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U. S. GENERAL ACCOUNTING OFFICE

STAFF STUDY

[POLAR CLASS ICEBREAKER SHIPS]



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DEPARTMENT OF TRANSPORTATION
U. S. COAST GUARD

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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

PROCUREMENT AND SYSTEMS
ACQUISITION DIVISION

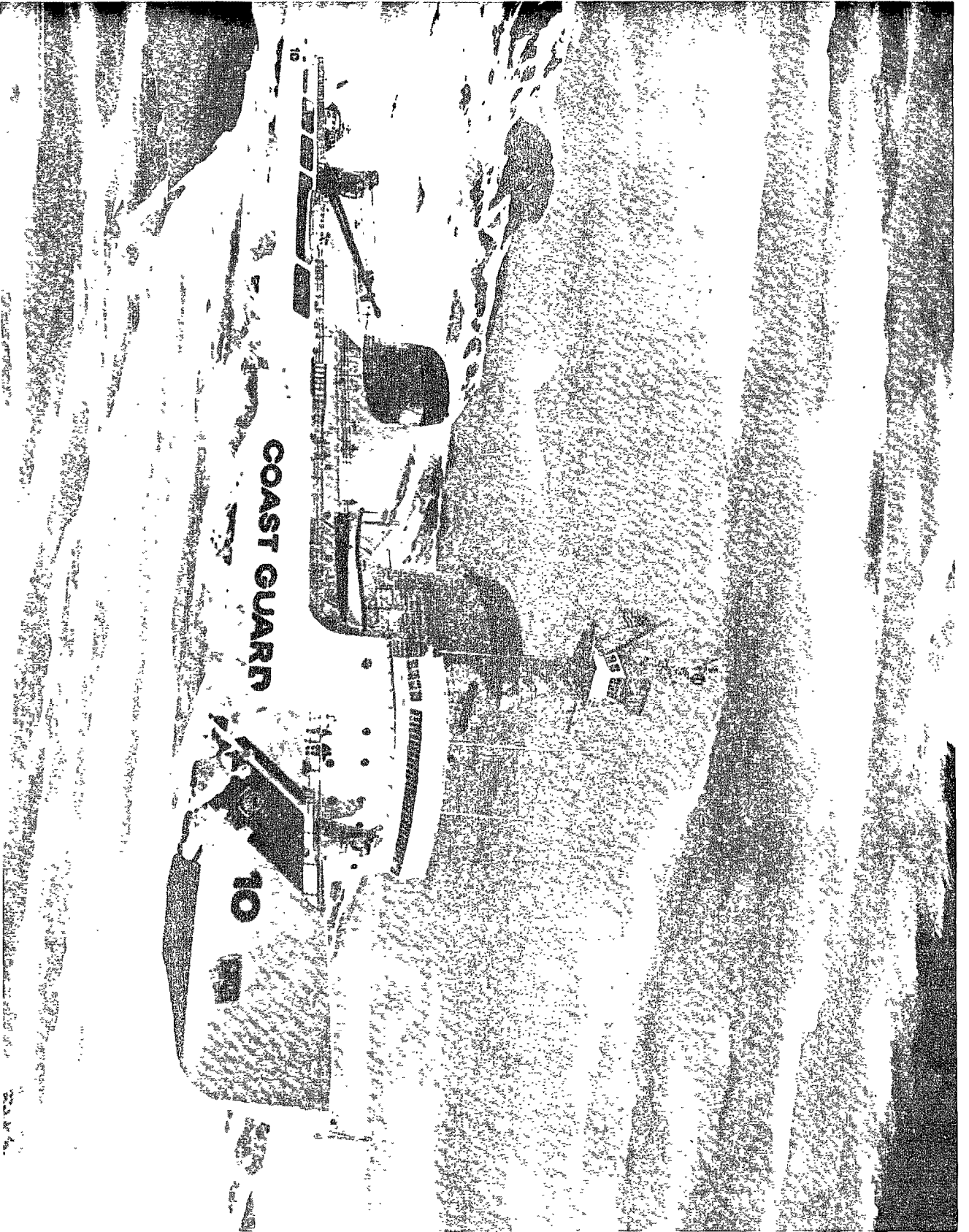
The General Accounting Office has performed a study of the procurement of polar class icebreaker ships by the Coast Guard, Department of Transportation. The study was primarily concerned with cost, schedule and performance aspects of the procurement and related matters such as need for the icebreakers, construction problems and contractor claims.

The purpose of this study is to provide to the Congress factual data on the acquisition of the icebreakers and to present open issues or alternatives which will require further attention. A draft of this study was reviewed by agency officials associated with management of this acquisition and their comments are incorporated as appropriate.

Copies of this study are being sent to the Chairmen of the Senate Committees on Appropriations, Commerce, and Government Operations; and the House Committees on Appropriations, Merchant Marine and Fisheries, and Government Operations; and members of Congress from the state of Washington. We are also sending copies to the Secretary of Transportation, the Commandant, U.S. Coast Guard and to the Lockheed Shipbuilding and Construction Company.

A handwritten signature in cursive script that reads "R. W. Gutmann".

R. W. Gutmann
Director



ARTIST'S CONCEPT OF POLAR ICEBREAKER

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ABBREVIATIONS

| | |
|-----|-----------------------------|
| DOD | Department of Defense |
| GAO | General Accounting Office |
| NSF | National Science Foundation |

SUMMARY

POLAR ICEBREAKER PROGRAM

DESCRIPTION AND STATUS

Polar icebreakers support Department of Defense and National Science Foundation missions; they are also used to satisfy commercial needs. Icebreakers operate in both the Arctic and Antarctic regions.

