UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Rockville, Md. 20852

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MIDLIFE REHABILITATION AND UPGRADE OF NOAA SHIPS

PREPARED FOR DIRECTOR
NATIONAL OCEAN SURVEY
APRIL 1978

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MID-LIFE REHABILITATION AND UPGRADE OF THE NOAA FLEET

I. INTRODUCTION

Improvement of the capabilities and material condition of the present NOAA Fleet is a basic issue that must be addressed by FY 1980, if program needs are to be met. The fleet, which provides vital oceanic data collection in support of both living and nonliving marine science programs, must respond to a growing number of new mission responsibilities as national emphasis increases on major marine science programs such as Energy, Extended Fisheries Jurisidction, Pollution, etc. With the growth in mission responsibilities placed on NOAA, the present fleet is now only capable of meeting seventy percent of the shiptime requirements of NOAA programs (Table I). Consequently, every effort must be made to assure that the fleet is in an efficient operating condition and that maximum use is obtained from this major capital investment.

Sixteen vessels of the fleet have now reached the age at which a decision must be made to extend their useful lifetimes by a program of mid-life rehabilitation. Material and technological upgrading at or about a vessel's mid-life can provide for full capability for up to 10 years beyond the vessel's normal expected lifetime of 25 years. Those vessels in the fleet which were constructed in the early 1960's are at the age when the decision can no longer be deferred. A program of rehabilitation instituted at this time will assure use of the majority of the present fleet through the year 2000.

TABLE I
REQUESTED SHIP TIME VS ALLOCATED SHIP TIME

MPE	FY 77					FY 78					FY 79					3 Yr. % Average	Ships In Program
	Req.	Alloc.	Δ	% Alloc.	Charter	Req.	Alloc.	Δ	% Alloc.	Charter	Req.	Alloc.	Δ	% Alloc.	Charter		
NOS	2965	1862	1103	63	0	3052	1872	1180	61	0	3200	1912	1288	60	0	61	10
NMFS	2420	1905	515	79	857	2241	1895	346	84	2154	2353	1905	448	81	2288	81	8*
ERL	2460	1080	1380	44	175	1179	1080	99	92	188	1283	1090	193	85	180	74	6
NESS						101	0	101	0	0						0	
TOTAL	7845	4847	2998	62	1032	6573	4847	1726	74	2342	6836	4907	1929	72	2468	69	24*

NOTE: The first column of each FY lists Major Program Element requests for sea days from NOAA's Fleet.
The second column of each FY lists the number of sea days allocated to each MPE from the fleet.
The third column represents the difference between the number of sea days requested and the number allocated.
The fourth column represents the percent of program requests being met.
The fifth column lists the number of days chartered by each MPE.

* Does not include new 120-foot fisheries vessel to be delivered in late FY 1979.

II. BACKGROUND

A. Overview

The present NOAA Fleet consists of 25 major vessels ranging in size from 86 to 303 feet and in age from newly constructed to 37 years, with the majority of the fleet having been constructed throughout the 1960's (Table II). These vessels represent an initial capital investment by the Federal Government of $80 million which would cost $400 million to replace today. Operational costs range from $100 thousand to $2.5 million annually. Consequently, the fleet represents a significant Federal investment that must be adequately maintained to assure operational efficiency and provide for maximum vessel lifetimes.

The fleet conducts operations in support of research and assessment of living marine resources, oceanographic baseline data acquisition, and bathymetric and hydrographic surveys, including marine charting. The present capacity of the fleet, however, is inadequate to meet NOAA's programmatic requirements. The addition of new statutory requirements and the expansion of existing programs over the past several years have generated increased needs for additional ship support, not only from within NOAA but also from other Federal agencies seeking assistance.

To improve efficiency and increase the use of the fleet to meet these growing demands, a number of steps have been taken in past years. Crews have been augmented to extend the number of days at sea, vessels have been chartered where outside capabilities exist, helicopters have been introduced to extend versatility, and a program of fleet electronic maintenance has been initiated. However, efforts to extend the lifetime

TABLE II
SCHEDULE OF REHABILITATIONS/REPLACEMENTS OF SHIPS OF THE NOAA FLEET

Class*	Name	Year Built	Scheduled Rehabilitation	Age at Rehabilitation
I	OCEANOGRAPHER	1966	1984	18
	DISCOVERER	1966	1983	17
	RESEARCHER	1970	1988	18
	SURVEYOR	1960	1980	20
II	MT. MITCHELL	1967	1985	18
	FAIRWEATHER	1968	1987	19
	RAINIER	1968	1986	18
	MILLER FREEMAN	1967	1989	22
III	PEIRCE	1963	1981	18
	WHITING	1963	1980	17
	DAVIDSON	1967	1982	15
	McARTHUR	1966	1982	16
	ALBATROSS IV	1962	---	**
	OREGON II	1967	---	**
IV	FERREL	1968	1988	20
	DELAWARE II	1968	---	**
	DAVID STARR JORDAN	1965	---	**
	TOWNSEND CROMWELL	1963	1980	17
	GEORGE B. KELEZ	1944	---	***
	(New 120-foot ship)	1979	---	---
V	RUDE	1966	1985	19
	HECK	1966	1985	19
	JOHN N. COBB	1950	---	***
	OREGON	1946	---	***
VI	MURRE II	1943	---	***

* Class of Ships

Following criteria established by the Military Sealift Command (MSC), NOAA's ships are grouped into classes depending on their horsepower-tonnage. This figure represents the arithmetic sum of the ship's shaft horsepower plus its gross tonnage.

Class I	- 5501 to 9000 horsepower-tons
Class II	- 3501 to 5500 horsepower-tons
Class III	- 2001 to 3500 horsepower-tons
Class IV	- 1001 to 2000 horsepower-tons
Class V	- 501 to 1000 horsepower-tons
Class VI	- 500 and under horsepower-tons but over 65 feet in length

** Fisheries vessels upgraded with resources justified by Extended Jurisdiction

*** Scheduled for replacement

of individual vessels have been limited to the rehabilitation of only four fishery research vessels. The full potential of such rehabilitations has yet to be achieved.

Despite the actions that have been taken, fleet capacity is less than program demand. The immediate need is to assure the availability of the existing fleet through a rehabilitation and upgrading program so that the present fleet capacity is not further reduced.

B. Aging of the Fleet

1. Evaluation Criteria

The responsibility for evaluating vessel capabilities and material condition in determining the need for vessel rehabilitation or replacement is a function of NOAA's Office of Fleet Operations. This Office has reviewed the management policies of organizations having similar operations in an effort to determine what should be considered as the lifetime of the fleet, and to determine what policies and procedures should be followed to maximize the expected lifetime.

