DESIGN AND CONSTRUCTION OF THE UNITED STATES COAST GUARD 44-FOOT MOTOR LIFEBOAT

THE UNITED STATES COAST GUARD YARD
Curtis Bay, Maryland
JUNE 1966

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THE AUTHOR

following graduation from the U. S. Coast Guard Academy in 1951, served in CGC MACKINAW and CGC SUNDEW for deck and engineering duty; Engineer Officer and Executive Officer in CGC TAMAROA; Engineer Officer in CGC CHAUTAUQUA; engineering duty at the Coast Guard YARD. Completed the postgraduate course in Naval Construction and Engineering at Massachusetts Institute of Technology in 1958, receiving the Professional Degree of Naval Engineer and a Master of Science Degree in Naval Architecture and Marine Engineering. Served as Chief, Boat Section, Naval Engineering Division, U. S. Coast Guard Headquarters from 1961 to 1965. Was a delegate to the International Lifeboat Conference, Edinburgh, Scotland in June 1963. Currently serving as Commanding Officer and Project Officer at Field Testing and Development Center.

This paper was presented by the author before the Ninth International Lifeboat Conference, Edinburgh, Scotland on 4 June 1963, and published in the February 1964 issue of the Naval Engineers Journal.

"The CG-44300 survived her sea trial with flying colors. She is considered by this command to be the most remarkable piece of equipment to bolster the operational capabilities of the Coast Guard since the development of the 52 foot MLB." These remarks concluded the most comprehensive design, construction, and evaluation project ever undertaken for a Coast Guard rescue craft.

Replacement of the traditionally famous 36 foot Lifeboat (Figure 2) was necessitated by advancing age, concurrent deterioration of material condition and reliability, and increased and varied scope of lifeboat operation concepts and requirements.

The fundamental design of this able and seaworthy boat, averaging 25-30 years of service as a class, had not changed significantly in the 90 years since the first lifeboat was imported from Great Britain. Engine improvements gave it slight changes in speed and maneuverability.

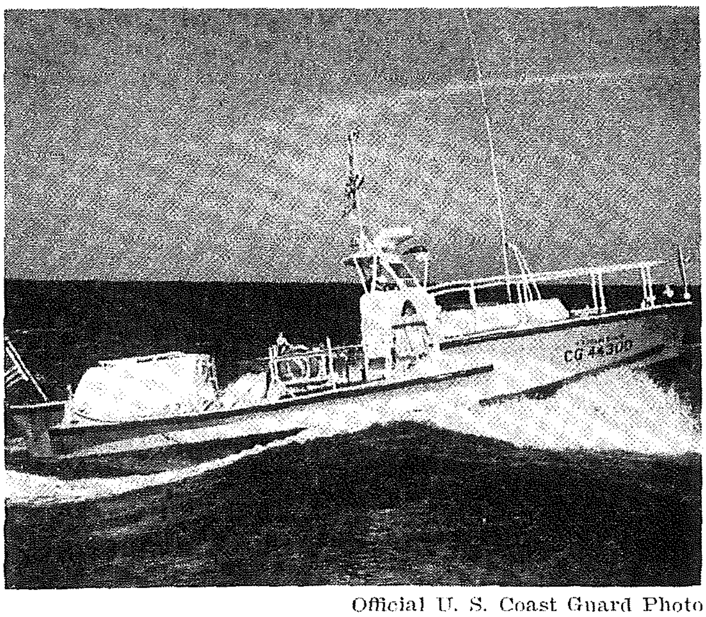

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Figure 1.

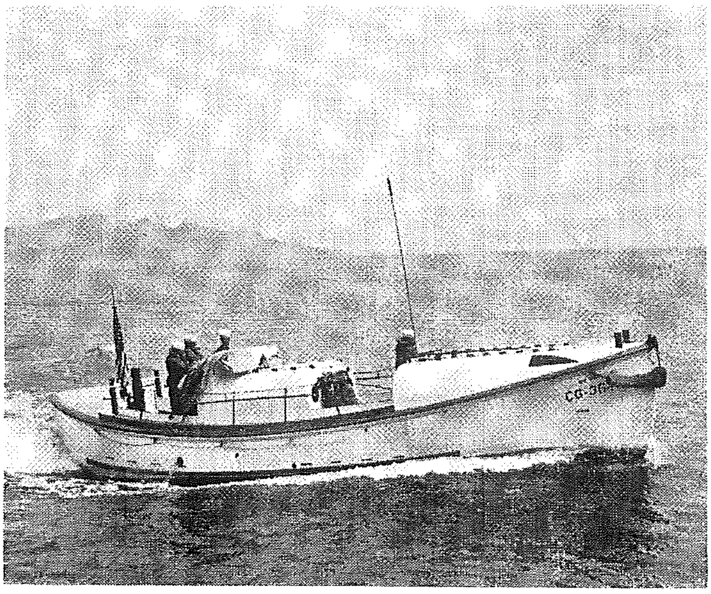

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Figure 2.

Comments solicited from experienced Coast Guard lifeboatmen on East and West Coasts, in addition to the Great Lakes, revealed three predominant shortcomings of the 36 foot MLB, excluding material condition. These are (a) poor towing control due to the far aft location of tow bitt, (b) lack of speed, and (c) poor steering station visibility. All comments stressed no compromise in retention of traditional seaworthiness, selfrighting capability, and compartmentation.

These considerations and the following factors influenced the new design:

1. Provision for complete electronics configuration; i.e., 100-mile range radio transceiver, direction finder, depth sounder, and radar; incorporation of integrated steering and control console; utilization of high capacity alternator generators.

2. Twin-screw propulsion handling characteristics and increased power and speed capability; design consideration for a full speed range of 150 nautical miles.