Two Coast Guard Polar Class icebreakers are under construction at Lockheed Shipbuilding and Construction Company, Seattle, Washington, to replace aging World War II vintage ships. These ships will be capable of breaking ice up to 21 feet thick.

In March 1974, we issued our first staff study on the procurement of the two icebreakers. This second study discusses the need for icebreakers and updates our previous study through May 1975.

NEED FOR ICEBREAKERS

Coast Guard officials stated that current plans forecast the construction of three additional icebreakers commencing in fiscal year 1977; however, recent updates to the plan, not yet promulgated, indicate that construction of replacement icebreakers will be held in abeyance until the extended service life of the reengined Wind Class icebreakers is definitely determined.

In 1972, the Coast Guard initiated a study of the need for icebreakers during the period 1975 through 2000. The study, however, has not considered the increased need for icebreaker services if oil is transported from the Alaskan North Slope by sea via the Northwest Passage. In June 1975, the agency advised us that it is examining and updating information concerning the need for future icebreaker services as data becomes more definitive.

The need for icebreaking services could be met in other ways than acquiring new icebreakers. There could be international cooperation in meeting multi-national icebreaking requirements of a non-defense nature. Canada, Finland and Sweden are some of the other countries that have icebreakers. In June 1975, the Coast Guard advised us that an agreement to further future cooperative icebreaking assistance between Canada and the United States is in a draft stage.

CONSTRUCTION PROBLEMS

The Coast Guard hired the Marine Consultants Corporation to assess the adequacy of construction processes at Lockheed. The firm reported many cases of poor workmanship, excessive rework, and lowered man-hour productivity on the first icebreaker because Lockheed departed in several ways from industry standards. Lockheed maintains that departures from general industry practices represented management's efforts to minimize production delays associated with welding the steel required by the Coast Guard. The Coast Guard stated that the contractor undertook construction of two commercial ships, gave the commercial work priority; and this disrupted his performance on the Coast Guard ships.

The contractor had a high rejection rate of steel weldments inspected by radiographic testing which resulted in a significant amount of rework.

Lockheed carried out sandblasting operations on the first icebreaker after equipment was installed, resulting in contamination of equipment and extensive clean-up work. The equipment vendor then negated the warranties until clean-up operations were completed in March 1975. The vendor indicated, however, that eventual performance problems traced to the sandblasting contamination would not be covered.

Marine Consultants observed that Lockheed's performance has improved as the second ship did not experience unusual shipbuilding problems. We found that the welding improved on the second ship and on the latter stages of construction of the first ship.

CLAIMS

As of December 1974, Lockheed had filed seven claims against the Government for contract price increases. Two claims had been settled. The unresolved claims represent a potential program cost increase in excess of \$20 million.

The largest individual claim, for more than \$15 million originated in February 1974 when Lockheed appealed the unilateral price of \$50.76 million set by the Coast Guard in January 1974. Lockheed claimed that the price was not reasonable and that the actual cost of the second icebreaker will allegedly exceed \$61 million. Lockheed asked the Department of Transportation Contract Appeals Board to determine a reasonable price including profit, of not less than \$66 million. Hearings have been scheduled for May through July 1975. Agency officials say the dispute involves interpretation of a clause limiting the price to an amount not to exceed \$53.75 million.

COST

The price of the first icebreaker, Polar Star, was set at \$52.7 million which included about \$5 million for design services. As discussed above the price of the second ship, Polar Sea, exclusive of design services and nonrecurring costs, was unilaterally fixed by the Coast Guard at \$50.76 million which is within the limit of the ceiling price of \$53.75 million. Lockheed has asked for about \$66 million.

As of May 1975, the Coast Guard has made progress payments of \$49.1 million for the first ship and \$37.4 million for the second ship.

SCHEDULE

The icebreakers were originally scheduled for delivery in August 1974 and January 1976. Contract modifications extended delivery of the first ship to December 1974 to allow time for propeller development and for settlement of claims that might arise from the contractor's interpretation of certain contract specifications. Lockheed recently notified the Coast Guard that deliveries will not be made until August 1975 and June 1976 respectively. The contractor cited unresolved claims involving schedule delays as the reasons for the latest schedule changes. The agency feels that the contractor had scheduling problems due to commercial work in the yard and used inefficient and costly production practices.

PERFORMANCE

The two new Polar Class icebreakers will be larger and more powerful than existing icebreakers. The new ships will break ice 6 feet thick in continuous operations and 21 feet thick in ramming operations. Existing ships can break ice up to 4 feet thick in continuous operations and 14.5 feet thick in ramming operations. The Polar ships will have more automated systems than present ships, and thereby operate with smaller crews.

OPEN ISSUES

Issues that we believe will require further attention include:

- The increased need for icebreaking services that would result if oil is transported by sea from the Alaskan North Slope via the Northwest Passage.
- The feasibility of meeting requirements for icebreaking services through cooperative agreements with other countries instead of procurement of additional icebreakers.

CHAPTER 1

INTRODUCTION

The Coast Guard is responsible for enforcing Federal laws upon the high seas and water subject to jurisdiction of the United States. It provides search and rescue capability for marine and air commerce and for the military services. In addition, it promotes merchant vessel safety, provides aids to navigation, and furnishes icebreaking services. The Coast Guard, as of June 30, 1974, had 43,013 personnel and it operated a fleet of 264 vessels, including four polar icebreakers.

The Coast Guard conducts a continuing program to replace old, obsolete, and deteriorating vessels to maintain its fleet at a required level of effectiveness. Between fiscal years 1964 and 1975, the Coast Guard received appropriations of about \$400 million for new vessel construction, including \$125 million for the two new polar icebreakers. The two icebreakers, Polar Star, and Polar Sea, are under construction at Lockheed Shipbuilding and Construction Company, Seattle, Washington, and are the subject of this study.

