are BIW's detailed comments on the issues and problems as presented in your draft report.

My greatest disappointment with the draft as currently constituted is that it fails to provide any substantive contribution toward improving the process for acquisition of Navy ships. GAO has been auditing the DDG 51 program for over two years. During that time, we have been fully open with GAO staff to ensure they received a full and complete understanding of the program's operation.

Although the report attempts to convey the impression of an in-depth analysis, it is primarily a collection of cost, schedule, and technical issues and fails to come to grips with underlying causes which gave rise to many of the problems cited. In other words, the report is largely a recitation of effects without addressing root causes.

It has become widely recognized now that the use of a fixed-price form of contract is not workable or compatible with the developmental nature of a highly complex ship. This recognition is reflected in recent actions by the Congress and the Department of Defense. The fact that the GAO report does not address that underlying issue and treat it accordingly constitutes a flaw in the report's logic. The report addresses symptoms, but skirts the central issues.

Of equal concern are GAO's comments with respect to the contract modification entered into by the Navy and BIW. GAO expresses the view that the contract restructuring could establish an "inappropriate precedent" because other competitively awarded fixed-price incentive shipbuilding contracts are also experiencing overruns. What GAO ignored is that use of a fixed-price form of contract on DDG 51 was a unique experience and represented a departure from previous combatant lead ship procurement practices.

The real precedent-setting aspect of this issue was use of a fixed-priced contract with an extremely tight schedule in the first place. That concept, which was implemented by a group of well-intended Navy leaders at the time, has not worked. Current Navy leadership has recognized the now clear and obvious inequities, and, to their credit, have taken corrective action.

By not dealing with the original underlying cause and failing to acknowledge that cost growth and schedule delays were a Navy/BIW shared responsibility, GAO implicitly suggests that BIW should have been held to terms of the original contract. The Navy's view is different. They have worked professionally to treat BIW's claims prudently and equitably and to construct a contractual relationship that will assure the completion of this highly complex ship within available appropriations. In our view, the government should always be willing to change its position when history deems it appropriate.

Finally, in BIW's view, the report's overall tone understates the excellent progress achieved over the last year, and the probability of delivering a superb ship which meets Navy expectations. On the other hand, it overstates concerns relative to future risks. Had GAO's report been published in late 1988, many of those worries may have been valid concerns. But, by late 1989, the program's overall status has been tremendously improved with no subsequent schedule slips.

Thank you for providing BIW an opportunity to comment on this report.

Sincerely,

William E. Haggett

William E. Haggett

BATH IRON WORKS CORPORATION (BIW)
DETAILED COMMENTS ON GAO DRAFT REPORT
"NAVY SHIPBUILDING - Cost and schedule
Problems on the DDG-51 Destroyer Program"

INTRODUCTION

BIW's comments are provided on the draft GAO report in the interest of achieving a more balanced and cohesive depiction of issues in the Navy's AEGIS destroyer shipbuilding program. The draft report contains a number of findings regarding lead ship cost and schedule and follow-ship impact. BIW's comments offer a comprehensive discussion of acquisition policy issues, design, lead ship delays and cost, follow-ship impact, contract modification, and current status.

ACQUISITION POLICY ISSUES

BIW believes dissemination of lessons learned in the DDG 51 program will be of benefit to DOD managers, Congressional leaders, and industry in subsequent major procurements.

Inexplicably however, GAO's draft report fails to assess the validity of the initial DDG 51 acquisition approach or its subsequent evolution in any comprehensive manner. Instead, what is offered is a critique that focuses heavily on the recent contract modification. By so doing, GAO fails to provide useful public policy insights, or even a sense of context, which the reader could legitimately expect from GAO's lengthy review.

Recent policy guidance from Congress and the Executive Branch supply more than adequate rationale for the Navy's recent restructuring of the DDG 51 combined design and construction contract with BIW. Yet, the report creates the impression that BIW alone contended that fixed-price contracts are inappropriate for the design and construction of highly sophisticated combatant lead ships.