In reviewing the policies used by other fleet operators, it is obvious that exact quantative criteria do not exist. The predominate factor used by fleet operators in determining a vessel replacement schedule is age since, in general, this is a measure of material condition. This age can vary depending on type of construction (wood or steel) or, in the case of the Navy, type of vessel (cruiser, submarine, etc.). Table III lists replacement criteria used by the various fleet operators. As can be seen from the table, NOAA has established 25 years as the expected material lifetime for its fleet. No differentiation has been made for the type of construction, i.e., wood versus steel. Nearly all of NOAA's vessels are

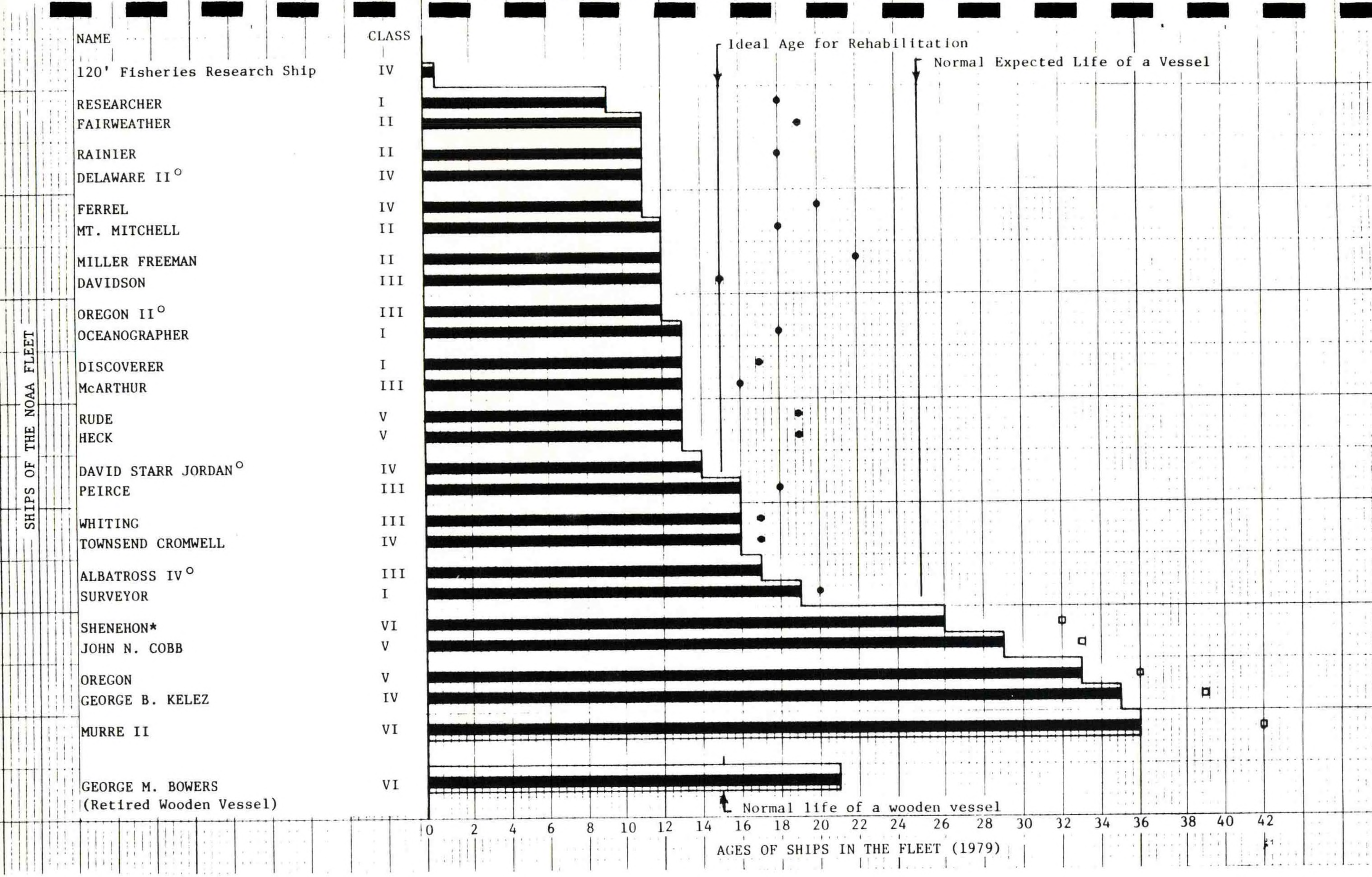
TABLE III
Replacement Criteria

Fleet	Expected Material Lifetime	Expected Technological Lifetime	Other Factors Considered
U.S. Navy (Service Craft)	Steel 25 years Wood 15 years	15 years 15 years	Material Condition FRAM Conversion Ability to Meet Mission Requirements
MarAd and Commercial Shippers	25 years	---	Profit
MSC	20 years	---	Material Condition Excessive Downtime Ability to Meet Mission Requirements
NOAA	25 years	---	Material Condition Ability to Meet Mission Requirements

steel hulled, and the few remaining wooden vessels are scheduled for replacement due to age and poor material condition. Although age is used as a starting point, no operator schedules replacement on age alone. The expected lifetime must later be adjusted based on evaluation of the material condition, technical ability to meet mission requirements, availability of parts for basic vessel machinery and, in the case of commercial shipping, the ability to make a profit.

2. <u>Current Fleet Status</u>

The relationship of present ages to expected lifetimes for vessels of the NOAA Fleet is shown in Graph I. Although the NOAA Fleet presently consists of 25 major vessels, 27 NOAA vessels are shown on the graph. One of the two additional vessels is the SHENEHON which is a 65-foot converted Army vessel supporting NOAA's Great Lakes Environmental Research Laboratories. Because small vessels, 65 feet in length or less, are managed by various NOAA Program Offices, rather than centrally managed by the Office of Fleet Operations, they are not ordinarily included in a listing of major vessels of the fleet. The SHENEHON has been shown in this case because the length of the proposed replacement vessel will be over 65 feet; therefore, the replacement will be a major vessel subject to centralized OFO management. The second additional vessel shown is the NOAA Ship GEORGE M. BOWERS which had to be removed from service after 21 years due to poor material condition. As is shown on the graph, the BOWERS was a wooden vessel and her normal expected lifetime would have been 15 years. In view of the fact that the BOWERS operated continuously in tropical and semitropical waters where the lifetime of similar vessels is as short as 10 years, this vessel well exceeded her expected lifetime. In total, the graph shows that six of NOAA's vessels, the SHENEHON, JOHN N. COBB,



● Age at time of scheduled rehabilitation.

□ Age at time of scheduled replacement.

○ Rehabilitated with resources justified by Extended Jurisdiction.

* Not ordinarily included in a listing of major NOAA vessels because of length, 65 feet. The proposed replacement will be categorized as a major vessel.

OREGON, GEORGE B. KELEZ, MURRE II, and GEORGE M. BOWERS, have exceeded their normal expected lifetimes and are in need of replacement rather than rehabilitation.

