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The Design of the United States Coast Guard 270-Foot Medium Endurance Cutter

No. 11

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ABSTRACT

The design of a diesel-powered 82.3 meter (270 ft.) Medium Endurance Cutter is described in two parts. Part 1 discusses the operational requirements and evolution of the ship configuration. Trade-offs and decision criteria between pre-conceptual and contract design are presented. Hydrodynamic model test data are included in the paper. Part 2 describes automation and command control functions representing a major departure from traditional Coast Guard design.

INTRODUCTION

The United States Coast Guard has begun a new ship procurement which promises to rival in numbers and technology the 378-foot turbine-powered "Hamilton" class of the 1960's. Part 1 of this paper addresses the design techniques and trade-offs from which the final configuration of the 270-foot Medium Endurance Cutter (WMEC) evolved. Part 2 describes in detail the integrated bridge and command display system which will make this ship the most technologically sophisticated floating unit in the Coast Guard.

BACKGROUND

The design requirement for a ship of the United States Coast Guard (referred to as a cutter) has its origins in a requirements analysis and planning document known as the Cutter Acquisition Plan. The 1974 edition of this document identified a need for a new high or medium endurance cutter (HEC/MEC) to replace ageing and technologically obsolete cutters in the inventory, and to close the gap between the Coast Guard's present and predicted workload and its afloat resources.

The design objectives for the new cutter were presented in a document titled the "Designated Task Statement". Broadly, these called for an economical and reliable cutter for multi-program employment in law enforcement (including fisheries patrol), search and rescue, marine environmental protection, and to contribute to the nation's force in being with ASW capabilities in support of the Navy's sea control mission. Accordingly, the design was to incorporate time-proven hull and machinery systems for reliability with sensor, weapons, and command-control system technologies for service well beyond the 1980's.

PART 1 - DESIGN SEQUENCE

The design of the 270' WMEC proceeded in three phases:

Phase I - a pre-conceptual size and cost estimate
Phase II - a computer-aided conceptual design study
Phase III - preliminary and contract design development

<u>Phase I</u>

The initial dialogue between the Office of Operations, the user, and the Office of Engineering, the designer, was conducted during the month of December 1974. Sizing studies based upon the existing 210-foot WMEC were conducted to evaluate the impact of providing helicopter hangar facilities and various speed capabilities on ship size and cost. Propulsion options of two or four medium speed diesels, two low speed diesels, a single 18,000 horsepower turbine CODOG plant, and two small twin turbines (also in a CODOG arrangement) were considered.

The design studies at this point were rather rough estimates, utilizing ratiocination for weights, and existing model test data and design lane data for form and powering estimates. Basically the methodology followed that presented in ref (1). The results, even though unrefined, were sufficient to demonstrate to the Commandant the costs, risks, and capabilities of various propulsion schemes and their effect on ship size. Specifically, it led to a re-examination of the need for speeds in excess of 20 knots, given that the cutter would be one part of a ship-helicopter team.

Phase II

Phase II studies began immediately following presentation of Phase I results to the Commandant on 20 January 1975. Due to fiscal constraints, the high cost and risk of the CODOG installations, and the small speed gains achieved in going from a two diesel engine to a four engine installation, it was considered desirable to center further studies on a 20 knot, twin engine diesel ship, while developing minimum non-hangar, minimum hangar and alternative propulsion plant options. Concurrent staff studies in the Office of Operations produced the Designated Task Statement (abstracted as Appendix 1) which defined further the design requirements.

A computer program, or design synthesis model, developed in-house, was utilized to calculate weights, centers, and principal dimensions for ships ranging in waterline length from 200 to 260 feet, and in draft from 10 to 15 feet. Using intervals of five feet in length and one foot in draft, the computer identified a spectrum of ships with reasonable form coefficients, and defined minimum beam requirements for stability (Fig. 1). These "design zone" charts were prepared to show cost, speed, and comparative seakeeping characteristics of all feasible combinations.

Cost predictions for each cutter were developed using an in-house computer program. Speed/power and seakeeping predictions, however, were made utilizing programs developed at the Naval Ship Engineering Center. Powering is based on Taylor series, utilizing a worm curve correction for destroyer type hull forms. Both the cost and powering routines were "proofed" against data for existing ships and used without modification. The seakeeping calculations estimate the initiation of slamming for a given sea state. Due to the preliminary nature of the estimate, the numbers produced have little absolute meaning, but did demonstrate the expected trends of improved seakeeping with increasing draft and length.

Based on these charts, a 255-foot waterline length, 13-foot draft ship was selected as a baseline because:

a. It was the smallest ship exceeding 20 knots with a twin diesel plant.

b. It had slightly better calm water speed and improved seakeeping characteristics in comparison with other options in the charts.

c. Cost was comparable to other options surrounding it on the chart.

At the time of the Phase II conceptual studies, the design model did not calculate arrangement volumes. It consisted basically of a weights calculation using an empirical data base, and evaluated stability (GM) as a percentage of beam. As the studies evolved, a Design Review Board, consisting of the Chief, Naval Engineering Division, and the Division Branch Chiefs concluded that the new cutter's operating environment demanded ability to meet the 100 knot wind heel criteria versus the 80 knot wind criteria used in the design of the existing 210-foot cutters. Following selection of the baseline, therefore, attention shifted to validation of that baseline.

Hull lines were developed very rapidly using the Navy's computerized hull form generator, which utilizes interactive graphics. Lines generated by this program approach fairness and can be automatically digitized. The

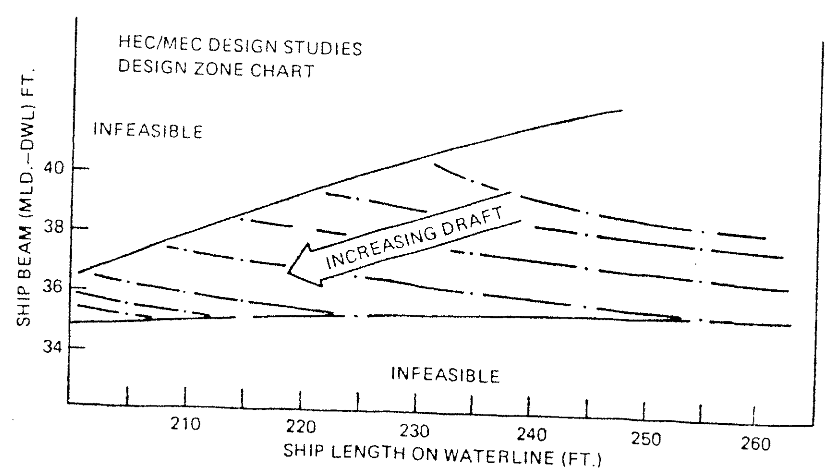


FIGURE 1.

resulting card decks can then be processed by Coast Guard computer facilities to generate data for hydrostatic and hydrodynamic studies.