3. Improved rescue and towing capability; provisions for survivor and crew spaces and facilities, relocated tow bitt and crew work decks; better side-tow provision, engine-driven fire and salvage pump with bilge eductor and main deck fire station.

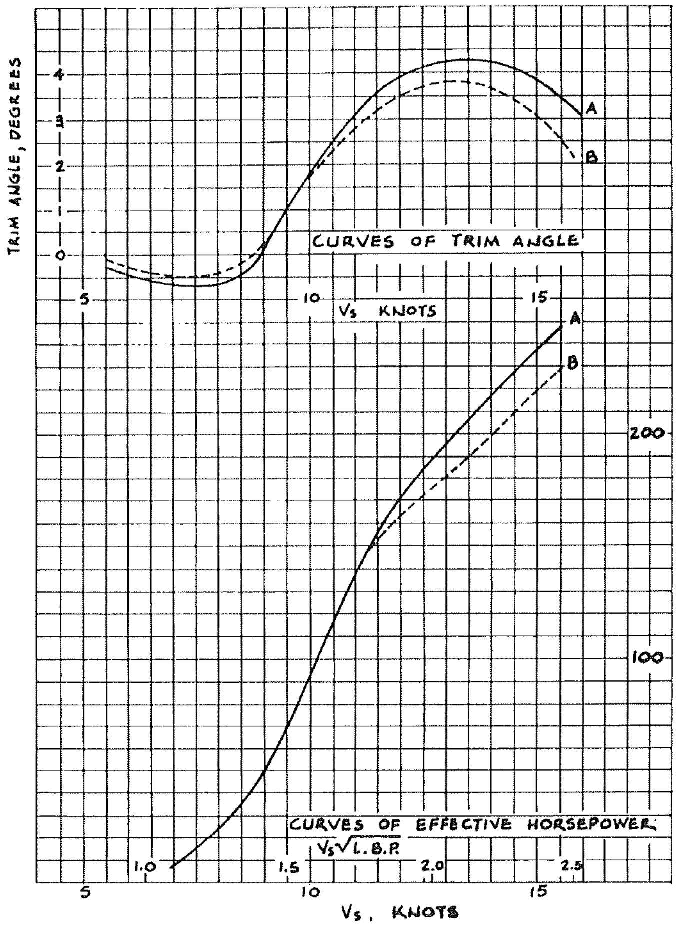
4. Self-righting capability by means of fundamental structural design; i.e., compartmentation layout, lightweight superstructure combined with low center of gravity and centerline fuel tank free surface effect in capsized position.

5. Ruggedness of welded construction, with ice-working capability, in combination with ease of hull maintenance through utilization of "exotic" preservation coatings on exterior and interior surfaces.

Characteristics of the new motor lifeboat evolved about July 1960 and preliminary design was initiated for model tank testing.

Formerly, small craft design in the Coast Guard was mostly a process of evolution; however, in the past two years, it has become more dynamic and exact. Traditional design practice developed a boat from previous similar boats of known characteristics; improvement changes were incorporated from operational experience. A prototype full scale boat would then be constructed and subjected to evaluation tests to determine adequacy of design and service suitability. The current trend of design is to rely more confidently on data obtained from scale model testing and on independent hydrodynamic and strength investigations. Full scale prototypes with their "to-be-expected" full scale mistakes are indeed considerably more expensive and costly than model determinations. The science and art of naval architecture has advanced to the point where test results of resistance and seakeeping obtained in the experimental model tank can be used with confidence.

From the developed lines, a 1/12 scale model was constructed and towed for resistance and trim at the experimental towing tank of Davidson



CONDITIONS, FULL SIZE

TEST	DISPL. LBS.	WETTED AREA SQ FT.	DRAFT - FT.			APPENDAGES
			FWD	AFT	MEAN	
A	36,400	462.1	3.25	3.26	3.25	SKEG, 2 SHAFTS, 2 RUDDERS
B	36,400	478.2	3.25	3.25	3.25	SAME AS "A", PLUS FINS

SHAFT ANGLE - 4°

Figure 3. Curves of Effective Horsepower and Trim Angle for 44 Ft. C.G. Motor Lifeboat 1/12 scale model.