Of the remaining twenty-one vessels shown on the graph, one is new, four have recently been rehabilitated and sixteen are near the ideal age for rehabilitation, 15 years. The basic issue for 1980 concerns these sixteen vessels. Should NOAA continue operating the fleet without materially upgrading its condition, allowing the expected lifetime to remain 25 years, or should NOAA rehabilitate the vessels and upgrade their condition extending the expected lifetime to 35 years?

III. RECOMMENDATIONS

Rehabilitation of the NOAA Fleet includes (1) the material and technological upgrading of presently operating vessels, (2) the upgrading and conversion of vessel(s) to change or expand their mission capabilities, and (3) the upgrading of selected onboard systems to reflect more advanced technologies.

A. Institute Mid-life Rehabilitation Program

1. Concept and Economics

Material and technological condition are fundamental to a vessel's operating capability. Ultimately they determine the time of replacement and, consequently, then are of primary concern to fleet management. The Navy, the largest fleet manager in the United States, has determined that a program of rehabilitation, which provides for material and technological upgrading at or about a vessel's mid-life is the most economical means of achieving a fully responsive fleet. The Navy, thus, established its Fleet Rehabilitation and Modernization Program (FRAM) in order to account for the technological obsolescence that occurs, historically, at about 15 years. The program insures full capability for up to 10 years beyond a vessel's normally expected lifetime and is increasingly being adopted by fleet managers around the world. The basic concept of extending vessel service by rehabilitation and upgrading is also applicable to the NOAA Fleet even though the missions and shipboard systems differ from those of naval vessels.

The economics of implementing a similar program of rehabilitation/upgrade in place of replacement vessels for the NOAA Fleet is shown in Table IV. This analysis compares the cost of rehabilitation of fifteen NOAA vessels with the cost of replacing those same vessels through new construction. The results show that for each dollar allocated for rehabilitation of the existing fleet almost two dollars can be saved over the average annual capital cost of new ship construction. This is shown under the Comparison Category of the table as the FY 1980 Discounted Dollar Cost resulting in a benefit/cost ratio of 1.93.

The sixteenth vessel in the rehabilitation program, the SURVEYOR, is also being converted. A separate analysis showing the economics of rehabilitation/conversion of the SURVEYOR is shown in Table V. This analysis compares the cost of rehabilitation/conversion of the SURVEYOR with the cost of a replacement vessel. The results show that for each dollar allocated for rehabilitation/conversion 1.43 dollars can be saved over the average annual capital cost of new ship construction. That is,

TABLE IV
(Ref. Explanation in Appendix 1)
COMPARISON OF COSTS BETWEEN
THE VESSEL REHABILITATION AND UPGRADE PROGRAM VERSUS
ADDING NEW SHIPS TO THE NOAA FLEET

CATEGORY	NEW SHIP CONSTRUCTION ALTERNATIVE ACTUAL	NEW SHIP CONSTRUCTION ALTERNATIVE DISCOUNTED*	VESSEL REHABILITATION ALTERNATIVE ACTUAL	VESSEL REHABILITATION ALTERNATIVE DISCOUNTED*
Program Cost (FY80 dollars) (15 ships)	$243.257M	$83.772M	$25.000M	$17.382M
Additional Years of Service	375	375	150	150
Average Capital Cost (FY80 $) per Additional Service Year	$648,700	$223,400	$166,700	$115,900
Program Cost (7% Inflation) (15 ships)	$551.475M	$185.279M	$35.738M	$22.830M
Additional Years of Service	375	375	150	150
Average Capital Cost (7% Inflation) per Additional Service Year	$1,470,600	$494,100	$238,300	$152,200
Program Cost (12% Inflation) (15 ships)	$859.821M	$284.213M	$46.379M	$28.669M
Additional Years of Service	375	375	150	150
Average Capital Cost (12% Inflation) per Additional Service Year	$2,292,900	$757,900	$309,200	$191,100

"BENEFIT-COST" RATIO PER ADDITIONAL SERVICE YEAR

COMPARISON CATEGORY	Benefit (Savings in New Ship Costs)	Cost (Cost of Vessel Rehab Program)		B/C RATIO
FY80 Actual Dollar Cost Basis:	$648,700	$166,700	=	3.89
FY80 Discounted Dollar Cost Basis:	$223,400	$115,900	=	1.93
7% Inflated Actual Dollar Cost Basis:	$1,470,600	$238,300	=	6.71
7% Inflated Discounted Dollar Cost Basis:	$494,100	$152,200	=	3.25
12% Inflated Actual Dollar Cost Basis:	$2,292,900	$309,200	=	7.42
12% Inflated Discounted Dollar Cost Basis:	$757,900	$191,100	=	3.97

* 10% discount factor as specified by OMB Circular A-94, revised 3/27/72

TABLE V
NOAA Ship SURVEYOR
Rehabilitation/Conversion

"Benefit-Cost" Ratio Per Added Service Year

Comparison Category	Benefit (Savings in New Ship Costs)	Cost (Cost of Rehabilitation)	B/C Ratio
FY 1980 Actual Dollar Basis	$1,207,275	$550,000	= 2.195
FY 1980 Discounted Dollar Basis	787,130	550,000	= 1.431
7% Inflated Actual Dollar Basis	$1,693,238	$550,000	= 3.079
7% Inflated Discounted Dollar Basis	1,103,991	550,000	= 2.007
12% Inflated Actual Dollar Basis	$2,127,596	$550,000	= 3.868
12% Inflated Discounted Dollar Basis	1,387,193	550,000	= 2.522

Item	Actual	Discounted (10%)
FY 1980 Rehabilitation Cost	$ 5,500,000	$ 5,500,000
FY 1980 Replacement Cost (FY 1985)	30,181,380	19,678,260
7% Compound Inflation Cost (FY 1985 Replacement)	42,330,947	27,599,777
12% Compound Inflation Cost (FY 1985)	53,189,904	34,679,817

Average Capital Cost Per Added Year of Service

	Actual	Discounted
FY 1980 Rehabilitation Cost	$ 550,000	$ 550,000
FY 1980 Replacement Cost	$1,207,225	$ 787,130
7% Inflated Replacement Cost	$1,693,238	$1,103,991
12% Inflated Replacement Cost	$2,127,596	$1,387,193

the benefit/cost ratio is 1.43.

2. Prior Rehabilitations

NOAA has previously upgraded four fisheries research vessels in support of Extended Fisheries Jurisdiction. A summary of typical rehabilitation items and details concerning a ship rehabilitation are given in Appendix II. These vessels averaged 14 years in age at the time of upgrading. Their useful life is projected to have been increased on an average of 10 years. Based on this experience with upgrading and the favorable economic analysis for other vessels in the fleet, NOAA proposes to rehabilitate the remaining 16 vessels presently at the age of mid-life.