Arrangement studies indicated sufficient space in the baseline for all desired ship functions. The arrangement, shown in Figures 2 and 3 was fairly compact, and built around the following criteria:

a. Underway replenishment of solid cargo forward and aft, with a midship fueling station compatible with Navy oilers.

b. Location of staterooms and magazines for rapid strikedown.

c. Medical facilities in a minimum motion location with rapid access to the helicopter platform and to the mess deck for survivor treatment.

d. Location of berthing in areas of minimum motion and traffic.

e. Location of the galley close to stores spaces.

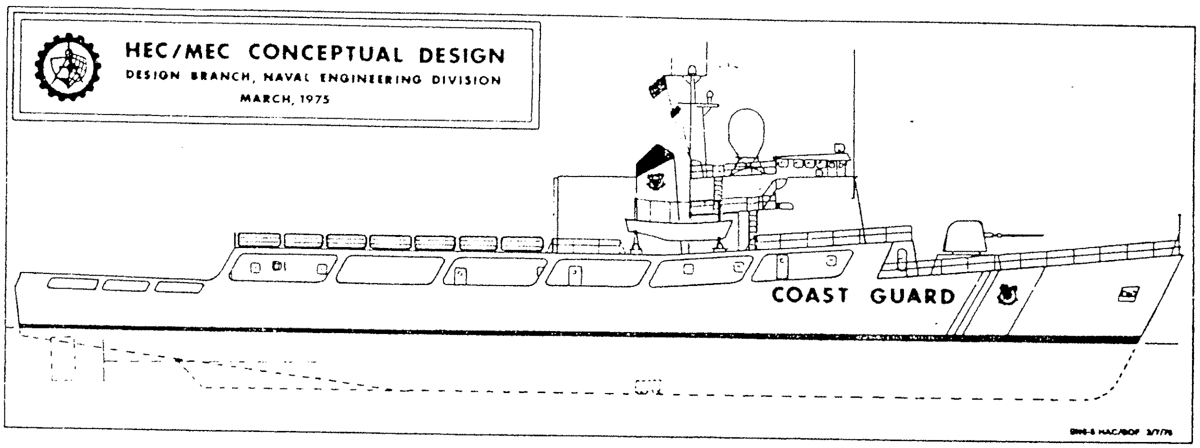


FIGURE 2.–OUTBOARD PROFILE

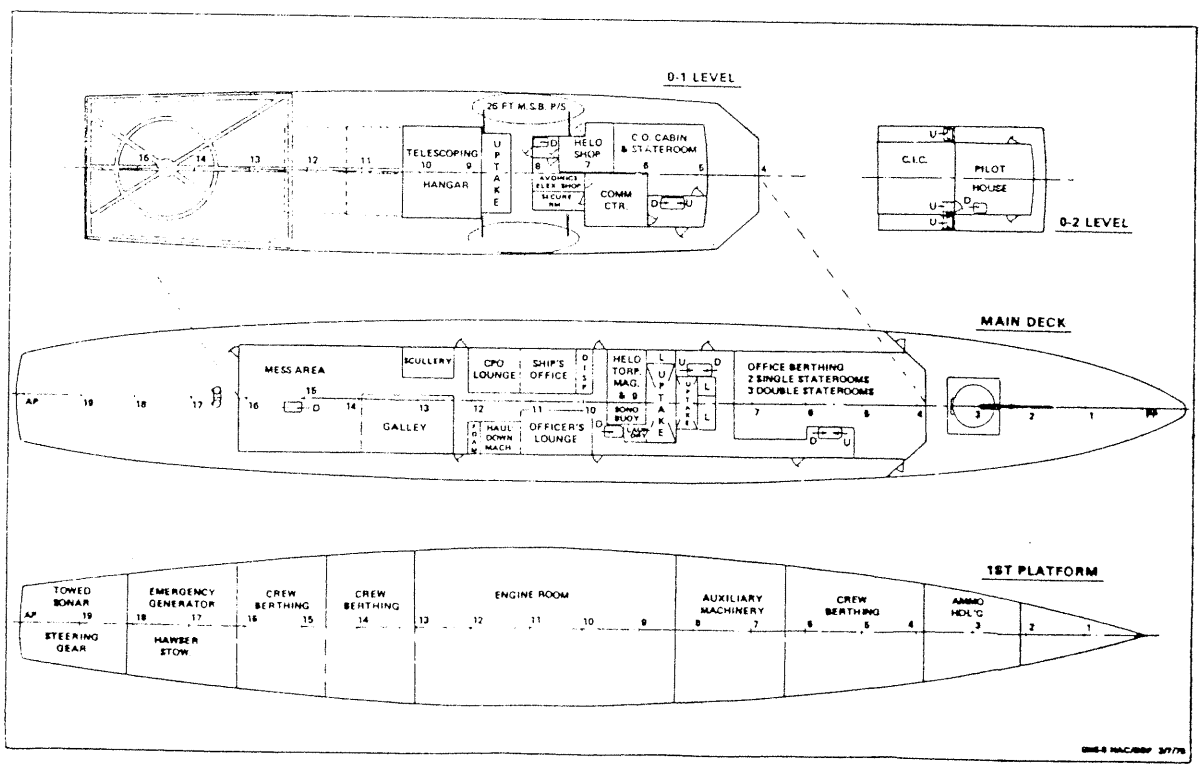


FIGURE 3.–DECK PLANS

Stability studies for the baseline design indicated that an increase in GM would be required to meet the 100 knot wind criteria with the hangar extended. At this point two sets of lines were developed using interactive graphics - one with a 39 foot beam and conventional transom, and one with 38 foot beam and a wide transom. Both hulls had satisfactory static stability characteristics, and nearly identical seakeeping properties as calculated by YF-17. Studies indicated that the full waterplane option could have improved seakeeping, but that it might be penalized in speed. The design proceeded with the full water plane option, and the issue was resolved during preliminary design by building a styrofoam core, fiberglass model and running a resistance test at the U.S. Naval Academy to verify the resistance characteristics of the 38 foot beam hull.

On the 8th of April, 1975, the Commandant was briefed on the results of the conceptual studies, and presented with 9 alternative designs in the form of a decision tree (Fig 4) The Commandant's selection at that meeting was the "optimal" design, 77.7 meters (255 ft) waterline length, 81.4 meters (267 ft) overall, with specific direction not to grow beyond 83.8 meters (275 foot) overall without further justification and approval. The prime movers were selected to be two 3500 horsepower diesel engines in one engine room. A helicopter hangar was to be provided, and also the following weapons systems:

MK 75 76 mm Gun Mount
MK 92 Fire Control System
Escort Towed Array Sonar System
Lamps III helicopter capability
SLQ 31/32 passive electronics suite with rapid blooming offboard chaff.