Congress for several years has curtailed the authority of the services to execute fixed-price contracts on major defense acquisition programs involving developmental risks. Defense Secretary Cheney submitted a comprehensive Defense Management Review to the President in May of this year. That document contains substantial discussion on the deleterious effects of imposing excessive risk on industrial base elements engaged in such undertakings for the government.

The same Review prohibits the use of fixed-price contracts for lead ships. Exceptions to that policy will be granted only if the Under Secretary of Defense for Acquisition concurs that a particular Navy procurement strategy satisfies a lengthy set of significant preconditions.

In August 1989, GAO released the latest in a series of reports describing mounting cost growth in fixed-priced Navy shipbuilding contracts. At that time, U. S. Comptroller General Charles Bowsher was quoted in the press suggesting that one solution was to "go to some cost-reimbursable contracts for the first of a class, and then go competitive and fixed-price for the follow-on phase."

Prior to award of DDG 51 in 1985, BIW had outlined objections not only to use of a fixed-price incentive-fee contract for this project, but particularly its combination with the prescribed 54-month delivery schedule. BIW formally recommended a cost-type contract and a 68-month schedule. The Navy issued a Request for Proposal (RFP) for 63 months, cancelled that request, and subsequently reissued the RFP with a 54-month schedule. The Navy's use of a fixed-priced contract, with a 54-month schedule, was a rejection of BIW's most significant recommendations.

While disagreeing with the Navy decisions, BIW understood the Navy's rationale at the time the final contract type decision was made. Fixed-price incentive-fee contracting produced acceptable results on many follow-shipbuilding programs during the late 1970s and early 1980s. The Navy apparently believed that the same type of contract could be employed successfully on a lead ship design in a competitive market.

From decades of experience successfully designing and building lead ships for the Navy, under both fixed-price and cost-type contract strategies, BIW is convinced that long-term program benefits are optimized when the Navy and the contractor can place their highest priority on the rapid resolution of technical challenges and on achieving excellent quality. On a lead ship, in BIW's view, that is best accomplished under a properly managed cost-type contract. The importance of a cost-type contract on a developmental program becomes even greater when the shipbuilders were required to compete vigorously for the contract in a weak market.

In a fixed-price environment, contractual issues can frequently take on greater importance than the timely resolution of technical matters. This may result (and did with DDG 51) in valuable time being lost before engineering change proposals can be implemented.

BIW supports the competitive procurement process. Competition in Navy shipbuilding not only returns dividends to the government, but, when managed responsibly, can also have a healthy influence on the shipyards themselves.

DESIGN

The GAO draft report includes numerous references to design difficulties and resulting increased cost and schedule delays.

In the words of Chief of Naval Operations ADM Carlisle A. H. Trost, "the ARLEIGH BURKE class of ships is being built to meet the threat of today as well as the threat of the 21st century. DDG 51 incorporates many of the survivability lessons learned and relearned since World War II. The ship will mark the return of all-steel construction for US warships. Extensive topside armor will be placed around vital command, electronic, and machinery spaces. Better and redundant fire fighting equipment will allow the ship to withstand damage. Noise and infrared suppression systems, in combination with other electronic gear, will make the DDG 51 difficult to detect or target. Protective systems will guard against nuclear, biological and chemical agents. Hardening systems will also provide greater protection against nuclear and thermal blast."

The survivability features for DDG 51 are vastly more comprehensive than the simple examples used in the GAO draft report. In many respects, those features had developmental elements, are being employed in the DDG class for the first time, or are being incorporated to a considerably more extensive degree than on any previous surface combatant.

In the aggregate, they have had a major impact on the design development process and will continue to pose challenges during remaining construction on the lead ship. While discussion of this topic is necessarily limited due to the classified nature of specific features, it should be noted in the final GAO report that these new survivability features represent a quantum advance in US naval surface combatant capabilities.