3. Urgency for Rehabilitation

As can be seen from Table II, all but two of the 16 vessels were built within three years of 1965. Consequently, NOAA is forced now to take action on their rehabilitation during a limited time period, 10 years. The Schedule of Vessel Rehabilitation and Upgrade to achieve longer lifetimes for the vessels in lieu of more immediate construction of replacements is projected in Table VI. As is evident from the rehabilitation ages listed in the Table (also shown graphically in Graph I), NOAA's vessels have now passed the preferred age for rehabilitation, 15 years. As a consequence, the rehabilitation/upgrade program must begin immediately. Otherwise, the program could extend to the point where it is no longer economically feasible to rehabilitate all the aging vessels because some will have become too advanced in age. The alternative of shortening the time period of the rehabilitation to accommodate more vessels each year would be disruptive to NOAA's programs. Too many vessels would be simultaneously inoperative due to upgrading. Therefore, FY 1980 is the decisive year for initiating a

TABLE VI
PROPOSED FUNDING SCHEDULE OF VESSEL REHABILITATION AND UPGRADE

($K)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Age at Rehab.
CROMWELL	1.0											17
Special Equip.*	2.3	.5	.5									
Management	4/.5	4/.5	4/.5	4/.3	4/.3	4/.3	4/.3	4/.3	4/.3	4/.3	4/.3	
WHITING	.5	.75										18
PEIRCE		1.25										18
McARTHUR			1.25									16
DAVIDSON			.75	.5								15
DISCOVERER				2.2	.8							17
RUDE & HECK						1.0						19
OCEANOGRAPHER					1.9	1.1						18
MT. MITCHELL						.6	1.4					18
RAINIER							1.3	.7				18
FAIRWEATHER								2.0				19
FERREL									1.0			20
RESEARCHER									1.7	1.3		18
FREEMAN										1.4	.6	22
	4.3	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	.9	

32.2^{M}

*Includes Class I second generation DAS systems, modern trawl winches, and four hydrographic launches.

major effort to prolong the life of the NOAA Fleet and gain resulting economics.

B. Rehabilitation/Conversion Program Details

1. Schedule and Description

The proposed schedule in Table VI shows for FY 1980 one million dollars for the rehabilitation of the TOWNSEND CROMWELL and $500,000 to begin rehabilitation of the NOAA Ship WHITING. The CROMWELL has been scheduled for immediate rehabilitation because poor maintenance practices over earlier years, lack of proper maintenance during the period of deactivation and the tropical working environment which have combined to degrade the physical condition of this vessel. Inspections of the Ships WHITING and PEIRCE have indicated that these vessels are also showing the effects of their age. They are the oldest of the vessels proposed for rehabilitation in the 1981-1990 period. The remaining vessels are scheduled for rehabilitation such that the average age for rehabilitation will be at the 17 to 18th year of service. The one notable exception is the MILLER FREEMAN. This vessel is scheduled for rehabilitation at the age of 22 years. The later rehabilitation is possible because this vessel was given a rather extensive overhaul at the time of reactivation in FY 1975. Rehabilitation actions in this program will be similar to those of NOAA's four previous rehabilitations. See Appendix II.

The 16th vessel in the rehabilitation program, the SURVEYOR, also is being converted. The additional conversion will make it more reliable and versatile insuring that NOAA can meet its responsibilities in deep ocean and continental margin research. This vessel is now 19 years old. It was originally designed for a primary mission of hydrography, with a limited capability for oceanography. As a result, the vessel is configured improperly to respond to NOAA's involvement in varied deep ocean programs. Upgrading of the SURVEYOR to a fully capable oceanographic vessel is desirable from an operating standpoint because it is one of the most stable platforms of the NOAA Fleet, it has the large size necessary for extended operations, and it has characteristics especially desirable for geophysical operations.

The rehabilitation/conversion will provide for a number of significant alterations in addition to those required to effect a typical Class I rehabilitation extending lifetime by ten years. Rehabilitation/conversion will upgrade the areas of scientific and engineering operations while improving total shipboard habitability.

For improved scientific operation, major structural modifications will be made, decreasing the size of the present deckhouse by 30 feet, eliminating the present carpenter shop to provide additional weather deck work space and increased laboratory space. This will not only provide the increased deck space needed for oceanographic activities, but will also allow the ship to carry the "scientific vans" that are increasingly being used for special projects. The carpenter and machine shops, which are particularly important to any vessel operating in remote areas, will be combined into one central location. The after mast will be moved forward clear of the after deck area and the helicopter platform located on the stern. This will improve the safety of helicopter operations and allow for the operation of larger helicopters. Other deck modifications will include replacing the main crane, which is beyond economical repair, and selected replacement of other cranes, winches, and "A" frames providing for needed update of capabilities and capacities. Removal of the traction winch and gravity davits, with rearrangement of hydraulically operated launch handling gear are also planned.

Engineering modifications will include installation of a bow thruster to improve oceanographic station keeping capability while also improving vessel maneuverability in close quarters. Electrical power generation systems will be overhauled, and the emergency generator will be replaced. The steam propulsion system will be overhauled, and the engineroom facilities will be modernized by upgrading air systems, renewing selected fresh and saltwater piping systems, effecting repairs to boiler foundations and associated propulsion components. Repairs will be made to the fuel oil heaters which are necessary for cold weather operations. General habitability will be improved, particularly through the consolidation of galley and mess deck areas. A centralized galley is planned to serve the three messes, thus, making for more efficient serving of the crew, scientists, and officers.

The SURVEYOR is of the age that the conversion/rehabilitation should be undertaken in FY 1980, or the vessel will be removed from service within the next five to seven years with the attended further loss of ship time for NOAA programs.

Rehabilitation will provide for extension of the SURVEYOR's lifetime by a projected ten years, while the conversion will provide a more responsive ship for NOAA's program needs.

2. <u>Upgrading</u>

Rehabilitation of vessels also will include the upgrading of selected onboard systems to improve the data acquisition capability of the fleet.

Primary systems to be upgraded will be:

- o Deck Systems
- o Hydrographic Launches and Small Boats
- o Shipboard Data Systems
- o Ship Equipment Validation and Spare Parts Inventory Control

The Deck System Program will focus primarily on winch and crane systems. Such systems are critical to the support of the oceanic data collection mission. The program will entail development and procurement of new systems where mission requirements exceed either present capability or that obtainable through upgrading of existing systems. Subsystems relating to controls, monitoring equipment and rigging of existing cranes and winches will also be upgraded.

The objective of the Hydrographic Launch Program is to improve the existing small boat capabilities of hydrographic vessels. A primary objective will be to augment the primary acquisition capability, provided by the recently acquired Type I survey launches, through development and procurement of new Type III shallow draft launches. Additional small boats will be acquired to provide the versatility needed and complete the upgrading of launch capability provided through the initial Type I launch procurements.