HEC/MEC DECISION TREE

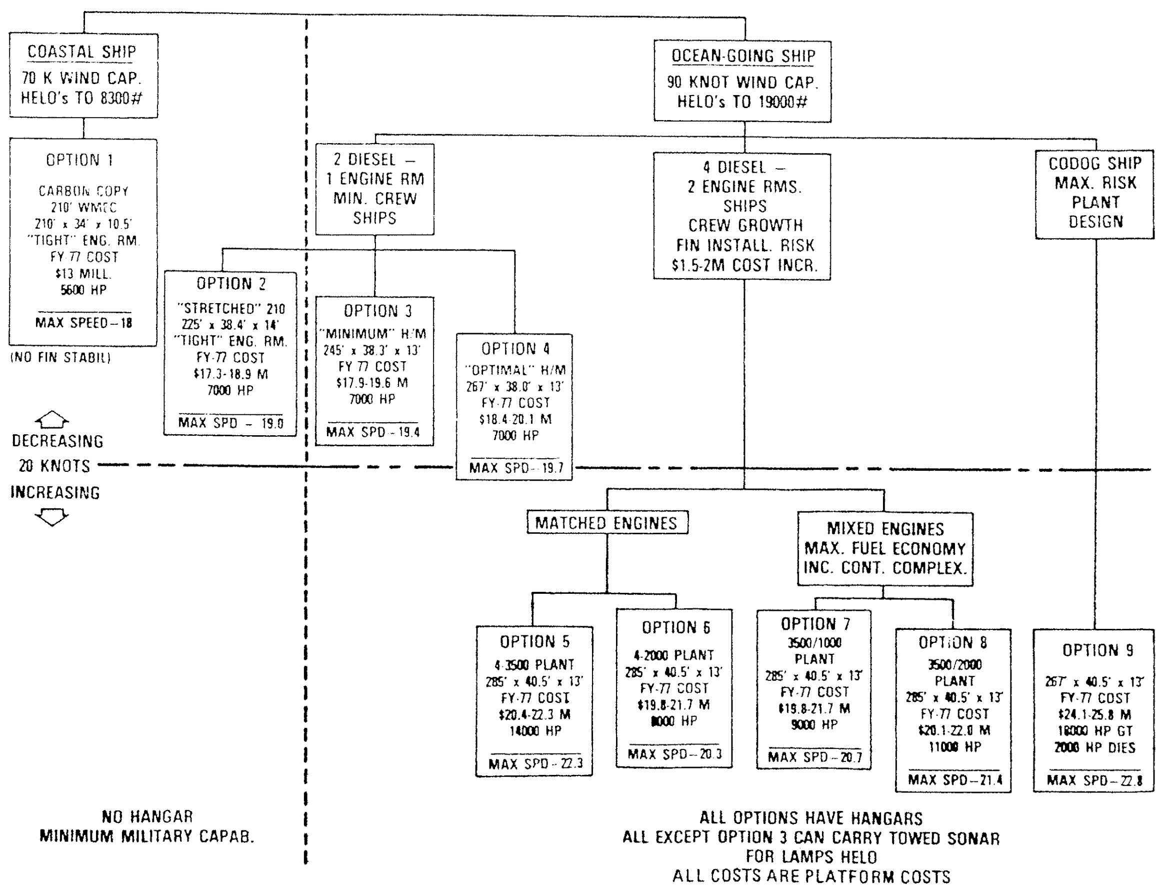


FIGURE 4.

Phase III

The Preliminary Design Phase, proceeded on the basis of the Commandant's decisions and an initial crew estimate of 80, including 10 officers. The hull lines were reviewed by personnel at the Naval Ship Engineering Center and David Taylor Naval Ship Research and Development Center, who recommended slight changes to stem and stern rake angle, which increased overall length to 82.3 meters (270 ft). Operational emphasis on a ship/helo team concept led to approval of non-retracting active fin stabilization, and configuration tradeoff studies were begun between flush deck and enclosed focs'l (or "broken deck") designs. The initial flush deck hull configuration was approved based upon adequate hull volume, utilization of a "flat front" deckhouse to assure a good structural connection to the transverse bulkhead below, and lower KG and structural weight. The design proceeded with incredibly few problems.

In late July 1975, the results of manning studies conducted by the Office of Operations were received, requiring accommodations for 85 enlisted (including 10 CPO's), 12 officers, 2 fisheries agents, and 4 enlisted data buoy technicians. This manning represented a change in support philosophy from clusters of 2 or 3 ships operating from a single base with shore support, to fully self-sustaining operations with no shore assist. Simultaneously, a major increase in electronics subsystems volume was identified for weapons systems and manning reduction automation. Since ship size and cost had been constrained by the Commandant, the design was in difficulty.

The MOD 1 Design.

The MOD 1 configuration of the 270-foot WMEC utilized the same hydrodynamic shape as the baseline design but changed from the "flush deck" to the broken deck configuration. The 0-1 Level was continued forward to the stem, and sheer removed from the decks below to provide an extra deck level forward (Fig 5). Expansion of electronics spaces forced removal of one boat. Hangar dimensions, accommodating a composite of the Coast Guard HH-52 and projected replacement helicopters, and Navy Lamps candidates required the hangar to be offset slightly to port. This permitted retention of one 26 foot motor surfboat on the starboard side, and a refueling station to port. The torpedo magazine was relocated from its former prime real estate location on the Main Deck to a van, since it would only be needed when a Navy helo was aboard on a combat or training mission. Similarly, vans or modules were proposed for military electronics on the philosophy that it could be located ashore when not needed, or for training and maintenance.

Accommodations for the increased crew size proved troublesome. Outboard (weather) passageways were retained aft of station 9 and officer berthing remained forward on the Main Deck with passage provided around officer's country. Berthing of 10 CPO's in two-man staterooms was accomplished by placing the staterooms forward on the First Platform and adapting a "modular" berthing concept for the crew (2). The modular concept provides a compartment containing only berths, 3 high, a separate locker compartment, separate sanitary space, and a recreation area. This concept allowed all functions to be accommodated with an overall space saving, plus providing lounges which can be easily converted for wartime berthing of an augmented crew.

The Mod 1 arrangement was literally designed over a weekend to show the impact of crew size and electronics requirements at a previously scheduled Tuesday morning presentation to the Commandant. The forward location of CPO berthing was clearly undesirable, and 6 alternative arrangements were prepared. Each of these was evaluated by design and maintenance personnel throughout the Naval Engineering Division according to a compilation of various criteria (3,4,5) shown in Appendix 2.

Simultaneously, detailed stability analyses were being conducted which revealed insufficient intact righting moment to meet wind heel conditions for these new, enclosed focs'l designs.

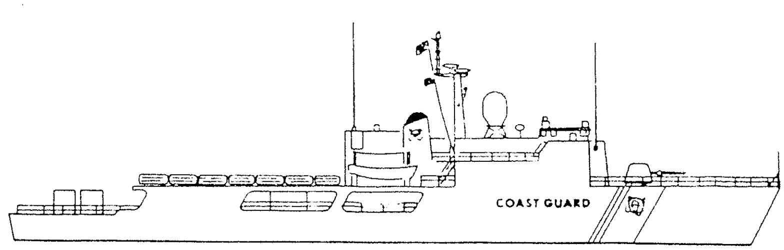


FIGURE 5.—MOD 1

Increase in length was not permitted, and increased beam was undesirable from a powering standpoint. The solution therefore, was to enclose the side weather deck passageways, carrying the shell plating and subdivision bulkheads continuous to the 0-1 Level. This decision was a definite trade-off of capabilities. Enclosing the sides was very undesirable for purposes of boat handling, firefighting, and boarding alongside. The primary mission of the cutter as a law enforcement unit however depends on the electronics systems, and on a helicopter, which in turn requires a hangar for protection during deployment. Even if it had been possible to remove the hangar, additional righting moment was required for all MOD 1 designs when the helicopter was aboard.