In March 1974, we reported on the status of the procurement of the two new polar class icebreakers. This report explains the Coast Guard's icebreaking program and updates activities through May 1975.

SCOPE OF STUDY

We performed a review of procurement activities for the two new Coast Guard icebreakers to update cost, schedule, requirements and performance information. Our work included discussions with officials of Lockheed

Shipbuilding and Construction Company, Seattle, Washington, and with officials of the Coast Guard, both at Lockheed and at Coast Guard headquarters in Washington, D.C.. We examined pertinent documents obtained from both the Coast Guard and Lockheed.

CHAPTER 2

THE COAST GUARD'S ICEBREAKING PROGRAM

The Coast Guard is responsible for the operation and maintenance of all United States icebreakers. Icebreakers provide access to icebound locations to further commercial, defense, economic, and scientific needs in both domestic and polar waters.

DOMESTIC ICEBREAKING

The domestic icebreaking effort is intended to promote economic efficiency in maritime commerce, to improve transportation systems by keeping waterways open, and to relieve or prevent flooding caused by ice. The domestic program is carried out by a variety of vessels, including buoy tenders, harbor tugs, and pusher ice-plow combinations.

Coast Guard officials said the present fleet is not adequate to carry out domestic icebreaking missions. The agency officials told us they hope to fund 10 new harbor tugs with limited icebreaking capabilities beginning in fiscal year 1976.

POLAR ICEBREAKING

The Coast Guard conducts icebreaking services in both the Arctic and Antarctic areas.

Antarctic effort

Coast Guard icebreakers perform an important role in the logistic support of the United States' programs in Antarctica. The National Science Foundation (NSF) has the responsibility for planning, funding, and managing the United States' scientific effort in that area. NSF accomplishes the resupply of fuel and materials in Antarctica by an

annual sealift using icebreakers to cut and clear channels for the cargo ships through heavy concentrations of ice. Icebreakers also are used as research platforms, cargo and personnel carriers, and foreign station inspection vessels.

Arctic effort

Unlike Antarctica, no one agency is responsible for the Arctic programs. The Coast Guard provides icebreaking services on a priority basis with preference given to the Department of Defense (DOD) programs.

Arctic requirements are divided into two areas, Arctic East and Arctic West. Arctic West basically includes areas north of the Alaskan Aleutian chain and western Canada; whereas, Arctic East includes areas of the Canadian Arctic Archipelago, Greenland, and Iceland.

TYPES OF UNITED STATES POLAR ICEBREAKERS

The first modern, deep-draft icebreakers, Wind Class, were built early in World War II. A larger and more powerful icebreaker, the Glacier, was commissioned in 1955. The two new Polar Class icebreakers are larger and more powerful than the Glacier. A comparison of the three classes of polar icebreakers follows.

Comparison of the three classes of
United States polar icebreakers

| | <u>Wind</u> | <u>Glacier</u> | <u>Polar</u> |
|------------------------------------|--------------------|--------------------|---------------------------------------|
| Length | 269 feet | 310 feet | 400 feet |
| Beam | 64 feet | 74 feet | 83.5 feet |
| Draft (full load) | 29 feet | 29 feet | 31 feet |
| Displacement | 6,515 tons | 8,450 tons | 12,000 tons |
| Horsepower | 10,000 | 21,000 | 18,000/60,000 |
| Propulsion | Diesel-Electric | Diesel-Electric | Diesel-Electric and Gas Turbine |
| No. of screws | 2 | 2 | 3 |
| Maximum speed | 16 kts | 17.5 kts | 17 kts |
| Endurance | 38,000 mi @ 10 kts | 25,000 mi @ 12 kts | 28,275 mi @ 12 kts |
| Crew | 174 | 197 | 138 |
| Scientists and other passengers | 8 | 16 | 10 |
| Icebreaking capability: | | | |
| Continuous | 3.2 feet | 4 feet | 6 feet |
| Ramming | 11 feet | 14.5 feet | 21 feet |

Coast Guard officials told us that because of their more automated ship systems, a smaller crew can operate the Polar Class icebreakers. The condition of the Wind Class icebreakers is characterized by DOD and the Coast Guard officials as extremely poor. As of December 1974, four of the seven Wind Class ships were retired and another will be decommissioned in 1976. Of the two remaining ships, one is reengined and the other is being reengined (to be completed June 1975). The Coast Guard has not determined the extended service life of the two reengined ships, but feels they will be operational at least six more years.

Agency officials cited the age of the Wind Class ships as the primary factor leading to retirement. These ships are approaching 30 years of age. They also noted that living conditions on Wind Class ships are not up to Coast Guard standards.

STUDIES OF ICEBREAKING
REQUIREMENTS

In June 1972, the Department of Transportation initiated a study on the national need for icebreakers in the 1975-1985 timeframe. The three main users of icebreaking services - NSF, DOD, and the Coast Guard - were directed to examine both current and projected future requirements. The DOD and NSF studies were completed in May 1973 and August 1974, respectively. According to Coast Guard officials, their study will incorporate the results of the DOD and NSF studies to arrive at national icebreaker requirements for the 1975 through 2000 period. The Coast Guard study had not been completed as of May 1975.

Alternatives to
Icebreakers

Both the DOD and NSF studies analyzed alternatives to icebreakers to meet their requirements. NSF reported that the present system of using sealift with icebreaker support to resupply Antarctica was less than one-third the cost of airlift, which is the next most feasible supply system. Most Arctic missions identified in the DOD study have no alternative to the use of icebreakers. Where alternatives were identified, the use of icebreakers was more cost effective.