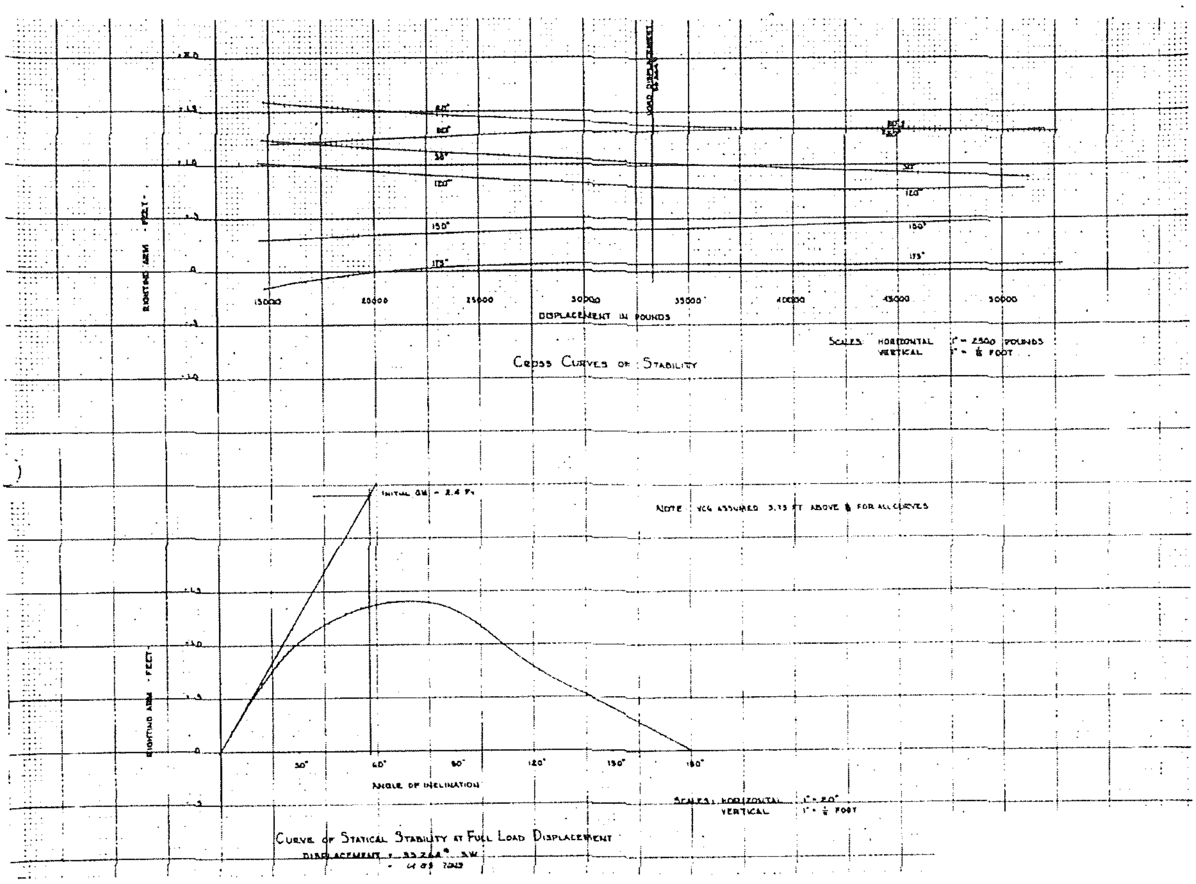


Figure 4. Cross Curves of Stability. Scales: Horizontal one division—2500 Pounds; Vertical one division—½ Foot.

Laboratory, Stevens Institute of Technology. The results shown in Figure 3 indicate the original hull tests and the data of a modification to be discussed further.

The ability to operate satisfactorily in coastal waters under unusually severe adverse weather and sea conditions was a major consideration for the new 44 foot MLB. Features intended to provide excellent seaworthiness characteristics were given high priority in the development of the preliminary design. The usual calculations for statical stability and floodable length indicated excellent stability and buoyancy characteristics for self-righting capability as shown in Figures 4 and 5. In the forward sections of the hull, emphasis was placed on lines favorable to easy driving with a minimum of pounding in a seaway. This new boat followed the important seaworthiness requirement of a small moderately fast Coast Guard craft in its ability to proceed into head seas at a maximum speed consistent with due consideration for damage to the boat's structure and equipment and a minimum of physical punishment to the crew. The adequacy of these design considerations was confirmed in evaluation trials following construction of the full scale boat.

Development of the general arrangements was subject to considerable study of the previously noted influence factors and full scale mock-up structures. The full scale mock-ups of wood construction aided immeasurably in the layout of mast platform, crew stations and steering control console.

In the determinations of hull scantlings emphasis was placed on highest strength obtainable in the least practicable weight considering the most severe service conditions of rescue at sea, possible grounding, working in ice, heavy surf, and towing assistance. The hull, which is framed by a combination of transverse and longitudinal members, is divided into seven watertight compartments. For safety against possible grounding damage, a double bottom is provided in the forward half-length of the boat. Further grounding protection, when broached, is afforded by a web frame located at the mid-section and extending from keel to cockpit deck level. See Figures 6, 7 and 8.

Bulkheads are constructed of mild steel, as are the hull framing, raised decks and cockpit deck. The shell plating is constructed of 3/16 inch CORTEN steel, a special low carbon formulation possessing high strength and corrosion-resisting properties.

The trunks over the mess and passenger space and the litter space are constructed of aluminum alloy 5086-H32. The trunk over the machinery space is constructed of mild steel. The windshield, dodgers and other parts of the superstructure are constructed of aluminum alloy 5086-H32.

The appearance of the hull and the general arrangement are shown in Figure 9. The steering station shown in Figures 10 and 11 is equipped with engine throttle and starting controls, steering wheel, instrument panel, special-damped compass, and remote-operated electronic equipment.