The MOD 2 Design.

Figure 6 represents the MOD 2 design - the final configuration of the 270-foot WMEC. This configuration still utilizes the original hydrodynamic form, however, the shell is continuous to the 0-1 Level all the way back to station 16. The MOD 2 also incorporated the recommendations of the MOD 1 arrangements evaluation, specifically:

a. Relocation of officer berthing to the 0-1 Level, removing it from the main flow of traffic.
b. Retention of modular berthing concepts.
c. Allocation of permanent fixed volume vs. modules for the MK-92 fire control system.
d. Incorporation of a sliding watertight door between the Engine Room and Auxiliary Machinery Room. This allows moving machinery components forward horizontally through the engineering spaces to a vertical lift to the shop.
e. Consolidation of messing and galley functions on the Main Deck, with the wardroom adjacent to the single galley.
f. Location of the trash compaction/stowage space aft on the Main Deck. This allowed easy off-loading of trash bundles and isolation from heat sources which could accelerate expansion and decay of compacted trash.
g. Location of a self-service laundry facility forward on the Main Deck.

Machinery Systems

Machinery systems for the new cutter are outlined in Table 1. Unique to this design is the installation of a waste-heat recovery system, in place of a conventional steam boiler, and the level of automation incorporated in the machinery plant. The waste heat recovery system will use the ship's service generator cooling water as an energy source, and be equipped with supplemental electric heating elements for pier connection when the plant is secured. The decision to utilize the waste heat system was based upon overall energy efficiency, and anticipated lower maintenance requirements than for the steam boiler.

The plant automation philosophy consists of centralized control, with automated controls and monitoring commensurate with unmanned engine room operation. Two watchstanders will occupy a control center in the Engine Room. Automation functions include preprogrammed remote control of engine speed and propeller pitch from both the Engineering Control Center, and the Bridge. Mimic boards with alarm lights, demand digital readout of machinery parameters, and automatic data logging for essential machinery parameters will be installed. Functions such as fuel oil transfer, lube oil purification and replenishment, and bilge pumping are not automated. However, manifolds with ported valves are specified to prevent line-up errors. Further features of the overall automation system are discussed in Part II of this paper. Fig (7 & 8) show the machinery plant arrangement.

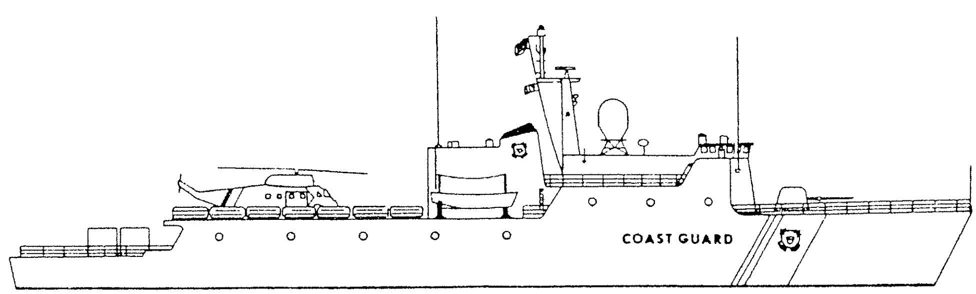


FIGURE 6.–MOD 2

TABLE 1

MACHINERY CHARACTERISTICS

Main Propulsion System

Twin screw diesel - reduction gear drive. 7000 Max. Cont. SHP
Propellers - controllable, reversible pitch - 9 foot diameter.

Auxiliary Systems

Ship's Service Generators - 2 475 KW diesel, 450 V., 60 Hz.
Standby Generator - 1 500 KW diesel, 450 V., 60 Hz.
Heat Recovery Units - 2 exhaust and jacket water waste heat recovery silencers, 2200 lb/hr steam.
Air Conditioning - 3 chillers, 20 ton each.
Distillers - 2 6000 gallon/day units
Roll Stabilizers - one pair of active, non-retractable fins electro-hydraulic, 50 hp each.

Pollution Control Equipment

Sewage - Vacuum flush system with 1400 gallon (3 day) sewage holding tank.
Turbid Drains - 2 ejection tanks (1 fwd, 1 aft), pumped to sewage holding tank or overboard.
Oily Water - Bilge water pumped through 10 gpm oily water separator.
Fuel oil tank ballast pumped through oily water separator.
Separated oil stored in dirty oil tank.
Clean Ballast - 3 tanks, total capacity - 11780 gallons.

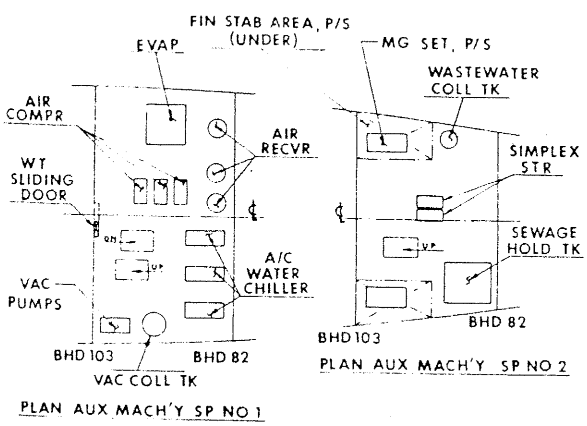


FIGURE 7.

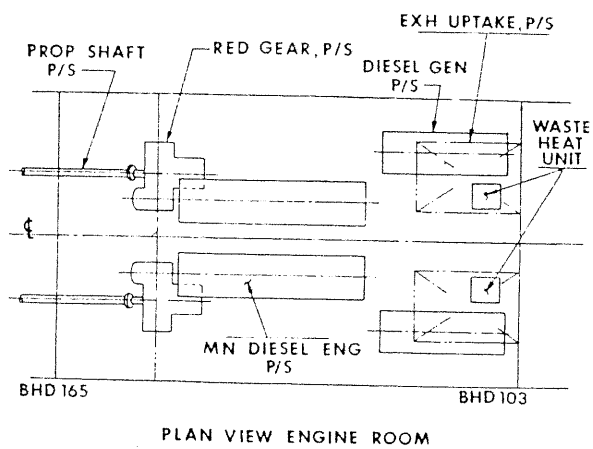


FIGURE 8.

Contract Design

The final configuration of the cutter is shown in Figures 9, 10 and 11. Significant changes in profile resulted from the addition of open bridge wings. The major perturbation to arrangement occurred due to assignment of women to the crews of major cutters. While the original arrangement had four distinct berthing units, each accommodating 21 personnel, a more flexible arrangement was desirable. Re-arrangement of the crew berthing area forward on the first platform now will allow berthing in groups of 9, 12 or 21.