Adequacy of present and
future icebreaking fleet

Research summaries prepared for the Coast Guard study identified the number of operating days required to accomplish the specific mission requirements of the three users of icebreaking services. The following table summarizes the operating day requirements for polar icebreakers.

Approximate annual operating requirements
for polar icebreakers (1975-1985)

| | <u>Operating days to transit to and from polar areas</u> | <u>Operating days to accomplish identified missions</u> | <u>Total</u> |
|-------------|--|---|--------------|
| Arctic West | 95 | 309 | 404 |
| Arctic East | 81 | 306 | 387 |
| Antarctica | <u>150</u> | <u>120</u> | <u>270</u> |
| Totals | <u>326</u> | <u>735</u> | <u>1,061</u> |

The Coast Guard currently has available two Wind Class ships and the Glacier. These three ships can operate on the average of about 180 days a year which allows the Coast Guard about 540 available annual operating days. This, is far short of the 1,061 days required to meet mission requirements.

Coast Guard officials told us that the current fleet is inadequate to meet icebreaking needs, explaining that shortages will exist in nearly all areas. However, when the new Polar Class icebreakers are delivered in August 1975 and June 1976 the shortages will be taken care of except in the Arctic East where some DOD requirements cannot be met. The new icebreakers will each operate about 240 days a year, increasing total available operating days from 540 to 1,020 annually.

Coast Guard officials stated that the current plans forecast the construction of three additional icebreakers commencing in fiscal year 1977; however, recent updates to the plan, not yet promulgated, indicate that construction of replacement icebreakers will be held in abeyance until the extended service life of the reengined Wind class icebreakers is determined.

Coast Guard officials expect the Glacier to stay operational until 1985. Current plans call for an additional Polar Class icebreaker to replace the Glacier.

We believe that icebreaking needs could be met in ways other than those involving the procurement of new icebreakers, such as international cooperation to meet multi-national icebreaking requirements of a non-defense nature. Canada, Sweden, and Finland are some of the other countries that have icebreaker fleets. In June 1975 the Coast Guard advised us that an agreement to further future cooperative icebreaking assistance between Canada and the United States is in a draft stage.

Alaskan North Slope
oil support

Coast Guard officials told us that the study initiated in 1972 did not include the potential icebreaking services that may be needed to support oil transported from the Alaskan North Slope area. This support function could significantly increase the number of icebreakers needed, particularly if the Northwest Passage is used to transport oil to East Coast refineries.

Members of the Society of Naval Architects and Marine Engineers in November 1974 noted that a specially designed fleet of up to 62 ships might be required to ship oil via the Northwest Passage. It was also reported that such ships would require greatly expanded Coast Guard icebreaking capability.

Coast Guard officials said that if such icebreaking needs develop, it would be unlikely that the Coast Guard could respond in a timely manner due to the long lead time required (about 5 to 7 years) to plan, fund, and build large icebreakers.

In June 1975, the Department of Transportation stated that it has copies of several studies that examine commercial transport of oil or petroleum products, but that these studies are not definitive enough to base requirements for future icebreaker construction. The Department advised that it is examining and updating information as data becomes more definitive.

CHAPTER 3

COST, SCHEDULE, AND SYSTEM PERFORMANCE

COST EXPERIENCE

In August 1971, the Coast Guard awarded a firm fixed-price contract for \$52.7 million to Lockheed for design and construction of Polar Star. In January 1973, the Coast Guard and Lockheed agreed to a contract modification for construction of a second icebreaker. At that time, a ceiling price of \$53.75 million for the second ship was agreed to and a March 1973 target date was established for definitization of a price.

Since a mutually agreeable price for the second ship could not be established within the limits of the ceiling price of \$53.75 million, the Coast Guard, in January 1974, unilaterally set the price of the second ship at \$50.76 million, subject to the contractor's rights under the disputes clause as provided in the contract.

In February 1974, Lockheed appealed the unilaterally-set price on the second ship to the Appeals Board. Lockheed later stated that a fair and reasonable price for the ship would be in excess of \$66 million. Including the price claim discussed above, unresolved claims submitted by Lockheed to the Coast Guard represent potential costs in excess of \$20 million.

It is Lockheed's position that the modification is a letter contract, the price of which will be determined by the Department of Transportation Contract Appeals Board. In December 1974, we were informed by contractor officials that their legal counsel had advised stopping production when the funding limit of the contract was reached. In March 1975, Lockheed officials told us that based on recent assurances by the Coast Guard that the price as determined by the appeals Board would be paid, construction would continue until the ship was completed.

Agency officials feel that since the contracting officer established a definitive price in January 1974, a letter contract no longer exists. The officials advised us that the agency had informed Lockheed in March 1975 it would take the necessary actions to provide sufficient funds for the contract as required by the Contract Appeals Board.

As of October 23, 1974, there had been 156 modifications to the contract for the two icebreakers. Contract modification increases of \$394,730 raised the firm fixed price of the first ship from \$52.7 million to \$53.1 million. Contract modifications totaling \$34,960 have increased the price of the second icebreaker to \$50.8 million.

The contract requires the contractor to report construction progress periodically and the Government to make progress payments based upon these reports. Program payments are based on the amount of ship completion, less contract reserves. These payments are summarised below.