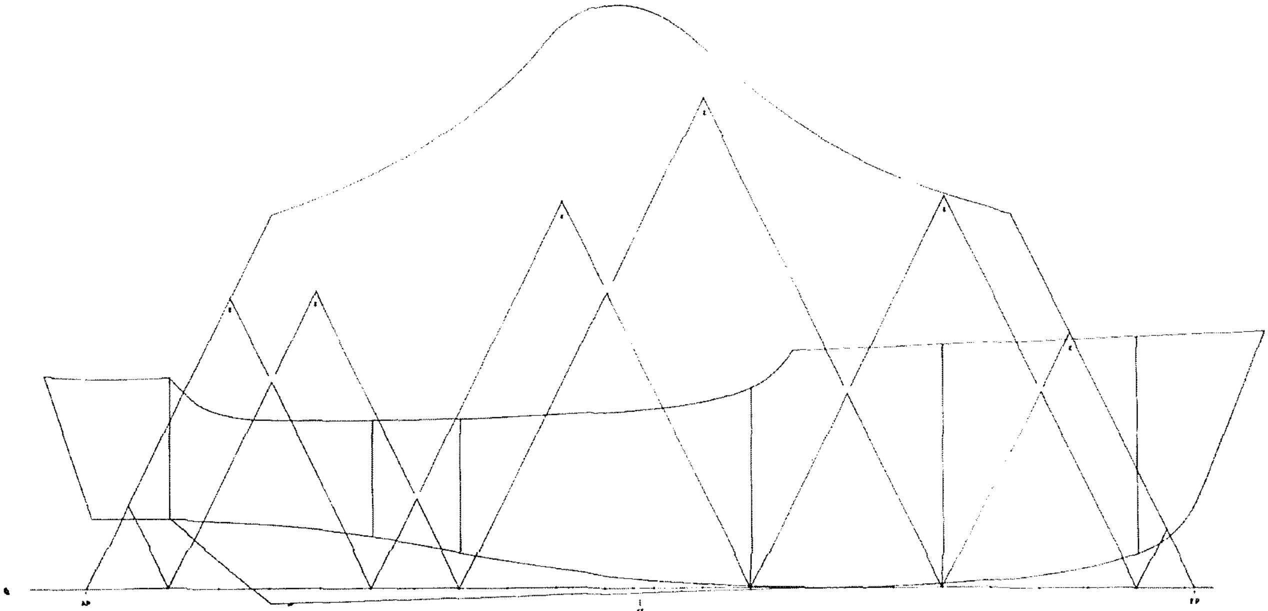


Figure 5. Characteristics: Length Overall 44′-1½″; Length, 10 stations 40′-0″; Beam, Molded 11′-11″; Depth, Sta. 8 5′-11″; Draft, Molded 3′-0½″; Displacement, total S.W. 14.85 tons; Floodable Length. Note: Margin Line Assume 3″ below sheer. Cockpit assumed open to sea. Permeability 95% throughout.

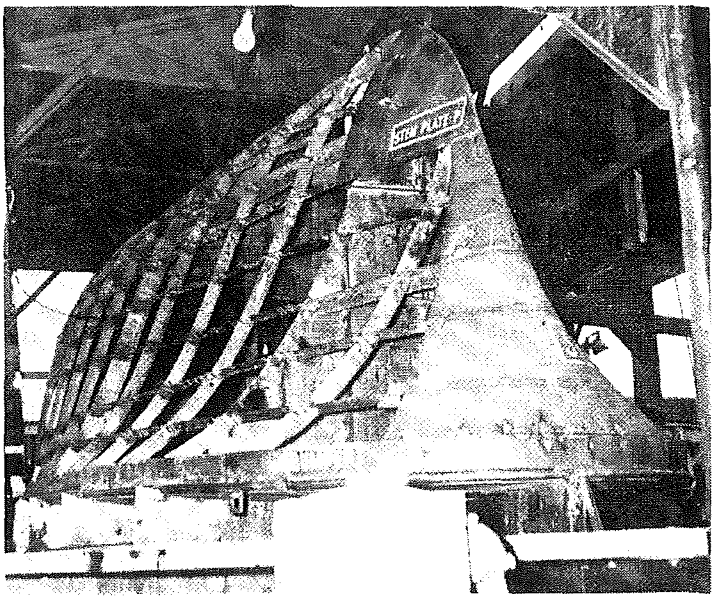


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Figure 6.

Figure 12 shows the after deck and stern configuration.

The passenger space includes two transom seats, fitted with foam rubber cushions and six auto-type safety belts. The mess space is similarly equipped with a single transom for accommodating three persons, in addition to including limited galley facilities consisting of a dresser with sink and hot cup receptacles. An enclosed toilet space is located convenient to this living area. The litter space includes two transom seats with safety belts for five persons. Stowage is provided for a Stokes litter and firefighting chemical foam.

The main propelling machinery consists of two diesel engines each producing 180 shaft horsepower, which are remotely controlled from the steering station by single lever control for both

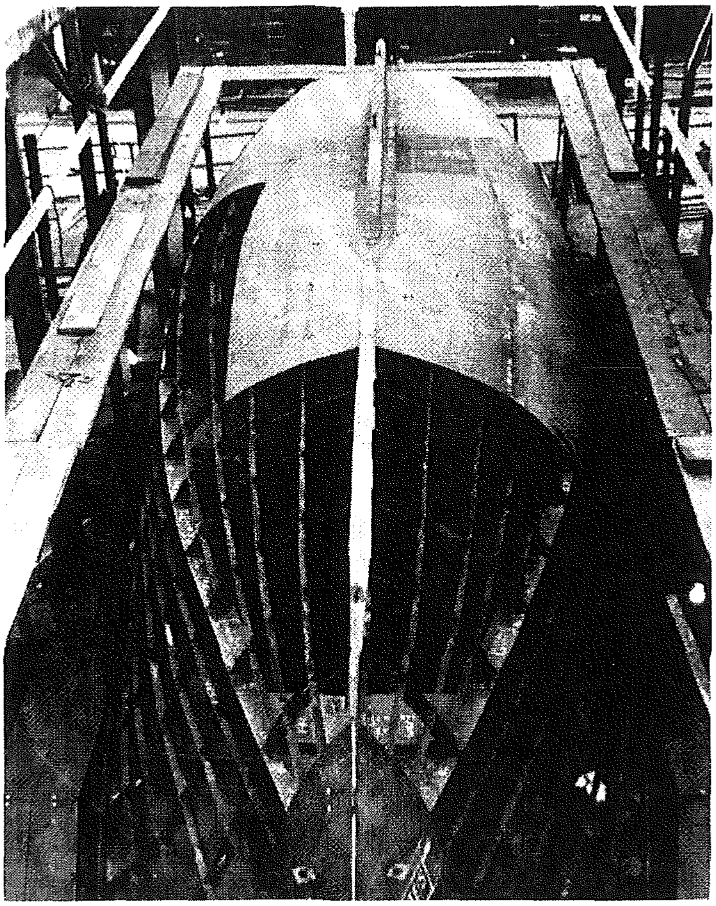

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Figure 7.

clutch and throttle. Each engine drives a monel propeller shaft through hydraulic reverse reduction gears. The propellers are three-blade cast manganese bronze. The shafting is supported on water lubricated cutless rubber bearings.