The contract design phase also saw completion of an extensive model test program. Included in the program was extensive motions testing in long and short-crested seas, powering and maneuvering tests, and roll damping tests in support of bilge keel and fin design. Powering characteristics are shown in fig (12) and motions characteristics in fig (13).

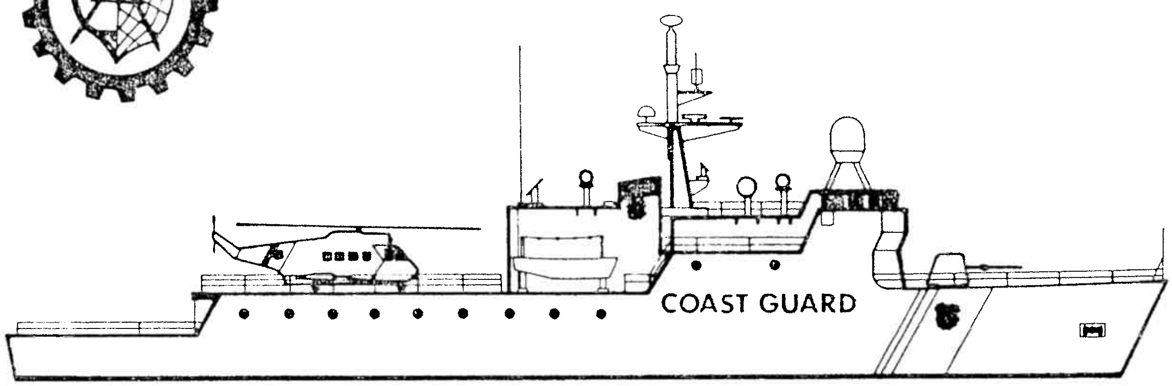


FIGURE 9.—OUTBOARD PROFILE

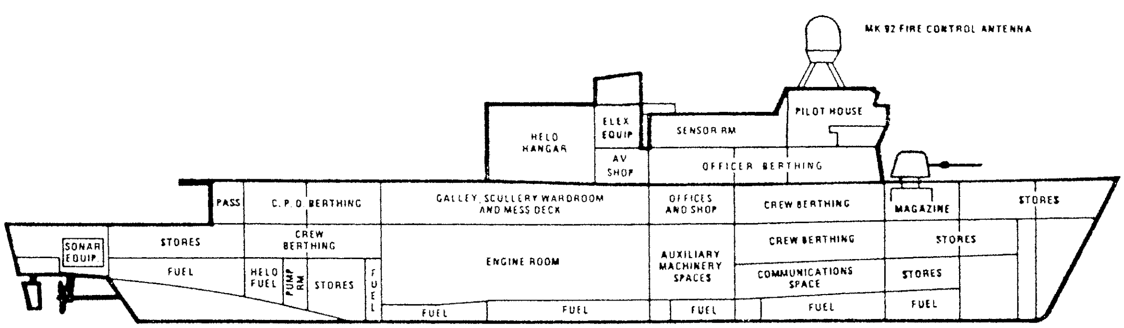


FIGURE 10.—INBOARD PROFILE

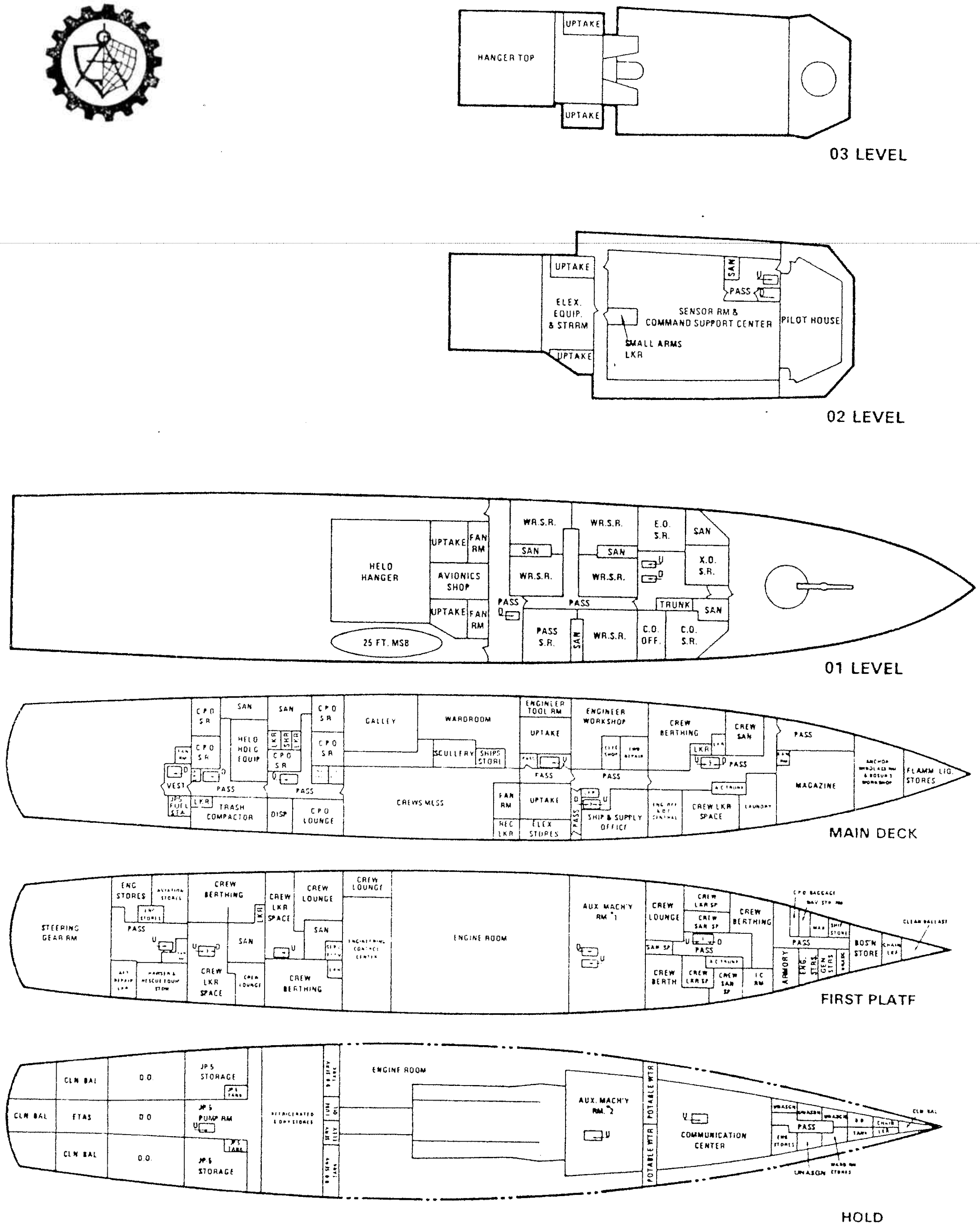


FIGURE 11.–DECK PLANS

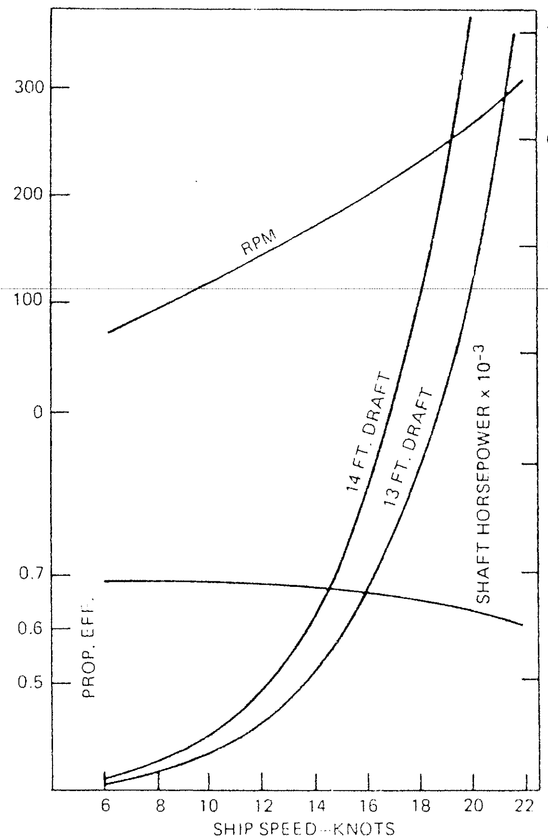


FIGURE 12.

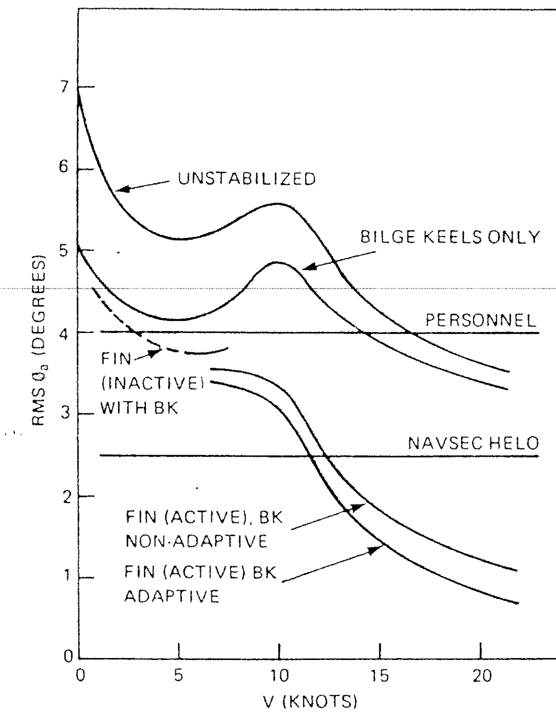


FIGURE 13.
Worst Heading RMS Roll Response as a Function of Ship Speed for Various Operating Conditions in Short Crested Seas With 3.5m (11.5 ft) Significant Wave Height.

PART 2 - AUTOMATION AND COMMAND/CONTROL

The 270 ft WMEC represents a major effort at integration of all the onboard electronics. Each and every system was considered from the aspects of manning level, power, weight, operational compatibility and reliability.

Navigation Systems

The Navigation System uses dual surface search radar, the AN/SPS-64, with both S-Band and X-Band. A regular indicator is installed both on the Bridge and in the Command Support Center (CSC). These will normally not be used because the radar is being transformed by a digital scan converter into high resolution TV. Both Loran-C and OMEGA receivers will be available for direct readout and input to the computers. Redundancy is provided in case of any failures. A dual axis doppler speed log will provide accurate ship speed both in shallow water (bottom bounce) and deep water (water mass) modes. A precision depth recorder will produce a paper chart and mag tape via computer.

Of particular interest is the optical sight system mounted on top of the Pilothouse. This unit is stabilized for both roll and pitch. The optics are fed directly into a low light level TV camera which provides a clear picture in almost total darkness. This picture is fully distributed to all TV monitors and video recorders. The lens system is capable of 3 powers of magnification. The cutter will also carry two gyro systems because of the importance placed on gyro reference.

Communications Systems

The Communications Systems are designed to be controlled from the COMMS Center by a one-man watch during routine patrols and two men during special evolutions. The transmitter equipment is mostly located in the CSC to allow short transmission lines to the antennas.

The HF and UHF COMMS equipments are capable of digital control and each operational station that needs access for voice communications can digitally patch in their handset and remotely change frequency. This digital control is routed and monitored by the command display system described below. The record COMMS is all handled by Model 40 teletypes in the COMMS Center. These units, with CRT display, page printers, and mag tape unit allow the radioman of the watch to work without paper tape and handle a higher volume of traffic. The Navy is furnishing both a receive-only Satellite COMMS System as well as the two-way satellite NAVMACS (Navy Modular Automated Communication System).