Summary of progress payments
as of November 1974

| | <u>Contract price plus modifications</u> | <u>Percent complete</u> | <u>Amount earned</u> | <u>Contract reserve</u> | <u>Amount paid</u> |
|------------|--|-----------------------------|--------------------------|-----------------------------|------------------------|
| Polar Star | \$53,076,215 | 91.66 | \$48,649,659 | \$2,653,811 | \$45,995,848 |
| Polar Sea | 50,801,677 | 65.51 | 33,280,179 | 2,540,084 | <u>30,740,095</u> |
| Total Paid | | | | | <u>\$76,735,943</u> |

As of May 16, 1975, the Coast Guard had made progress payments of \$49.2 million for the first ship and \$37.4 million for the second ship.

SCHEDULE EXPERIENCE

The icebreakers were originally scheduled for delivery in August 1974 and January 1976. Contract modifications extended delivery of the first ship to December 1974 to allow time for propeller development and final and full settlement of all claims that might arise from specific situations previously encountered by the contractor in interpreting certain contract specifications. In July 1974, however, Lockheed notified the Coast Guard that deliveries would not be made until August 1975 and June 1976, respectively.

These new delivery dates indicated that 211 weeks would be required to construct Polar Star and 180 weeks to construct Polar Sea. The Coast Guard contract with Lockheed includes a provision for payment by the contractor of liquidated damages of \$3,000 for each day of delay in delivery, limited to 330 days for a maximum of \$990,000.

Lockheed cited unresolved claims involving schedule delays as the reason for change in delivery dates. One contractor official said that delays occurred because of difficulties in developing weld procedures for CGA537M steel and because these difficulties made it necessary to employ a much larger number of welders than called for in the original work schedule. Lockheed has claims outstanding for contract extensions totaling 106 days on Polar Star. Coast Guard officials, however, told us that delays occurred because Lockheed was "just plain behind" on construction of the first icebreaker. They said Lockheed had not met planned work schedules partly because of an insufficient number of workers, ineffective utilization and scheduling of workers and because of inefficient and costly production practices. The Coast Guard also stated that the contractor undertook construction of two commercial ships, gave the commercial work priority; and this disrupted his performance on the Coast Guard ships.

SYSTEM PERFORMANCE
CONSIDERATIONS

We asked the Coast Guard if the icebreakers will be able to achieve planned performance factors of speed, horsepower, endurance, and icebreaking capability (see table on page 9 for details).

Coast Guard personnel told us that there is no way to know for certain if the icebreakers will perform as planned until operational testing by the contractor, started in May 1975, is completed. They explained, however, that they believe the ships will perform as planned and were aware of no factors that would lead them to believe otherwise. For example, the diesel electric and gas turbine engines are similar to engines used successfully in other ships and should not provide significant problems. Also, testing showed that the propellers will perform satisfactorily.

Coast Guard officials said that Lockheed is responsible for building the icebreakers to meet specified dimensions and to assure that the specified shaft horsepower is attained and the agency is responsible for the performance characteristics such as speed, endurance, and icebreaking capability. Performance characteristics were formulated during the Coast Guard's development of preliminary ship designs prior to offering the contract for bid.

CHAPTER 4

CONTRACTOR PERFORMANCE

Contract specifications require Lockheed to develop and maintain a quality control system to assure that all supplies and services conform to contract requirements. The contractor has issued quality assurance procedures for use during icebreaker production, including a weld test program, welded fabrication control procedures, and weld inspection instructions.

We found significant problems relating to Lockheed's construction on the first icebreaker. The contractor contends that these problems were largely associated with the difficulties encountered with welding CGA537M steel and the out-of-sequence work performed in trying to maintain schedule. It is the Coast Guard's position that most defective welds were caused primarily by welder error and joint design. Improvements, however, were made that had a positive impact on the construction of Polar Sea and on the latter stages of construction of Polar Star. The contractor attributes the improved weld rejection rates largely to greater use of Japanese steel. The Marine Consultants Corporation, hired by the Coast Guard in August 1974 to assess the adequacy of construction processes for the Polar Sea, also noted significant problem areas and subsequent improvement in the contractor's construction processes. Problems encountered on two processes relating to performance in constructing the icebreakers--welding and sandblasting--are discussed below.

WELDING

We reported in our prior staff study that there was a high frequency of rejections of welding inspected by radiographic testing. Rejections of weldment work continued through our current study period but at a reduced rate.

Weld tests and rejections

We examined radiographic test reports for virtually all weld areas tested on both ships through October 10, 1974. In some cases, data was incomplete. If an initial radiographic test evidenced a defective weld, the weld area was subject to repair and retesting. Our analysis of weld rejection rates was based only on the first test of each weld area--2,830 tests. The amount of weld included in each inspection varied from a few inches to several feet. For both ships, each inspection report included an average of about 16 inches of weld. We found that for the first ship:

--about 15 percent of all inches of weld inspected were rejected.

--almost half (47 percent) of all radiographic tests resulted in a weld rejection when initially inspected.

--some weld areas had been tested and repaired as many as nine times before being accepted.

--the rejected weld areas required an average of 61 inches of repair work per weld.

On the second ship:

--about 11 percent of all inches of weld inspected were rejected.

--about 31 percent of all radiographic tests resulted in a weld rejection when initially inspected.

--some weld areas had been tested and repaired as many as eight times before being accepted.

--the rejected weld areas required an average of 53 inches of repair work per weld.

The Coast Guard considers a weld rejection rate in inches of up to 5 percent as acceptable. Lockheed told us that a rate between 6 and 7 percent

is the best that can be reasonably expected and that corrective action is not warranted unless the rate exceeds 10 percent. Our review showed that the rate of inches rejected did not begin to consistently meet any of these standards until March 1974.