In a new ship design incorporating many advanced features, the design development process is iterative and time consuming. Although the contract design provided to BIW by the Navy at time of DDG 51 contract award was fundamentally sound and had been thoroughly evaluated, there were still significant issues left to be discovered as the functional and detail design process evolved. Roughly ninety percent of the detailed engineering and drafting work could not be accomplished until after contract award. In many cases, vendor-furnished information is absolutely essential to the design completion process, but is not available until vendors have been selected and purchase orders placed.

In GAO's discussion of Computer-Aided Design (CAD), the statement that BIW "prepared nearly all of the production drawings manually" is misleading. In an attempt to meet the 54-month schedule, BIW's approach was to implement a very aggressive plan calling for use of technical and management

systems which potentially would minimize elapsed time and manhour expenditures. One such system was CAD. BIW was able to use CAD in the development of essential structural information. Where the company fell short of its initial objectives was in areas of outfitting design, and this did contribute to increased manhours, elapsed time, and cost.

With the benefit of hindsight, the company attempted to go too far too fast with computer-aided design technology. The company was, however, faced with performing to the 54-month schedule for design and construction originally required by the contract. While that timetable was subsequently demonstrated to have been unrealistic, as evidenced by award-to-delivery terms on follow-on ships, every resource available was dedicated toward achieving the original contract schedule.

Despite initial difficulties, the Navy, Gibbs & Cox, and BIW have learned a great deal from their collective efforts to work with CAD. BIW is planning to systematically roll the DDG design into a CAD format which will: benefit follow-ship construction; greatly enhance the Navy's life-cycle maintenance of destroyers once they enter the fleet; and assist the Navy's attainment of DDG class affordability goals. Those lessons will also be directly applicable to development of new Navy designs.

The statement in the GAO draft that "BIW representatives cited changes in design requirements as a major cause for the design delays" could lead readers to believe that Navy-initiated changes were inordinately high or out of control. In fact, BIW believes the Navy has attempted to diligently control the change process from award through the present time, even though that is a difficult management task, especially in a first of class.

There have been few significant changes approved by the Navy which affect the planned operating characteristics of the ARLEIGH BURKE class. However, in a developmental design where the government is furnishing the entire combat system and substantial related information, many changes are mandatory to assure compatibility within the system and optimum integration of the combat system with the balance of the ship which is being designed by the lead-shipbuilding team. This evolution, too, involves one design iteration after another.

BIW believes the final GAO report should reflect the fact that the Navy has done an outstanding job of minimizing changes required to modify or enhance the planned operating characteristics of the ship, even though many other changes had to be implemented as part of the normal, evolutionary design and construction process.

The draft report states that "BIW and Navy representatives believe the design problems have been resolved for the lead ship, and the drawings are essentially complete as of September 1989." BIW representatives told GAO they believed all major design problems have been resolved for the lead ship. The company knows of no significant or potentially show-stopping design issues which remain to be resolved. BIW from past experience does, however, fully expect there will be a continuing flow of design issues which must be addressed and solved as the ship continues through its remaining construction, activation, testing and sea-trial phases.

LEAD SHIP DELAYS AND COST

The GAO draft report cites two changes in the lead ship delivery date: the first, in January 1987, delayed delivery nine months; the second, in February 1988, delayed delivery an additional eight months, until February 1991. BIW does not disagree with the reasons cited: additional time required for the design effort; additional time needed to test the AEGIS weapon system (based on AEGIS cruiser experience to date); and BIW facility throughput schedules. Two additional points should be considered, however.

BIW believes the destroyer schedule was also affected by its clerical and production workers' strikes (February-October 1985), since work scheduled for that time frame was moved to a later period. This resulted in a different mix of work in 1986 and 1987 than was contemplated when the destroyer bid was submitted. Thus, BIW believes the strike, design development, normal lead ship construction problems, and system testing requirements all contributed to the delays.

In addition, it should be noted that the second delay, attributed to BIW facility limitations, allowed several important combat system engineering changes to be incorporated in line, without any associated delay and disruption costs to the Navy.