The internal COMMS System for the cutter is comprised of regular telephones throughout for administrative COMMS, and an intercom for operational COMMS, with sound powered phone as the intercom backup.

Special Systems

A video recording system is used for recording operational data such as low light level TV observation, radar picture, and chart or status board info. This same system can be used for training and distribution to recreational TV's located at the crew's lounge, wardroom, etc.

The cutter will be supplied with a rapid fire 76 mm automatic gun mount (MK-75), controlled by a MK-92 Fire Control System. This fire control system is also distributed to the command control system to provide a backup radar capability to the bridge. The mission of the cutter is heavily oriented toward the Navy ASW role of the 1980's and 1990's. Specifically, this requires the use of a LAMPS III helicopter for ASW. During LAMPS III operation, the helo data is received and processed on board the ship. This places a heavy burden on the on-board processing capability. The use of NTDS was considered, but the total cost plus the limited usefulness for regular Coast Guard missions, such as Law Enforcement and Search and Rescue, deemed it to be inadvisable.

There will be no fixed-hull active sonar system on board. Rather, the AN/SQN-19 Tactical Towed Array Sonar (TACTAS) will be added when available. This system will provide information to the displays in CSC. There are no plans at present to directly interface TACTAS to the cutter's command/control system, but the capability to do so exists.

The cutter will carry the new AN/SLQ-32 V2 Electronic Surveillance Methods (ESM) System. This provides a missile defense capability when used in conjunction with RBOC (Rapid Blooming Offboard Chaff). The ESM information will interface to the command control system in a similar manner to that ultimately selected for the NTDS interface.

Command Control Systems

The use of a Coast Guard Command, Display, and Control System (COMDAC) provides not only an opportunity to reduce plotters and status board keepers, but to also interface with LAMPS for ASW. The COMDAC system is the first major attempt to reduce operational personnel while still providing full capability for all missions. The system is conceptually a successor to previous efforts in the automation of CIC by the Coast Guard (OASIS) and Bridge manning reduction by the Navy (IBS). The mission for the Coast Guard in ASW clearly mandated automatic processing of information because of the rapid data flow from the LAMPS helicopter. This data cannot be manually reduced, plotted, and summarized without seriously degrading the helo response time. One might ask why the standard NTDS system was not selected for use in this case. The space, weight, and cost, of NTDS was not feasible particularly when its utilization for SAR, ELT, and other normal Coast Guard operations would not be directly applicable. The COMDAC system is precisely tailored to both the hardware and software requirements of the Coast Guard and integrates the total ASW problem. All portions of the total electronic system were designed with integration of the COMDAC system in mind.