The upgrading of shipboard data systems will begin a program intended to ultimately upgrade the total data acquisition/processing system both at sea and at ship support facilities ashore. This initial phase is necessary to upgrade selected vessel data acquisition systems in concert with the vessel rehabilitation program to make vessels fully capable of meeting mission requirements. While it is necessary to upgrade selected shipboard systems along with the rehabilitation program, it must also be realized that the expected lifetime of a computer system, ten years or less, differs from that of a vessel. Therefore, the upgrading and acquisition of computer systems cannot be totally integrated into the rehabilitation program. The need for standardization of hardware in both data processing and data acquisition is a problem encompassing more than just the vessels in the rehabilitation program.

The computer systems on board Class I vessels, in particular, have reached the end of their useful lives. As replacements, a single computer system is to be developed and procured that will eventually be used throughout the fleet. It is to provide for more efficient management and support of the fleet data acquisition/processing systems. The long range goal is to have a standard hardware module used throughout the fleet instead of the three separate systems presently in use. Such standardization would make the fleet more versatile by allowing any vessel to accept the data collection/processing software from any other vessel. It also would greatly improve logistics and maintenance, particularly in the area of software maintenance where inefficiencies occur through the necessity to provide unique but similar programs for each type of hardware module.

The objective of the Ship Equipment Validation and Spare Parts Inventory Control Program is to provide an effective system to achieve more efficient ship operations through reduced down time and lower maintenance costs.

This would be a more comprehensive program in inventory maintenance and control than presently exists. The proposed program, when fully operational, will provide a uniform system of indexing equipment throughout the fleet, data on equipment performance, and information on spares consumption relative to equipment operation/maintenance. Historical data collected during the beginning of the program will be used by management for scheduling maintenance/overhaul at convenient times, to prepurchase necessary materials, and to develop and maintain an economical yet effective shipboard spares inventory. The program will be ongoing, continuously adding to the data base, improving the basis for decisions on spares control.

The Configuration Accounting System (SECAS) group under the Naval Sea Support Center, Atlantic (NAVSEACENLANT), will provide the actual manpower to conduct the onboard equipment validation through an interagency agreement between NOS and NAVSEACENLANT/SECAS. The equipment validation will be limited to Hull, Mechanical and Electrical (H, M, & E) equipment and spare parts used in support of the HME equipment. The data collected will be computerized for ready acquisition and analysis. At the completion of the onboard validation effort, a comprehensive review and analysis of existing spare parts stowage areas on NOAA ships will be conducted. The purpose of this review and analysis is to evaluate the adequacy of stowage areas in terms of environment and security, and make realistic recommendations for improvement. Ship allowance lists will be revised, eliminating spares that cannot be properly stored in the shipboard environment from the fleet. This program is in response to a Department of Commerce audit report which recommended increased inventory control, more standardized preventive maintenance, and a longer range program in overall vessel support.

C. Summary

In summary, the above fleet rehabilitation program proposed to commence in FY 1980 provides for vessel upgrade at approximately the 17th year of service of a vessel. It would insure full capability to meet mission requirements for up to 10 years beyond the normal expected lifetime of 25 years. Such a program initiated in the NOAA Fleet would maximize the useful life of the existing fleet by providing an additional 160 years of ship time and allow NOAA to defer replacements by 10 years.

IV. RESOURCE REQUIREMENTS

The resources required for implementation of the ten-year plan for the rehabilitation of 15 ships of the NOAA Fleet is shown in Table VI. The initial funding in FY 1980 requires a total of $4,300,000; and will include $1 million for rehabilitation of the CROMWELL, $500,000 to begin rehabilitation of the WHITING, $2.3 million for the procurement of upgrading equipment, and $500,000 plus four positions for management. The positions included under management are necessary for the establishment of the Ship Equipment Validation and Spare Parts Inventory Control Program. After the initial year, the rehabilitation program funding reduces to $3 million per year.

The proposed rehabilitation/conversion of the Ship SURVEYOR would begin at the end of the 1979 field season and cover a time period of eight months. The funding of $5,500,000 in FY 1980 includes rehabilitation, which for a Class I vessel costs about $3,000,000, plus conversion to make the vessel fully responsive to NOAA's program requirements.

APPENDIX I

DESCRIPTION OF THE DISCOUNTED COST COMPARISON BETWEEN THE VESSEL REHABILITATION PROGRAM VERSUS ADDING NEW SHIPS TO THE NOAA FLEET (REFERENCE TABLE IV)

A comparison between the cost of implementing a vessel rehabilitation program versus the cost of replacing those same vessels with new ships was made to determine the benefit, if any, of a rehabilitation program. To provide a valid quantitative means of making a choice between these two alternatives for providing future ship years of service from the NOAA Fleet, a discounted cash flow analysis has been made. This technique allows the decision maker to calculate the present FY 1980 dollar value of each option assuming a 10% rate of interest for the value of future time periods. (The 10% discount factor is specified by OMB Circular A-94, revised 3/27/72.) In other words, discounting future expenditures "backwards in time" to FY 1980, a lower value would need to be "put on deposit at the 10% rate of compound interest" in order to correctly value the two options from the FY 1980 perspective.

The first step in the analysis was to obtain the estimated FY 1980 new construction cost for replacement of the 15 NOAA vessels used in this analysis. The SURVEYOR was omitted from the analysis because it is scheduled for both conversion and rehabilitation. The estimated FY 1980 construction costs were calculated from the original construction cost and acquisition year for each of the 15 vessels under consideration. A price inflation factor for commercial vessels then was obtained from the U.S. Navy Ship System Command (NAVSEA) and applied to the ages and original costs in determining the estimated FY 1980 replacement cost for each ship (See the table at the end of this appendix). The total FY 1980 replacement cost, $243.257 million, was then applied over the number of ship years of service expected from a newly constructed fleet, 15 ships x 25 years per ship = 375 years, to obtain an average actual capital cost per ship year of service, $648,700 in FY 1980 dollars. A second computation was then made to determine corresponding discounted values for the new ship construction alternative. Application of the 10% discount rate to the FY 1980 replacement value at the time when each ship reaches the end of its 25-year service life produced a total discounted value for the 15 ships of $83.772 million. Applying this value over the number of ship years of service expected from the newly constructed fleet, 375 years, results in an average discounted capital replacement cost per ship year of service of $223,400, i.e., $83.722 million ÷ 375 = $223,4000.