It is also worth noting that by the time of the second delay, follow ships had been awarded with construction schedules longer than the original 54-month lead ship design and construction schedule. GAO, however, does not assess the validity of the original contract schedule.

BIW does not disagree that "design delays and construction inefficiencies have caused substantial cost growth under the lead ship contract." However, it is important to note that lower than forecast government escalation payments are projected to offset $45 million of BIW's cost growth under the lead-ship contract. Forty-five million dollars less escalation will be paid to BIW because the labor index has been virtually

flat, contrasted to the company's projected increase of four percent per year. Thirty percent of BIW's estimated overrun will be attributable to that factor alone.

FOLLOW-SHIP IMPACT

BIW believes its overall support of design and other supporting data required for the efficient and high quality construction of DDG 52 at Ingalls has been acceptable and will continue to meet future requirements. History has proven it impossible to achieve perfection in the design of a highly complex combatant ship requiring over 3,000 basic drawings and thousands of other deliverables. But, with few exceptions, BIW's response time has been supportive of the follow shipyard. In addition, as problems are uncovered in the lead-ship construction process, most are promptly resolved, and corrected information is forwarded to Ingalls within days.

Since the lead ship is being constructed more than one year in advance of DDG 52, BIW believes this process is a sound method of validating and verifying the design before DDG 52 major construction milestones take place. While all risks to the follow shipbuilder cannot be eliminated, the methodology being employed on the DDG program should prove effective in minimizing them.

With regard to the DDG 53, the Navy agreed to BIW's proposal to swap two ship construction schedules at Bath to provide a more orderly cruiser and destroyer construction sequence in the shipyard. One of the benefits of moving CG 70 seven months to the left and DDG 53 seven months to the right, will be that most DDG 53 software will have been tested on DDG 51 prior to construction of DDG 53, BIW's first follow-on destroyer.

There is no evidence presented in the draft report to substantiate the assertion that problems encountered on DDG 51 will have significant impact on destroyers awarded in FY89 and contemplated to be awarded in FY90. The keel for DDG 54, the first of the FY'89 ships awarded a year ago, will not be laid until three months after the projected delivery date for DDG 51, the lead ship at Bath. BIW expects to build FY89 destroyers in an efficient manner, on or ahead of contract schedule requirements.

The draft report raises concerns about lead ship experience impacting follow-on ship cost. Although there is always some risk, BIW sees no reason at this time why follow ships cannot be built efficiently. To the extent some risk will remain until the lead ship is tested, that potential exposure needs to be balanced against the significant costs associated with a decision to delay construction of follow ships already under contract, or slow down the procurement of additional ships.

While the magnitude of cost increases associated with consciously delaying the program would be large, it is impossible to accurately quantify the impact without evaluating alternative procurement profiles. In addition to substantially increased costs due to the introduction of program instability, national defense capability would suffer as a result of later deployment of AEGIS destroyers to the fleet.

BIW believes the government can proceed with the DDG follow shipbuilding program with a high degree of confidence that the class' design and operating characteristics are sound and will be achieved. Furthermore, presently unknown problems that could arise over the next year during construction completion on the lead ship should be known in sufficient time to minimize any potential impact on follow-on ships already under contract.

CONTRACT MODIFICATION (ECP 760)

The draft report suggests that the executed contract modification sets an "inappropriate precedent." That allegation represents a complete failure by GAO to acknowledge the equity on which the modification was based.

BIW is convinced the ECP was negotiated because: BIW proved entitlement; actual experience had shown that several original contract terms required adjustment; the revised structure created a better form to efficiently complete the lead ship; it was mutually agreed that restructuring the lead ship contract would prove beneficial to follow ships; and BIW gave the Navy additional consideration such as Liquidated Damages and extended warranties.

The GAO draft fails to reflect the Navy's agreement that the shipyard was clearly entitled to increased compensation irrespective of whether other contractual terms were modified. Between late 1988 and September 1989, BIW was able to demonstrate conclusively its entitlement to significant cost increases as a result of growth experienced resolving numerous technical issues. Many of those issues were associated with developmental aspects of the design.