The radiographic test results indicate that for the first ship, the total inches repaired exceeds total inches inspected by over 10,000 inches. This is due to repair requirements when weld defects are found. A weld defect must be gouged out until the end of the defect is found. Thus, an initial inspection of only a few inches can result in several feet of repair work. We found many such examples on the icebreakers.

Examples showing extensive repairs
where only a small area was inspected

| <u>Radiographic test number</u> | <u>Weld rejected</u> | <u>Weld repaired</u> |
|-------------------------------------|--------------------------|--------------------------|
| 2,654 | 11 inches | 147 inches |
| 2,660 | 8 inches | 171 inches |
| 2,702 | 3 inches | 207 inches |

Lockheed and the Coast Guard disagree on the extent of radiographic tests and repair work required after an initial radiograph shows a weld defect. Lockheed's interpretation of the contract would require fewer tests and less inches of repair work per defect. This matter is the subject of the radiographic inspection requirement claim discussed in Chapter 5.

Radiographic inspections cover only a small portion of welds. Agency officials estimated that only about 3 percent of the welds are subject to radiographic testing. They said, however, that welds tested are more critical and are more likely to be defective than welds not tested.

Coast Guard officials told us that some previous contracts for conventional ships have required increased radiographic testing when weld rejection rates exceeded 5 percent. The icebreaker contract, however, does not require increased radiographic testing. A Coast Guard official told us test requirements for the icebreakers were set higher than for conventional ships because of the severe conditions in which the ships must operate. He said that the test requirements will assure the integrity of the hull even given the high weld rejection rates the contractor experienced. Both Coast Guard and Lockheed officials told us that existing test and repair requirements would result in reliable and serviceable vessels.

Reasons for weld rejections

The agency and contractor differ sharply on the reasons for weld defects. They are discussed below.

Type of steel

A Lockheed official informed us that the "unusual" steel (CGA537M) required by the Coast Guard contributed to the high rate of weld rejects because this type of steel was of a development nature, and that the rate of weld rejections confirmed this view. The Coast Guard told us that the steel was not developmental, but is a commercially available low carbon steel.

We compared weld rejection rates on both icebreakers by type of steel. Three types of steel are used in the construction of the icebreakers, two heat-treated steels - CGA537M and HY80, and mild steel. About 85 percent of the welds subject to radiographic tests involve CGA537M steel. We found the rejection rate for CGA537M steel was only slightly higher than for the other two steels on the first ship. The rejection rate for mild steel was higher than the heat-treated steels on the second ship. The data is summarized below.

Weld rejection rates
by type of steel

| | <u>Percent of</u> <u>inches rejected</u> | |
|---------------------|---|------------------|
| | <u>Polar Star</u> | <u>Polar Sea</u> |
| Heat-treated steels | 15.4% | 8.3% |
| CGA537M | 15.9 | |
| HY80 | 11.4 | |
| Mild steel | 12.7 | 16.6 |

Lockheed stated that all of the mild steel weld rejections occurred in areas which would normally result in high rejection rates regardless of the type of steel used. Coast Guard officials flatly denied Lockheed's statement and said that the areas in question should have had low weld rejection rates.

Welder performance

Our examination of welds rejected on both ships through October 10, 1974, revealed that slag and porosity were the most common causes for rejection. A Coast Guard official advised us that these defects were primarily caused by welder error and joint design. The contractor told us that these defects resulted from the use of CGA537M steel which requires a higher level of welder competence than normal.

The Marine Consultants Corporation reported that Lockheed's high welder turnover and relatively short company and trade experience had unfavorable effects on productivity. We found that during 1974, Lockheed had an average welder employment of 405, hired 506 welders, and lost 604.

Contractor practices and procedures

The Marine Consultants Corporation reported that while Lockheed practices and procedures observed are consistent with general industry standards, their implementation on the Polar Star departed in a number of ways from industry standards. They reported that this resulted in many cases of poor workmanship, excessive rework, and lowered manhour productivity. For example, they reported that:

- An unusually large amount of rework was observed.
- A significant amount of work, both structural and outfitting, was done out of sequence. When welding is done out of sequence, the chances of weld defects are greatly increased.
- Repair and pickup work, or catch-up work, was apparently done without taking all necessary precautions. For example, sand-blasting was performed without adequately protecting all machinery and equipment.
- Pickup work was often done in locations that preclude good efficiency. For example, welding was often finished in less efficient positions on board ship (e.g., vertical or overhead positions) rather than in horizontal positions in the building slab.

Lockheed officials told us that departures from general industry practices represented management efforts to minimize the production delays resulting from using CGA537M steel.

The Agency feels that the contractor had scheduling problems due to other work in the yard and employed inefficient and costly welding and production practices. The Coast Guard contends that the contractor must bear the responsibility for its decision to disregard accepted practices.

Reasons for Improvements

The Marine Consultants Corporation reported that construction practices and procedures had improved on the second icebreaker. Cases of poor workmanship, excessive rework, and lowered manhour productivity on the second ship were not found in amounts considered unusual. This was in direct contrast to conditions found on the first ship.

Lockheed officials said that the improvement in weld rejection rates was due to increased use of "cleaner" (fewer impurities) Japanese steel and to closer control over the welding in areas subject to radiography. Contractor officials said that about one-half of the CGA537M steel used on Polar Star was manufactured in the United States and about one-half was manufactured in Japan. On Polar Sea, however, all the CGA537M steel was made in Japan. Although Lockheed officials had not performed an analysis of weld rejections to support their position, they believed that the use of Japanese steel was primarily responsible for fewer weld rejections.

We compared rejection rates on Polar Star hull area weldments involving only United States manufactured steel plates with weldments involving only Japanese steel. This analysis involved a total of about 400 radiographic tests. We found that the percent of inches rejected was about the same for both steels, and that the percentage of radiographs with weld defects was higher for Japanese steel than for United States steel.