Analogous values were then determined for the alternative of rehabilitation. The actual case was calculated by applying the program cost in FY 1980 dollars of $25 million, excluding the cost of special equipment and management shown in Table IV, over the number of additional ship years of service expected to result from the rehabilitation program, 15 ships x 10 years per ship = 150 years, to obtain an average undiscounted capital cost per additional ship year of service, $166,700 in FY 1980 dollars. Again, a second computation has been made to determine corresponding discounted values. Discounting each vessel's rehabilitation cost by 10% to the year in which rehabilitation is to occur produced a total discounted program cost of $17.382 million. Applying this value over the number of additional ship years of service expected from the rehabilitation program, 150 years, results in an average discounted fleet rehabilitation cost per additional ship year of service, $115,900 in FY 1980 dollars.

The evaluation so far has been made in terms of uninflated (i.e. FY 1980) dollars. Some initial inflation escalation was necessary to develop the FY 1980 replacement value of the 15 NOAA vessels included in this analysis in order to make a consistent evaluation based upon comparable shipyard costs. If an assumed rate of inflation after 1980 is assumed, the distortion of the "benefit-cost" comparison ratio would make selection among projects difficult because of the inability to assess future costs on a comparable "purchasing power" basis. As a result, the application of the discounted cash flow technique is usually made in constant (i.e. uninflated FY 1980) dollars because it will provide the most rigorous test in constant purchasing power or "real cost" dollars to the decision maker.

Continuing the analysis, by dividing the average cost per service year for replacement by the average cost per service year for rehabilitation, a ratio of replacement cost to rehabilitation cost was calculated. This process produces a "benefit-cost" ratio of 3.89 for the undiscounted cost comparison and 1.93 for the discounted FY 1980 dollar cost comparison. In other words, assuming that benefits can be defined as the amount of capital cost in FY 1980 dollars saved per service year expected, the vessel rehabilitation program will save $1.93 in future new ship capital cost for each $1.00 spent on rehabilitation and upgrade.

Although an assumed future rate of inflation distorts the benefit-cost comparison ratio, two calculations were made as examples. The effect of a 7% inflation from FY 1980 forward raises the discounted "savings" in new ship replacement costs to \$3.25 for every \$1.00 spent on the vessel rehabilitation program. Similarly, a 12% inflation from FY 1980 forward increases the discounted "savings" in new ship replacement cost to \$3.97 for every \$1.00 spent on the vessel rehabilitation program. However, \$1.32 of the "savings" at the 7% inflation rate and \$2.04 of the savings at the 12% inflation rate are illusory because they would result from the inflation itself and not from any inherently valid cost minimization attribute of the vessel rehabilitation program as such.

CALCULATION OF FY 1980 REPLACEMENT COST VALUE FOR SHIPS OF THE NOAA FLEET INCLUDED IN THE VESSEL REHABILITATION AND UPGRADE PROGRAM

VESSEL	INFLATION FACTOR	TOTAL COST*	INFLATED COST	CONTINGENCY (10%)	FY 1980 Cost Tota
AMC					
RESEARCHER	2.64	$9,400,452	$24,817,193	$2,481,719	$27,298,91
MT. MITCHELL	3.40	5,940,498	20,197,693	2,019,769	22,217,46
PEIRCE	4.08	2,382,350	9,719,988	971,999	10,691,98
WHITING	4.08	2,541,043	10,367,455	1,036,746	11,404,20
FERREL	3.18	1,159,797	3,688,155	368,816	4,056,97
RUDE**	3.62	1,089,704	3,944,729	394,473	4,339,20
HECK**	3.62	1,097,957	3,974,604	397,460	4,372,06
SUBTOTAL		$23,611,801			$84,380,79
PMC					
OCEANOGRAPHER	3.62	$9,362,081	$33,890,733	$3,389,073	$37,279,80
DISCOVERER	3.62	9,160,640	33,161,517	3,316,152	36,477,66
SURVEYOR***					
FAIRWEATHER	3.18	5,526,988	17,575,822	1,757,582	19,333,404
RAINIER	3.18	5,604,414	17,822,037	1,782,204	19,604,241
MILLER FREEMAN	3.40	3,642,376	12,384,078	1,238,408	13,622,48
McARTHUR	3.62	3,205,373	11,603,450	1,160,345	12,763,795
DAVIDSON	3.40	3,424,943	11,644,806	1,164,481	12,809,287
TOWNSEND CROMWELL	4.08	1,556,109	6,348,925	634,893	6,983,818
SUBTOTAL		$41,482,927			$158,874,506
TOTAL		$65,094,728			$243,255,305

* Including cost of construction and GFE at time of construction, but not all equipment necessary for full operation.

** RUDE and HECK counted as single vessel for mission assignments and will be rehabilitated simultaneously.

*** SURVEYOR is not included in this analysis because it is scheduled for both conversion and rehabilitation.

APPENDIX II
SUMMARY OF TYPICAL REHABILITATION ITEMS FOR FISHERIES VESSELS PREVIOUSLY MODIFIED

Boat Deck

- Expanded Deck House to Port
- New Electronics Lab
- New ET Work Area
- New Computer Room
- New Winch and Boom Control Station
- New ET Stateroom and Head
- New First Engineer's Stateroom
- New Second Engineer's Stateroom
- Relocated Refurbished Hydro Winch and A-Frame
- New Officer and Scientist Lounge
- Boat Davits for New Rescue Boat
- Refurbished Other Berthing Areas

Main Deck

- New Oceanographic Wet Lab
- New Oceanographic Dry Lab
- New Biology Lab
- New Plankton Lab
- New Scientist Office
- New STD Handling/Stowage System and Platform
- Refurbished Messing, Galley, and Rooms
- New Bottom Grab/Neuston Winch and A-Frame
- Modified Dredge Winch for Trawl Mensuration

- New Resource Collection Handling Chute

- Extended Main Boom and Upgraded Main Hoist Winch and Vang Winches

- Refurbished Photo Lab

Lower Deck

- Refurbished Scientist Berthing Area

Systems

- New 150 KW 440 volt AC Diesel Generator

- Modified 25KW 440 volt AC Motor Generator

- New 9KVA Invertor DC/AC

- New Regulated AC Power Distribution

- New 7.6 Tons of A/C

- Refurbished Existing HVAC

- New Emergency Generator Tie to Steering and Transfer to Main Board

- New Winch Metering Systems for Trawl, Dredge/Constant Tension, Hydrographic, and Bottom Grab/Newston Winches - Remote Readouts in Electronics Lab and Oceanographic Lab

- New Electronic Systems Remotes for Gyro, Lat-Long, Time, Depth, etc.