As a result of extensive data reviews and protracted negotiations, BIW and the Navy ultimately agreed that target cost should be increased by $31 million, and target profit increased by $3.7 million.

Other modifications to contractual terms, such as combining the design and construction line items and implementing one new shareline and ceiling percentage, were agreed upon to more appropriately share risks on a contract which both parties by 1989 had come to agree required restructuring.

GAO should note in its report that BIW provided additional consideration to the Navy in the form of liquidated damages, extended warranties, and the company's commitment to maintain high manning levels on the lead ship until delivery.

Having now established a contractual environment more appropriate to a largely developmental program, BIW believes the resolution of technical issues will move more rapidly than was previously possible. The revised contract terms will also help assure that DDG 51 is delivered at the earliest possible date. Achieving that objective will provide the best leverage to produce optimum results on each follow-on ship in the class.

CURRENT STATUS

On September 16, 1989, DDG 51 USS ARLEIGH BURKE, lead ship of the advanced AEGIS destroyer class, was launched at Bath Iron Works in Maine.

In October, 1989, DDG 51 is more than 50% complete. BIW is achieving physical progress at a rate of roughly four percent per month, and the current rate of progress will be sustained until sea trials commence in the fall of 1990.

Virtually all major structural work has been completed, and most power plant and other main machinery is already on board. The 61-cell aft vertical launcher has been installed, and by late April, 1990 AEGIS combat system spaces will have been loaded-out and activated. By the end of June, 1990 the machinery plant will be in its activation cycle, with dock trials commencing shortly thereafter.

Confidence in the quality of the ship design grows daily as production progress continues at a rapid rate on the lead ship.

Shore-based test facilities have already demonstrated that the machinery plant, machinery controls and combat systems are fundamentally sound, even though they continue to identify essential changes with relatively low impact which must be incorporated into the destroyers. Moreover, in most key detail design areas, BIW's engineers and draftsmen have undergone at least three reviews to assure design accuracy and completeness.

During accomplishment of each remaining pre-delivery activity, BIW will discover and resolve the numerous small problems which are a complicating but manageable reality in the construction of a sophisticated lead warship. In fact, as hardware is installed and software tested, the remaining universe of previously unknown problems diminishes incrementally.

A key point which should be understood is that most of a lead ship's design quality and operational characteristics become confirmed well before the actual ship delivery date. While

additional knowledge is gained during the post-delivery operational phase, any necessary modifications there usually take the form of design refinements as opposed to the disruptive correction of fundamental flaws.

SUMMARY

Knowledgeable observers will agree that the rate of progress on DDG 51 during the last year has truly been impressive. The government can proceed in the AEGIS destroyer shipbuilding program with a high degree of confidence that the DDG design is fundamentally sound and that the operating characteristics envisioned for this advanced combatant class will be achieved.

Building, activating and testing a prototype ship is a sequential process. Some major design features are proven very early in the cycle, but typically, every vital system is tested before sea trials, and those exhaustive trials precede actual delivery. From BIW's lengthy experience with combatant lead ships, all critical systems are proven well before final acceptance trials, and remaining production tasks in the post-trial phase are generally cosmetic in nature.

Policy guidance from Congress and the Executive Branch supply substantial rationale for the Navy's September 1989 restructuring of the DDG 51 combined design and construction contract.

Having now established a contractual environment more conducive to a largely developmental program, BIW believes the resolution of technical issues will move more rapidly than previously possible. During each remaining pre-delivery activity on DDG 51, BIW and the Navy will discover and resolve numerous small problems which are a complicating but manageable reality in the construction of a sophisticated lead warship.

BIW believes dissemination of lessons learned in the DDG 51 program will be of benefit to DOD managers, Congressional leaders, and industry. BIW values the opportunity to offer comments on the draft report in contribution to that important objective.

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