Comparison of weld rejection rates for welds
made with United States and Japanese steels

| | <u>United States</u> | <u>Japanese</u> |
|--|----------------------|-----------------|
| Percent of inches rejected | 13.5% | 12.5% |
| Percent of radiographs showing defects | 31.9 | 35.6 |

When informed of the GAO findings, one Lockheed official said that he was amazed. Later Lockheed took the position that although American steel is more difficult to weld it would not necessarily be reflected in a higher weld rejection rate.

The Coast Guard told us that improvements in welding performance resulted from changes in Lockheed's plant supervisory personnel, better planning and scheduling of work, and the increased use of manual welding techniques.

SANDBLASTING

On the first icebreaker, Lockheed contaminated propulsion equipment during sandblasting operations. As a result, clean-up costs were incurred and vendor warranties rescinded.

Coast Guard officials and the Marine Consultants Corporation stated that Lockheed failed to adequately protect equipment during sandblasting.

Lockheed contends that the equipment was adequately protected, but that contamination resulted from unanticipated partial destruction of the protective material by sandblasting crews.

Lockheed officials explained that sandblasting was done in areas near installed equipment to save time and put production of Polar Star back on schedule. Pressured by production schedules of Polar Sea, Lockheed decided to sandblast in the above manner rather than sandblast the modules on the dock before attachment to the ship. Contractor officials attributed the schedule delays and out-of-sequence operations to problems involved with welding the CGA537M steel.

The propulsion equipment subcontractor revoked all warranties on the contaminated equipment. Subsequent to cleaning of the equipment by Lockheed the propulsion equipment contractor reinstated the applicable warranties but stated that Lockheed will be responsible for any equipment that fails during the warranty period as a result of sandblast contamination. Although Lockheed officials told us that, to prevent further contamination, sandblasting will be accomplished prior to loading equipment on the second ship; they also

stated that further sandblasting might be done in areas near equipment on the first ship.

On May 8, 1974, Lockheed filed an insurance claim with the Coast Guard for an undetermined amount under the self-insurance provisions of the contract to recover clean-up costs. (See Page 30)

CHAPTER 5

CONTRACTOR CLAIMS AGAINST THE GOVERNMENT

Lockheed, as of December 1974, had either submitted or given notice of intent to submit seven significant claims to the Coast Guard for increases in the contract price. Two claims had been settled. The five unresolved claims represent a potential price increase in excess of \$20 million. In addition, the claims on Polar Star call for contract extensions totaling 106 days. We believe, however, the number of additional days requested will go significantly higher.

POLAR SEA PRICE

In February 1974, Lockheed appealed the unilateral price, including adjustments, of \$50.76 million set by the Coast Guard in January 1974. Prior to that time a ceiling price of \$53.75 million had been agreed to. Lockheed later claimed that the unilateral price was not reasonable and that the actual cost of the second icebreaker will exceed \$61 million. Lockheed asked the Appeal Board to determine a reasonable price, to include profit, of not less than \$66 million. Hearings have been scheduled for May through July 1975.

RADIOGRAPHIC INSPECTION REQUIREMENTS

In March 1974, the Coast Guard was notified that Lockheed considered a Coast Guard ruling on certain radiographic test requirements to be in excess of contractual obligations. Lockheed subsequently advised the Coast Guard that additional costs of \$990,000 and delays of 44 days accrued through June 1974 from following the Coast Guard ruling. The contractor estimated that the additional cost on Polar Star will exceed \$1,120,000 and that the additional cost of Polar Sea will at least equal that of Polar Star.

The claim involves the extent of radiographic tests and repair work required after an initial radiograph shows a weld defect. Lockheed's interpretation of the contract specifications would require substantially fewer radiographs and repair work than required under the Coast Guard's ruling.

The Appeal Board has permitted Lockheed to include this claim in the appeal of the steel claim. (See page 29)

MAGNETIC PARTICLE INSPECTION
REQUIREMENT

In July 1974, the Coast Guard was notified that Lockheed considered its ruling on certain magnetic particle inspection requirements to be in excess of contractual obligations. Lockheed agreed to follow the ruling but advised the Coast Guard that a claim for increased costs and increased performance time will be submitted when such facts are determined.

The claim involves the extent of magnetic particle inspections required on weldments made with Lockheed weld procedure 2A3-2-05. This procedure was approved for production in July 1973 and discontinued by Lockheed in January 1974. The contractor stated that contract modification 77 provides for a reduction from full to spot testing after a history of good weld production is established. Lockheed maintains that a good history was established and that inspections should be on a spot test basis.

The Coast Guard acknowledged that at the time the contract modification was issued, a good weld performance record was established with weld processes in effect at that time. It noted, however, that weld procedure 2A3-2-05 was not approved for production until after the issuance of modification 77 and that a number of cracks had been found in weldments made with the procedure. The agency concluded that the procedure could not have been

included in the good production record upon which the contract modification was based. The Coast Guard, therefore, ruled that except on two relatively inaccessible compartments, weldments are to be subjected to full testing.

This claim was settled in the Coast Guard's favor under contract modification 165, effective February 14, 1975, under which the price of the first icebreaker was slightly reduced in recognition of the two compartments that were not required to be inspected.

STEEL

In February 1973, Lockheed filed a claim with the Coast Guard for a price increase due to alleged difficulties in welding certain specified CGA537M steel. A detailed statement in support of the claim called for a price increase of about \$2.1 million and a contract extension of 62 days.