- New 18 Station 21MC System

- New HF Communication Teletypewriter

- New Navigation Lights

- New Winch Room to Engine Room Access Plate

- New Deck Washdown Pump

- New Major Sections of Sanitary Piping

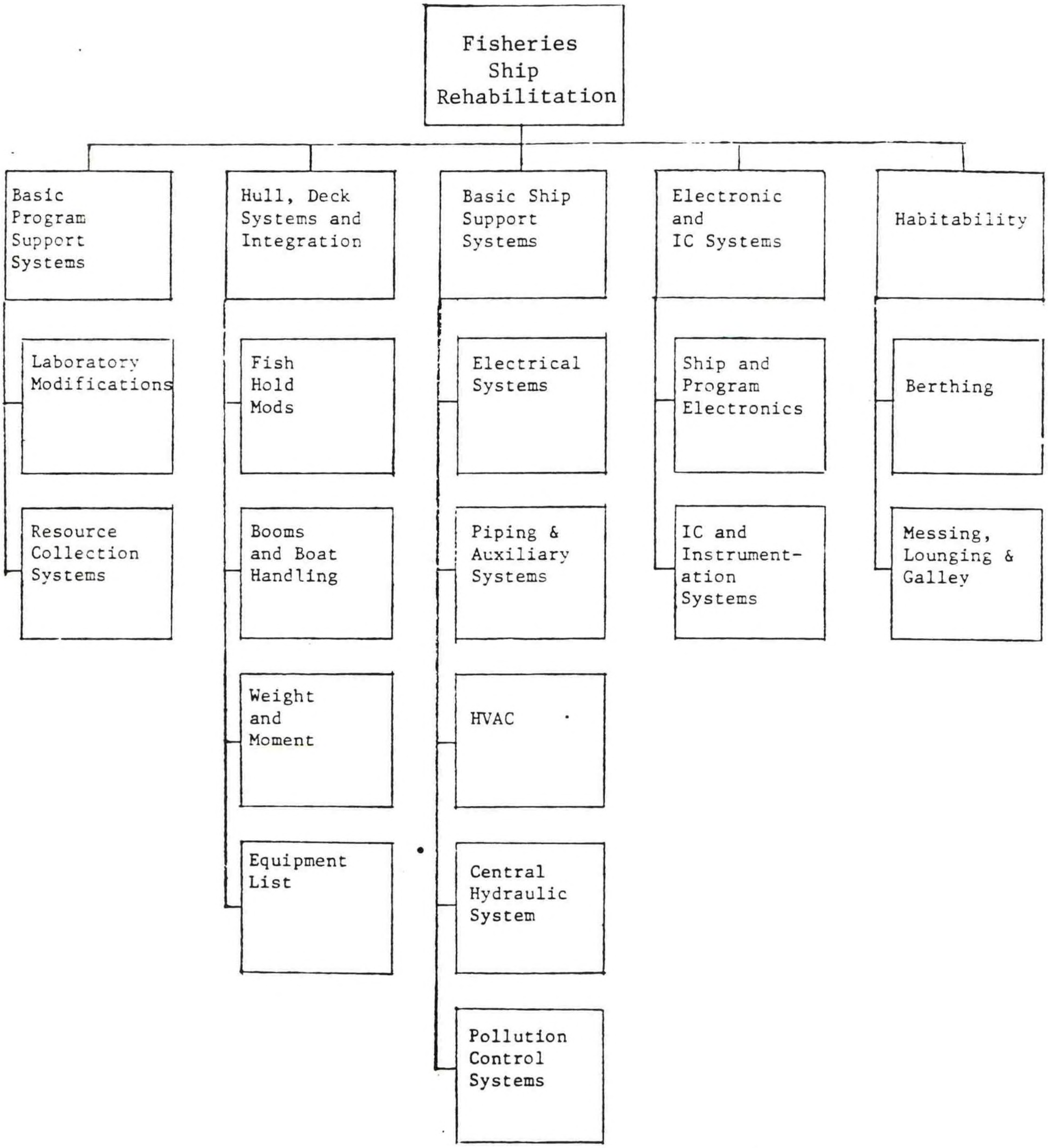
- New Air Compressors

- New Main Engine Exhaust Sheating P/S

SAMPLE REHABILITATION SCHEDULE

1. May 1977 - Determine requirements.
2. September 1977 - Finalize requirements and commence preengineering definitions.
3. November 1977 - Complete definitions and trade offs.
4. November 1977 - Commence design development.
5. November 1977 - Conduct ship check.
6. January 1978 - Complete preliminary design and weight analysis.
7. February 1978 - Develop technical specs for procurement of long lead Government-furnished Equipment (GFE).
8. March 1978 - Design freeze effected.
9. March 1978 - Conduct design review.
10. March 1978 - Conduct inclining experiment.
11. April 1978 - Conduct incremental review of specs and drawings.
12. May 1978 - Complete rehabilitation installation specs and drawings.
13. May 1978 - Conduct final review and complete corrections of rehabilitation installation specs and drawings.
14. June 1978 - Rehabilitation package delivered to PMC Procurement.
15. June 1978 - IFB for shipyard work issued.
16. July 1978 - Bid review completed.
17. August 1978 - Award contract.
18. September 1978 - Commence shipyard rehabilitation.
19. December 1978 - Complete rehabilitation.

WORK BREAKDOWN STRUCTURE
FISHERIES SHIP REHABILITATION



DETAILS OF TYPICAL REHABILITATION FOR FISHERIES VESSEL PREVIOUSLY MODIFIED

LABORATORY SPACE

EXISTING LABS	SQ. FT.
Dry Oceanographic	96
Wet Oceanographic	70
Fish	400
Photo	30
TOTAL	596

COMMENTS

Wornout/obsolete furniture, poor drainage, insufficient lighting, limited power outlets, no scientific office, no dedicated biological lab, no dedicated plankton lab, no high performance coatings, no watertight lighting, outlets, etc.

NEW LABS/MODERNIZATION	SQ. FT.
Dry Oceanographic (Chemical)	156
Wet Oceanographic	125
Biological	350
Plankton	120
Scientific Office	113
Photo	30
TOTAL	874

GAIN FROM MODERNIZATION 178 SQ. FT.

COMMENTS

Labs rearranged as an integrated complex, new work-benches, cabinets, sinks, piping, lighting, power outlets, bottle racks and shelves. New IC system, data displays, STD handling/storage, and scale. New dedicated labs for biological and plankton and scientific office; Photo lab refurbished. High performance coatings, stainless steel sheathing, watertight fixtures and outlets in all labs. Electrical regulated AC power provided; all furniture is removable.

REHABILITATION DETAILS (continued)

ELECTRONICS/IC

Existing Lab Space	Sq. Ft.	New Lab Space	Sq. Ft.
Electronics Lab	110	Electronics Lab	225
		Computer Room	105
		ET Work Space	82
Total	110	Total	412

Gain from Modernization 302 Sq. Ft.

Comments: New lab provides a central location for all scientific electronic equipment. Ten standard height electronic racks are installed, data displays, IC, sensor feed cables are installed in the lab. New ET work space has workbench, shelves, two standard height racks and cabinets. Computer room has desk and electronic racks. All spaces are air conditioned.