System Description

The COMDAC system is comprised of 8 racks of electronics which receive data, format it in accordance with pre-determined doctrine, and then display it to any of several locations. The display consoles are located on the Bridge, Command Support Center (CSC) and Damage Control Central (DCC).

The main display and control console is on the Bridge and it is used by both the OOD and ship control Petty Officers (Fig. 14) The console is divided into three sections. The Port

COMDAC BRIDGE CONSOLE

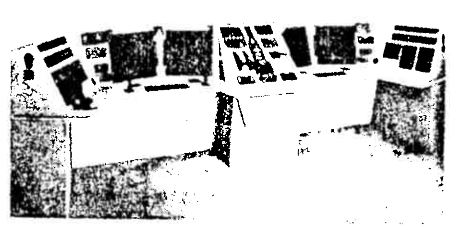


FIGURE 14.

and Starboard sections are nearly identical and offer not only dual screen monitoring of all COMDAC information but complete communications access. The COMMS panels shown in Fig 15 provide direct pushbutton 3 digit calling to nearly any compartment on the ship as well as intercom to all vital spaces. Sound powered phone is the backup mode for both. The PA mike and select buttons are accessible at either end of the console.

BRIDGE CONTROL COMMS PANEL

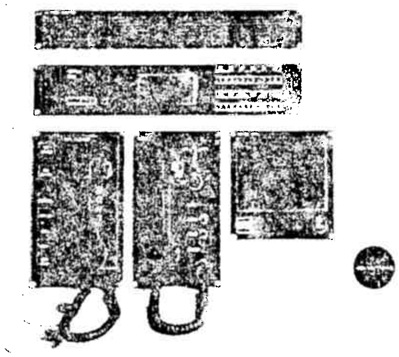


FIGURE 15

Each display position provides a keyboard with which to "talk" to the coupler, a track ball for interactive graphic work, and two 17" TV screens. These screens are fed from a distribution network that allows more than one position to monitor the same information simultaneously.

The use of TV screens for the consoles is of particular interest since it requires changing standard radar video to TV scan. With the recent introduction of reliable solid state scan converters, the ability to convert radar to high resolution (945 Lines) TV became feasible for shipboard systems. The two screens are used in conjunction such that one will normally have a radar picture with graphics such as track lines and chart contours. The other will be used to keep target listings or other alpha-numeric information normally found on status boards. It should be pointed out that a wide variety of data listings are available from the computer and display of each can be called by the operator instantly. Hence, one screen serves as a multitude of status listings.

To aid the operator and do away with a vast number of special purpose buttons, most selections are made by paging through a library with buttons on the side of the screen. The function of these programable buttons changes with each library page that is called from the computer.

The center of the console (Fig. 16) is used for direct ship control and houses the auto pilot, rudder control, and engine controls. This section is independent of the computers. In the

SHIP CONTROL POSITION

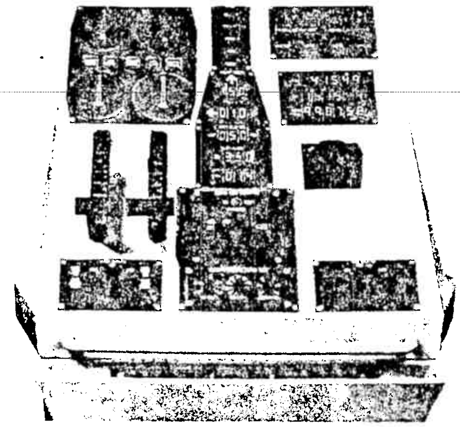


FIGURE 16

corner panels of the console some special controls and readouts are mounted. On the left there is a status panel for the MK-75 Gun Mount, a searchlight control panel, a video tape recorder remote control, and a radar range scale selector. On the right is a manning status board for locations throughout the ship, TV tape recorder remote control, and pan-tilt controls for the flight deck TV camera. The pistol grips shown at the OOD position (Fig. 17) are plugged in for train and azimuth control of the high-powered optical sight system mounted on the Pilothouse Top.

COMDAC OPERATOR POSITION

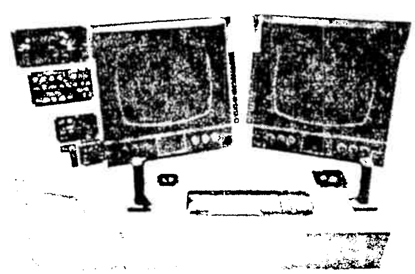


FIGURE 17.

The CO's console is located on both sides of a chair which is on a raised platform at the after pilothouse bulkhead. The console has no controls, only monitor selections. The TV screen can be patched into any other operating position to monitor the status. A full COMMS panel similar to that of the OOD is also provided.

Located behind and a half deck below the Pilothouse is a compartment designated as the Command Support

Center. During conditions, when the Bridge is considered to be too busy to work up its own data, the CSC will perform that function for them.

The two-position console located in CSC is basically a duplicate of the Bridge without engine and rudder controls. In addition, the CSC console is intended to carry the bulk of the workload during ASW and SAR. As such it contains such special items as the IFF code control and Link 14 printer. Adjacent to the CSC console is a COMMS console which will be used by the COMMS officer to monitor and control the required COMMS networks at various evolutions. He will act as the tactical communicator and use the COMDAC System to rapidly code and decode tactical signals.

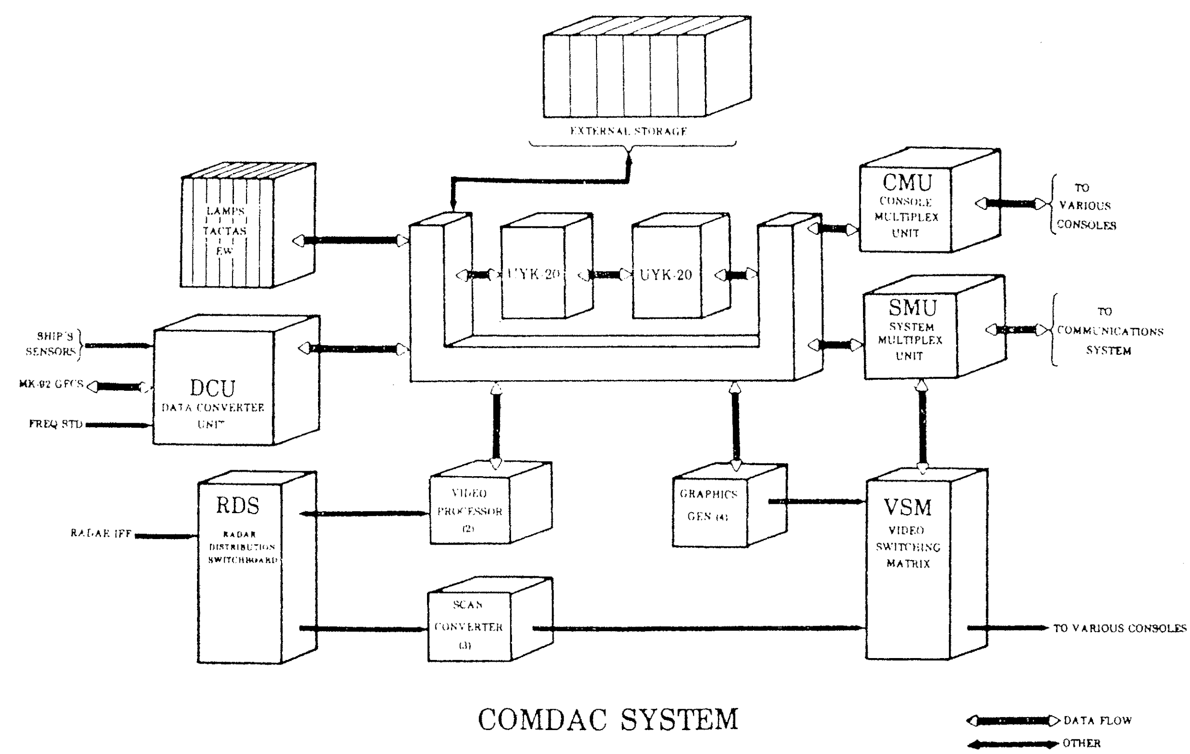
The final console is located in Damage Control Central and is used by the Damage Control officer for maintaining damage status. A light pen is used to mark up compartment diagrams which are displayed graphically on a TV screen. Templates can be scaled for convenience and ease in filling out damage status forms. Both of these information banks can be called up for display on the bridge.