Each engine is equipped with a 2000 watt, 28 volt DC alternator with a rectified output and

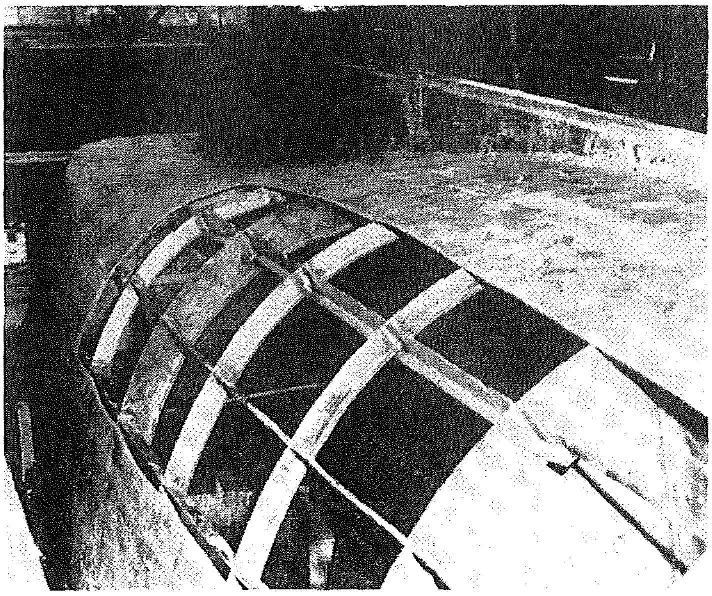

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Figure 8.

voltage regulator to supply auxiliary electrical power to the boat. Service electricity is controlled and supplied through a distribution switchboard to two 750 watt converter units for 115 volt AC power to operate the electronics equipment. Batteries are installed to provide "dead-boat" communications capability.

Starting for the main engines is by means of a hydraulic system with controls to remotely actuate the starting motors. Stored pressure accumulators provide starting reserve during standby engine status.

The port engine has a manual clutch type power take-off for operation of a 120 GPM fire and salvage pump. This engine also drives the hydraulic starting system pump and air compressor. The starboard engine drives the hydraulic steering system pump.

The boat is provided with twin, balanced foil plate rudders of welded construction and controlled by means of a cable system with power assist from the hydraulic steering booster. Quick and precise rudder action is thus afforded.

Towing equipment consists of the 4-inch diameter tow bitt and tow line stowage reel with 100 fathoms of 3½ inch circumference nylon rope. Double bitts are located at each side for side tow positioning.

Minimum hull maintenance is expected from the utilization of "exotic" paint coating systems for all interior and exterior surfaces of the hull.

Principal dimensions and characteristics as developed from design and construction stages are as follows:

Length, overall	44'-1½"
Length, design waterline	40'
Beam, overall	12'-8"
Beam, waterline	10'-10"
Draft	3'-2½"
Displacement	15.8 tons
Fuel capacity	333 gallons
Water capacity	16 gallons
Shaft horsepower, maximum	400
Trial speed	15.3 knots
Endurance	200 miles, 10 knots 150 miles, 15 knots
Block coefficient	0.38
Prismatic coefficient	0.52
Midships coefficient	0.73
Range of stability, in excess of 175 degrees	
GM	1.8 feet
KG	4.3 feet

Adequacy of stability calculations and confirmation of self-righting capability was checked during capsizing test. See Figure 13. This indicated approximately 2 or 3 seconds were required for return from overturned to upright position. Self-bailing of the midships cockpit is achieved through the 4 inch diameter non-return ball-check scupper valves. Approximately 55 seconds elapsed in clearing water scooped in capsizing tests.

During evaluation trials following construction, performance and standardization data were obtained. Bollard pull and performance tests conducted on CG-44300, the development boat, are shown in Figures 14 and 15. It will be noted that two curves are plotted for data of performance tests of the full scale boat. Curve A represents the original design configuration. Curve B represents data observed after modification involving addition of stern fins.

The measurement and determination of shaft horsepower utilizing MAIHAK torsion equipment serves two purposes: first, a measure of engine performance is afforded to verify manufacturer's service rated power; secondly, confirmation of model test results and design assumptions is possible through correlation of data, thus increasing confidence of design methods.

In the design stage, after analyzing original model data, a propulsive coefficient of 0.60 was assumed for powering determinations. Thus, for a model indication of 218 EHP at 14 knots, the SHP requirement is 363. Selection of propelling machinery could then be assessed in order to conform to space and weight limitations. A twin engine arrangement, each producing 180 SHP, was installed in the boat. The boat, in condition A, was run on preliminary trials for horsepower determination. Performance results of CG-44300 indicated 355 SHP at 14 knots; correlative translation to the model-indicated 218 EHP produced a propulsive coefficient of 0.615.

Initially, the model-indicated running trim angle seemed reasonably acceptable, though adversely sensitive to added weight. It was found during preliminary evaluation trials that the boat had a trim angle of about 4.5 degrees at full speed (14.5 knots) and a maximum of about 5 degrees at intermediate speeds. Deleterious effects were poor ahead visibility from the steering station and lifting of the fore-foot which influenced driving into a seaway and control of the boat in the surf. The excessive stern "squat" resulted in an undesirable heavy wake. Therefore, drawing on experience of Coast Guard and commercial small high-speed craft, it was decided to install triangular-shaped stern fins, six feet long and seven inches wide, inclined to and just below the water line on