New Equipment

- Central Chronolog Digital Calendar Clock System; master in Chart Room, remotes in Electronic Lab and Oceanographic lab.
- Gyro Compass Repeater in Electronics Lab and Oceanographic Lab
- Two Loran C systems with Lat/Long Conversion units and remote readouts in Electronics Lab and Oceanographic Lab.
- Raytheon Depth Indicator Readouts in Oceanographic Lab and Electronics Lab.
- Doppler Speed Log Readouts in Oceanographic Lab and Electronics Lab.
- IC - Hands Off 21MC with 18 stations (intercom)
- Plessey Thermosalinograph 6600T in Oceanographic Lab
- HF Communication Teletypewriter

RESOURCE COLLECTION SYSTEM WINCHES

Existing System	Qty	Drive	HP	LINE PULL (lbs)	SPEED (FT/MIN)	No. of DRUMS	WIRE DIA. (inches)	Cable Capacity (FT)	MFG	MODIFICATION/COMMENT
Trawl	1	Elect DC	125	16000	215	2	7/8	6000	N.E. Trawler	None
Dredge (Existing)	1	Elect DC	30	4000	183	1	5/8	3900	N.E. Trawler	Replaced DC motor with 40 HP AC elect hydraulic, modified winch
Dredge (Modified)	1	Elect Hydraulic AC (new)	40	Modified to two modes: constant tension mode for trawl mensuration and dredge mode.						
• Constant Tension Mode				2100	220		5/8	3900		Constant tension mode is for trawl mensuration; user conductor cable; Dredge mode uses wire rope. Cable change is required to shift from one mode to the other.
• Dredge Mode				4000	220		5/8	3900		
Hydrographic	2	Elect DC	10	3800	250	1	1/4	20000	N.E. Trawler	Removed one winch from the ship on port side; refurbished other winch, provided new controls and winch metering instrumentation
Boom										
• Main Hoist	1	Central Hydraulic			100	1			MARCO	The main hoist winch was upgraded to increase speed to 150 ft/min.

RESOURCE COLLECTION SYSTEM WINCHES

Existing System	QTY	Drive	HP	Line Pull (lbs)	Speed (FT/MIN)	No. of Drums	Wire DIA. (Inches)	Cable Capacity (FT)	MFG	MODIFICATION/COMMENT
• Vang Winches	2	Central Hydraulics							MARCO	Vang winches were upgraded to decrease vang time by increasing slewing speed
Bottom Grab/ Neuston (new)		Elect Hydraulic AC	30	3500	200	1	3/8 Conductor	6600	N.E. Trawler	New winch to provide dedicated winch for Neuston and bottom grab sampler.

RESOURCE COLLECTION SYSTEMS (Other Than Winches)

Existing System (A-Frame/Gantry)	Qty	Drive	Capacity (lbs)	Modifications/Repairs/Comments
• Gantry (Trawl)	1	Hydraulic 30 HP	10,000	At Shipyard: corrected minor hydraulic leaks, reviewed gantry system and determined that no major work required, load tested.
• A-Frame (Hydro) Port Side	1	Hydraulic	4,000	Relocated to starboard side to be used with hydrographic collection system
• A-Frame (Hydro) Starboard Side	1	Manual	4,000	Removed from ship
• New A-Frame (Bottom Grab/Neuston) Trawl Deck-Stbd Side	1	Hydraulic	5,000	Furnished by NE Trawler

SYSTEM IMPROVEMENTS

• Winch Boom and Control Station -	New enclosed station on boat deck aft - new control consoles and instrumentation for dredge/constant tension, trawl, main boom, and vang winches.
• Other Trawl System -	Added constant tension trawl mensuration; fish resource collection chute
• Neuston System -	New dedicated winch for Neuston tows
• Plankton System -	Extended main boom, increased speed and flexibility by upgrading winches
• Hydrographic -	Refurbished hydrographic winch improved level wind, new hydro platform, and new STD storage/handling system

ELECTRICAL SYSTEMS

EXISTING	QTY	VOLTS	KW	ADDED/CHANGED	QTY	VOLTS	KW	COMMENTS
DC								
Ship Service Generator	2	240	150					
Auxiliary Generator	1	240	150	None				
Take-off	1	120	30	None				
Emergency	1	240	25	Emergency - Added steering gear transfer power CB to permit emergency power feed to steering gear; installed transfer between emergency and main DC boards				
AC (60 Hz)				AC (60Hz)				
Motor Generator	2	120	25	Ship Service Generator	1	440	150	
Back-up		None		Back-up Motor Generator	1	440	25	Modified existing motor generator set; removed the other.
Regulated Power Distribution		None		Back-up Invertor	1	208	9KVA	Backup power from DC emergency generator to navigational equipment
				Regulated Power Distribution	4	440/ 208/ 120	3.0- 7.5KVA	One 7.5KVA to Electronic Lab, one 5.0KVA to Computer Room; Two 3.0KVA to Lab Complex.

PEAK OPERATING LOAD SUMMARY

	DAY		NIGHT		GROWTH ALLOWANCE
	AMPS	KW	AMPS	KW	
Ship's Service DC	890	205	961	221	32%
Ship's Service AC	172	107	172	107	28%

REHABILITATION DETAILS (continued)
HEATING VENTILATION AND AIR CONDITIONING

1. Existing

- A/C Capacity 25.6 Tons

The system was refurbished: New sea water pump and larger capacity condenser. Refurbished duct work, mixing boxes, fans, central station units, A/C plant, etc.

2. New

- A/C Capacity 7.6 Tons

The new system is AC powered and integrated into the existing A/C system. Four new room fan coil units were installed to serve modified spaces. The electronics lab and computer room have one unit each. Two new heater units were installed in the Winch Boom and Control Station.

3. Balancing

- The new and modified existing systems were balanced.

REHABILITATION DETAILS (continued)
HABITABILITY (BERTHING)

BERTHING MODIFICATIONS/UPGRADING

1. Boat Deck New & Modified

- Chief Engineer's Stateroom Modified and Upgraded.

- 1st Engineer and 2nd Engineer provided with new staterooms identical to Mates staterooms on starboard side.

- ET - New stateroom and head on port side.

2. Boat Deck Upgraded

- Captains, First Mate and Second Mate's staterooms painted and decks renewed.

3. Main Deck Upgraded

- All crew's rooms 1 - 8 painted and decks renewed.

- Showers and Heads - painted and decks renewed.

4. Lower Deck Upgraded

- All Scientist's rooms painted and decks renewed.

5. Gain in Berthing

- Officers - New ET stateroom - one bunk with room for add-on bunk.

- Crew - No increase in bunks.

- Scientists - No increase in bunks.

Summary Number of Bunks

	Existing	Total	New	Total
1 bunk	8	8	9	9
2 bunk	7	14	7	14
3 bunk	5	15	5	15
TOTAL		37		38*

* Can add one bunk in ET room to bring total to 39