A Model 40 teletype in the ships office can be tied into the computer for administrative work on a not to interfere or background basis. Model 40 teletypes in the COMMS Center, which is located about 5 decks below the bridge, are also interfaced to the COMDAC computer. This allows high priority message traffic to be handled rapidly in both directions. For instance, the CO can fill out a SubSighting Report by calling for the proper form in the computer, fill in the blanks, add his release code and have it instantly on the radio watch Model 40 screen. The radioman then adds the appropriate heading and addresses and places the mag tape cassette into a transmit mode.

The racks of electronics that format, process, and control the information to and from each of the consoles described previously is housed in the after part of the Command Support Center. Many of the critical pieces of equipment are supplied with redundancy and backup manual modes to prevent single point failures. An overall block diagram of the COMDAC system is provided in fig 18.

The DCU (Data Converter Unit) accepts many different data words such as wind speed and direction, gyro heading, air temp., depth of water, etc. This DCU then formats each word into a code that is easily handled by the computer. The words are stored in a buffer to be read out when polled by the computer.

The CMU (Console Multiplex Unit) is the device that keeps each console in touch with the computer and allows each



COMDAC SYSTEM

FIGURE 18.

to be routed to and from the proper console.

The SMU (System Multiplex Unit) routes other instructions and status messages to and from other devices in the ship not associated with the consoles themselves.

The external storage shown is comprised of 2 discs each of which is capable of a 5 million word storage and 2 magnetic cartridge tape units with tape drives each.

The precise interface to some of the U.S. Navy supplied systems such as LAMPS, TACTAS, and ESM are pending a final resolution by the Navy as to the standard interface form to NTDS. The COMDAC system uses Standard Military Computer Interfaces and NTDS symbology.

References:

1. Richards T. Miller "A Ship Design Process," Marine Technology, October, 1965.

2. Saklem, Castle and Weiler, "The Shipboard Environment - Past Present and Future," ASNE Journal, June 1971.

3. Wolfgang Reuter, "Lecture 40 Notes," MIT Professional Summer Summary.

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Appendix 1

DESIGNATED TASK STATEMENT SUMMARY

Primary Employment

ELT up to about 200 miles off East, West and Gulf Coasts and Hawaiian Islands.

Other Employment

SAR, MSA, MEP and other incidental Coast Guard tasks in primary areas and coastal southern and southeastern Alaska.

Endurance

Homeport to ELT area (400 miles) at economical speed, 14 days on station at economical speed, 24 hours at maximum speed, and ELT area to homeport at economical speed.

Other Tasks

Conduct routine helicopter operations with an anticipated 80 flight hours per patrol.

Fight fires aboard other vessels and off-shore structures.

Tow vessels up to 10,000 tons displacement.

Launch, tow and retrieve VDS.

RAS capable.

Weather Constraints

Ability to sortie and perform its missions in any and all weather conditions in its areas of operation.

Ability to carry, launch and recover helicopter 90% of the time in weather of ELT areas.

Other Features

Minimize manning through automation.

Maximum speed 20 knots.

Habitability equal to or exceeding Coast Guard current standards.

Appendix 2

DESIGN ARRANGEMENT EVALUATION

Alternative designs are ranked comparatively according to the following factors:

A. Noise
Guidance: Separation of noise generators (e.g. main and auxiliary machinery, heavy hydraulic equipment, propeller and rudder machinery) from quiet functions (berthing, control spaces).

B. Vibration
Guidance:
Without specific data available, the aft 1/3 of the cutter is considered unsuitable for vibration-sensitive functions (e.g. medical work, avionics shops, berthing).

C. Temperature
Guidance:
1. Avoidance of human support spaces adjacent to very hot or very cold areas - particularly over heat and under cold.
2. Avoidance of wet space locations along the shell to minimize condensation.
3. Separation of hot and cold spaces by an unmanned buffer space.

D. Motions
Guidance:
1. Avoidance of human support spaces, especially medical and commissary spaces near the bow or stern.
2. Arrangement of berthing, messroom seating, ladders, and sanitary fixtures fore and aft.
3. Arrangement of steam kettle rows and deep fat fryers athwartships.

E. Humidity and Odors
Guidance:
1. Separate areas of high heat and humidity (laundry) or fumes (trash room, weld shop), from habitability spaces, especially medical or commissary spaces, by at least a passageway or watertight boundary.
2. Isolate HVAC circuits for various functions (e.g. living, commissary, medical) to avoid re-ingestion of fumes.

F. Functional Adjacency
Guidance:
1. Stack sanitary spaces vertically above holding or treatment facilities.
2. Provide adjacency between food preparation areas and storerooms.
3. Provide adjacency between helicopter platform, medical facility and mess deck.
4. Provide adjacency of senior officer's berthing to conspaces.
5. Provide adjacency of electronic equipment rooms to antennae; magazines to weapons.
6. Provide adjacency of special firefighting equipment to machinery and aviation spaces.
7. Provide adjacency of shops to each other for mutual support, and to the spaces served.

G. Operational Separation
Guidance:
1. Separate officer berthing from enlisted traffic paths.
2. Separate main traffic routes from berthing and operating spaces.
3. Separate manned stations from radiating antennas.

H. Miscellaneous
Guidance:
1. Provide internal access throughout ships length suitable for litter and damage control timber movement.
2. Provide messline arrangements which do not block passage in good or bad weather.
3. Place laundry above water line, with good access for bulk loads.
4. Provide ship's office with access to crew, officers country and quarterdeck.
5. Arrange mess deck for movies and training sessions.
6. Provide for structural continuity throughtout.