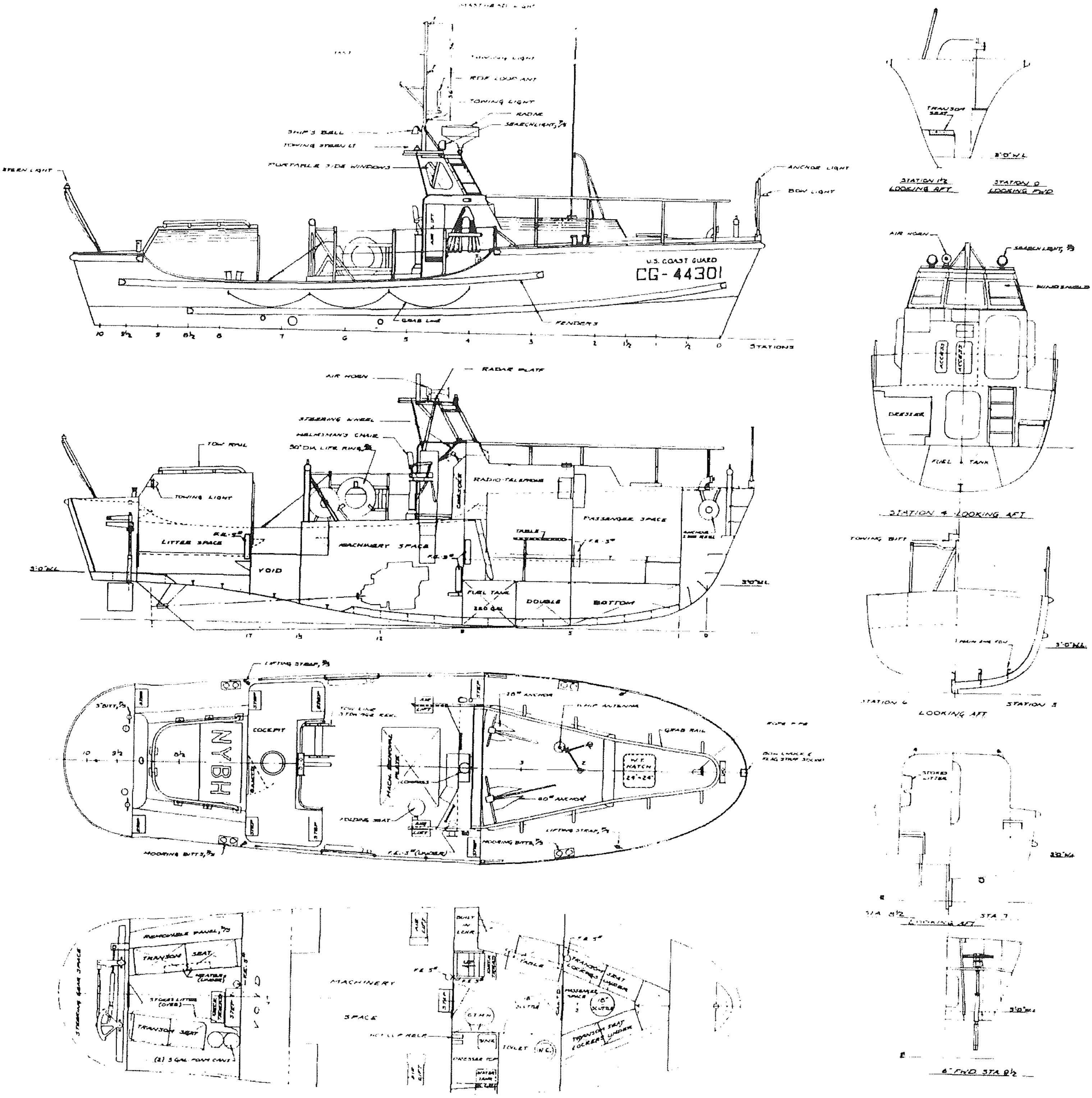

Figure 9.

each side. The expected effect was a reduction of trim angle and stern "squat."

From the model tests, the addition of the fins resulted in a clear reduction of trim angle and of resistance in the 11 to 15 knot speed range. The reduction in resistance appears to be directly related to the reduction of the induced drag component, a factor of trim angle. The model tests further indicated that the fins begin to supply lift at about 10.5 knots, and become more effective with increasing speed. The improved resistance characteristic was an unforeseen dividend which was confirmed further from the full scale test determinations. Maximum speed advanced from 14.5 to 15.3 knots at the same shaft horsepower. A satisfactory running trim of 3.5 to 4 degrees resulted.

Foil rudders with power assist steering were added along with the installation of the stern fins. Boat control was greatly enhanced under all operating situations during evaluation trials. Operation in following seas was excellent.

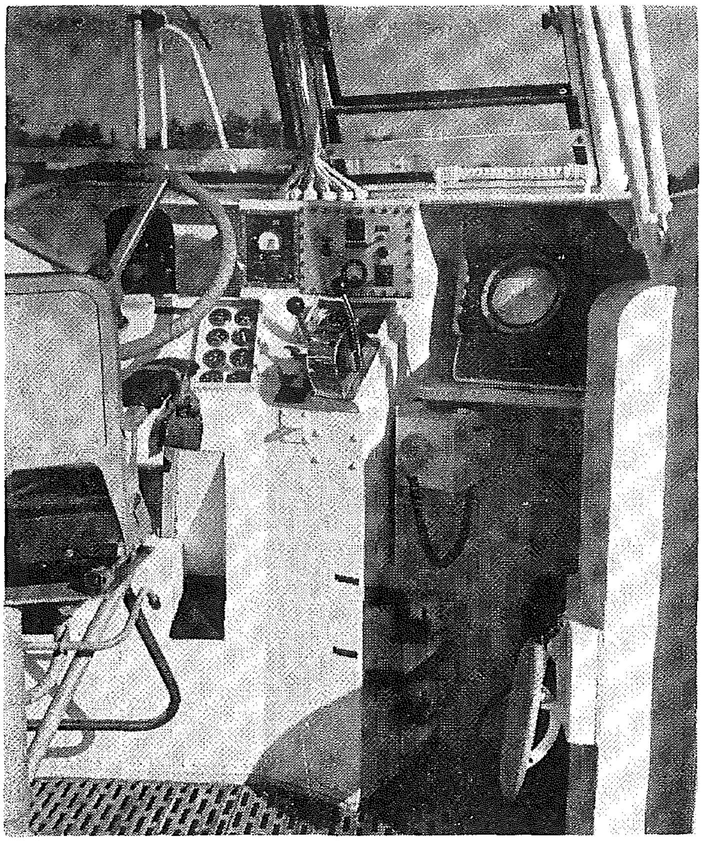

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Figure 10.