Lockheed asserted that the steel is a product whose chemistry was devised by the Government and which had not been industrially produced or tested prior to award of the contract. The steel was depicted by Lockheed as a "novel" material for which welding procedures had to be devised. Lockheed stated that its experience with the steel, together with stringent Coast Guard test requirements, caused use of a welding procedure less efficient than contemplated in the original bid price.

In November 1973, the Coast Guard denied Lockheed's claim. The basic position of the Coast Guard is that the steel in question is not unique but is from a family of commercially available, low-carbon, heat-treated steels, and that such steels have been used for some time in ship and off-shore oil-rig tower construction. The Coast Guard maintains that Lockheed did not present any information supporting a finding that contract specifications were defective. The Coast Guard noted Lockheed's

contractual obligation to develop welding procedures for the steel, and said that the Government cannot accept responsibility for Lockheed's alleged failure to recognize in its bid the factors essential to produce acceptable and reliable welds.

In December 1973, Lockheed appealed the decision. Hearings are scheduled in September 1975.

EQUIPMENT CONTAMINATION
AND DAMAGE

On May 8, 1974, Lockheed submitted to the Coast Guard an accident and loss claim report on the sandblasting incident discussed on page 25 of this report. The claim involves the cost to repair equipment contaminated from sandblasting operations. Agency officials informed us that the claim originally included the cost of removing rust from machinery surfaces; that part of the claim was dropped. The amount of the claim, however, had not been determined as of April 1975.

Lockheed maintains that the Government self-insurance provisions of the contract provide for reimbursement of the repair costs. Lockheed maintains that the Government is liable for "all risks" while the ships are under construction and being outfitted.

However, contract specifications require that the contractor take special measures to minimize damage incident to storage, installation, and construction. Further, the contract specifies that all damages of the ship, its parts, fittings, and outfit be corrected at the contractor's expense.

As of May 1975, the Coast Guard had not ruled on Lockheed's claim since the contractor, according to agency officials, had not submitted supporting cost data.

LONGSHOREMEN'S AND HARBOR
WORKERS' COMPENSATION ACT

During February 1973, Lockheed submitted a claim for a \$386,000 price increase because of additional costs resulting from amendments to the Longshoremen's and Harbor Workers' Compensation Act. The amendments increased the contractor's premium costs for statutory workman's compensation.

The Coast Guard denied Lockheed's claim. The agency maintained that the specific clauses cited by Lockheed did not provide a basis for recovering increased workman's compensation premiums.

Lockheed appealed the agency's decision. A hearing was held in February 1974, and the decision is still pending.

SOCIAL SECURITY TAX

During February 1973, the contractor submitted a claim for a \$134,000 price increase because of additional contractor costs resulting from the Social Security Amendments of 1972. The amendments increased social security taxes payable by an employer for wages paid during 1973 and in subsequent years.

The Coast Guard and Lockheed reached a final settlement of \$111,000 and a contract modification was issued in September 1974 to increase the contract by that amount.

CHAPTER 6

OPEN ISSUES

The prospect of heavy tanker traffic to transport oil from the Alaskan North Slope via the Northwest Passage had become the topic of serious discussion by members of the shipping trade. Coast Guard officials have acknowledged the greatly increased icebreaking services associated with such an eventuality and have recognized the long lead time required to plan and build the required icebreakers. An unresolved issue relative to this matter is the potential impact such a need may have on the Coast Guard's ability to provide icebreaking services and various alternatives in meeting the need at various funding levels over the next several years.

Another unresolved issue is the feasibility of meeting requirements for icebreaking services through cooperative agreements with other countries instead of procurement of additional icebreakers.



ASSISTANT SECRETARY
FOR ADMINISTRATION

OFFICE OF THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

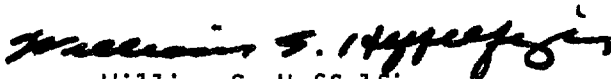
June 13, 1975

Mr. Henry Eschwege
Director
Resources and Economic Development
Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

This is in response to your letter dated April 28, 1975, requesting the Department of Transportation's comments on the General Accounting Office's (GAO) report entitled "Staff Study on Polar Class Icebreaker Ships." The Department basically agrees with the findings in the GAO report. I have enclosed two copies of the Department's statement on the report.

Sincerely,


William S. Heffelfinger

Enclosure
(two copies)

DEPARTMENT OF TRANSPORTATION
STATEMENT OF GAO REPORT

I. TITLE: Staff Study Polar Class Icebreaker Ships, June 1975

II. GAO FINDINGS AND RECOMMENDATIONS:

Matters For Consideration

The Congress may wish to have the Coast Guard:

--Study the feasibility of meeting requirements for ice-breaking services through cooperative agreements with other countries before requesting funds for procurement of additional icebreakers.

--Study the increased need for icebreaking services that would result if oil is transported by sea from the Alaskan North Slope via the Northwest Passage.

III. DOT COMMENTS ON FINDINGS AND RECOMMENDATIONS:

The Department of Transportation basically agrees with the GAO findings and recommendations.

IV. STATUS OF CORRECTIVE ACTION:

--As a result of the 93rd Congress authorizing ice-breaking operations in foreign waters pursuant to international agreements, an agreement to further, future cooperative icebreaking assistance between Canada and the United States is in a draft stage at this time.

--There have been several studies that the Department of Transportation has copies of, that examine commercial movement of oil or commercial transport of oil or petroleum products. These studies are not definitive enough to base requirements for future icebreaker construction. The Department of Transportation is examining and updating information as it becomes more definitive.



E. L. PERRY

VICE ADMIRAL, U. S. COAST GUARD
ACTING COMMANDANT

Enclosure (1)

OUT FOR SCANNING