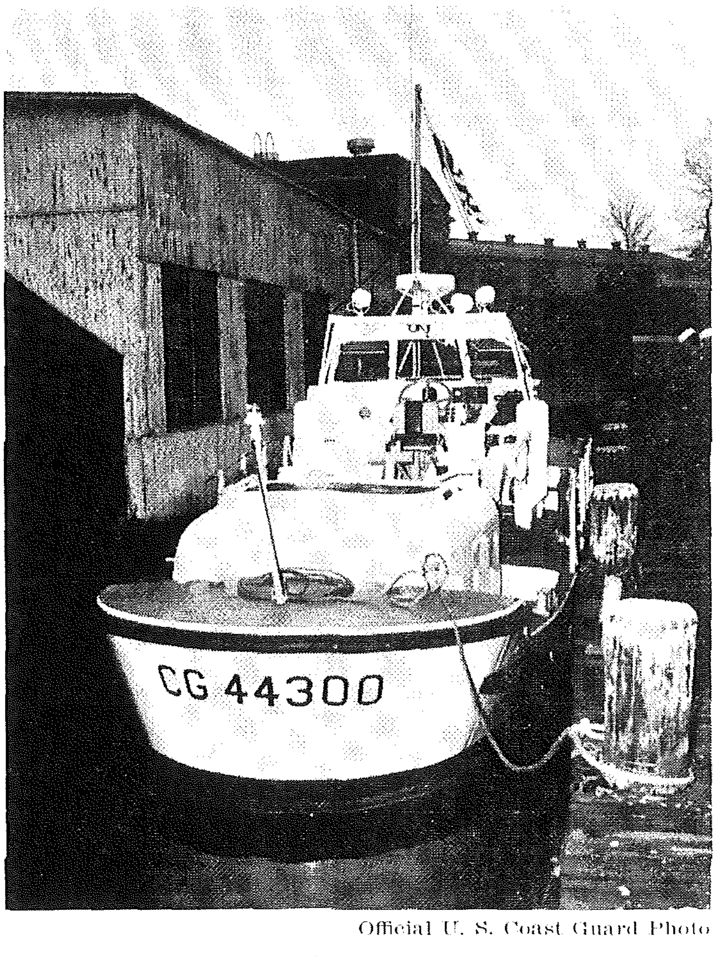

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Figure 12.

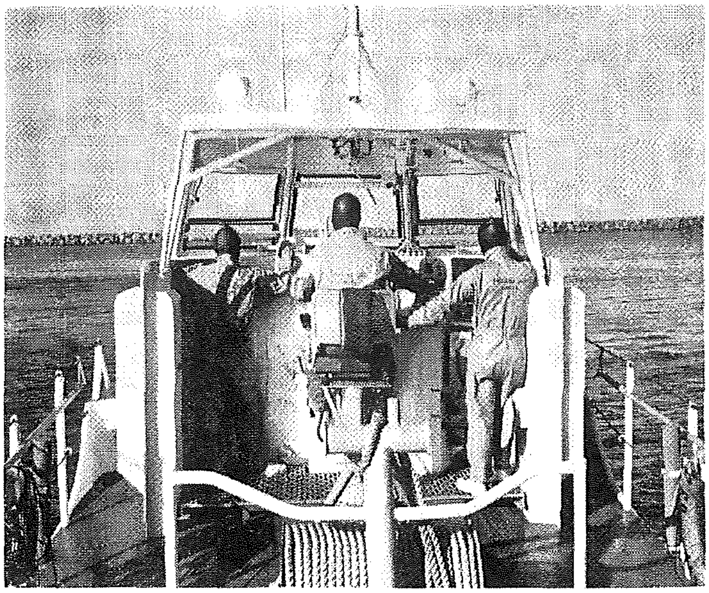

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Figure 11.

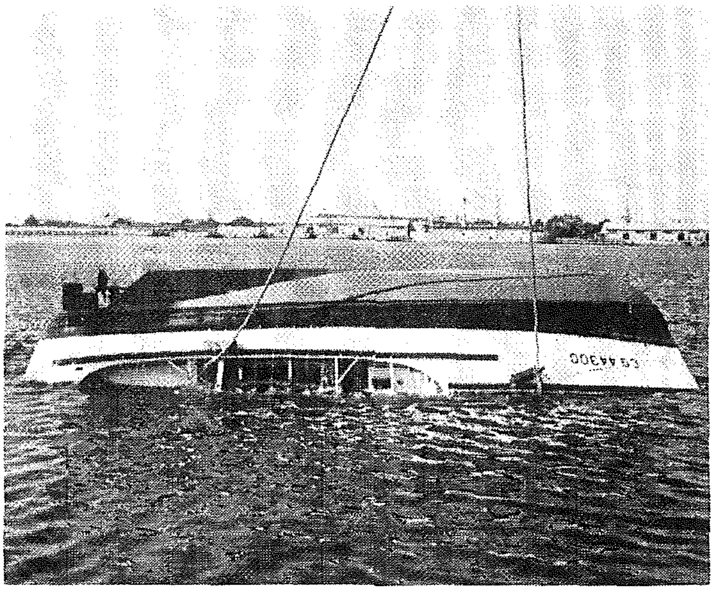

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Figure 13.

Certain modifications of control station, towing and deck arrangements, and engine room layout resulting from preliminary evaluation trials were incorporated prior to placing the boat in service. Approximately one year had elapsed from the start of construction of CG-44300, but confirmation of design adequacy and resolution of construction and operating difficulties enabled the commencement of a 25-boat production program without being concerned with concurrent developmental changes in basic design and arrangement.

In this construction program underway at the Coast Guard YARD, Curtis Bay, Maryland, production cost is about $115,000 per boat with a six-month delivery time.

Upon delivery of the CG-44300 to a lifeboat station crew, a cruise schedule was established for visits to varied operational areas and stations extending along the East Coast of the United

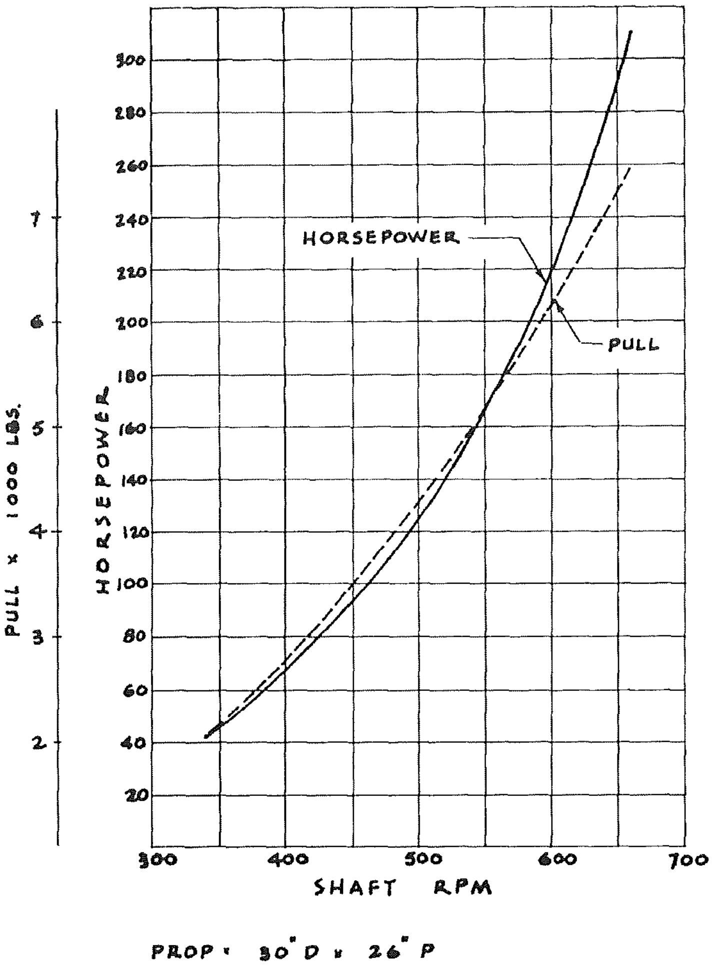

Figure 14. Bollard Pull. CG 44300.

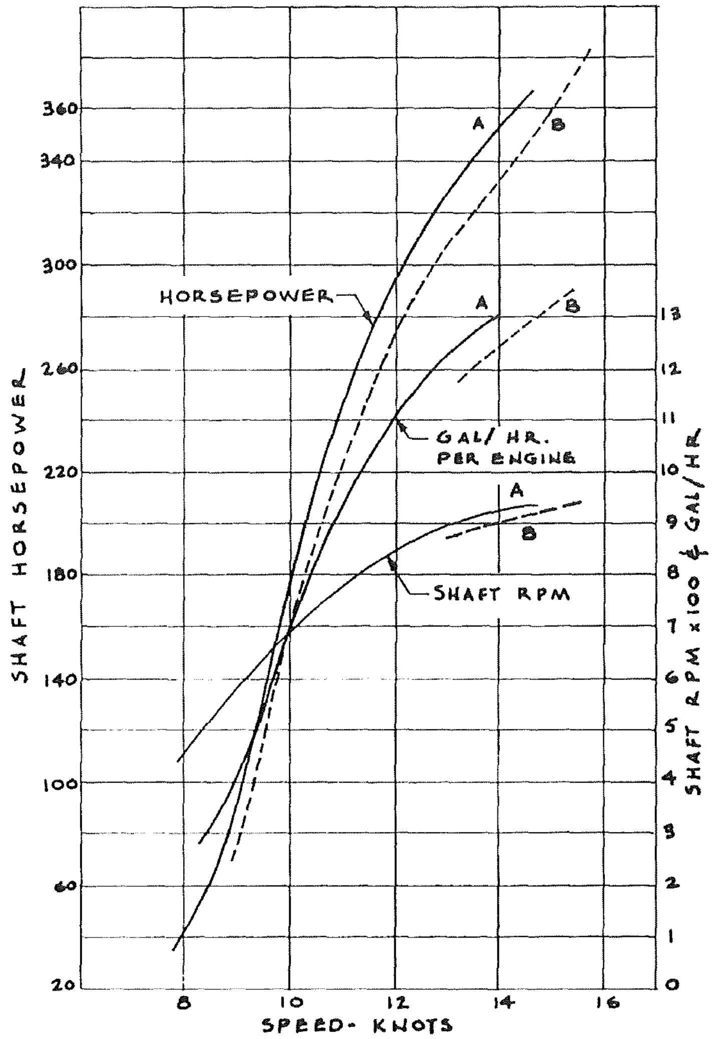

Figure 15. Performance Tests. CG 44300. Data: Curve B—Fins Installed; Displacement—35360 Lbs.; Prop.—30"D x 26"P; Red. Ratio—2.91:1.

States from Hatteras Inlet northward to the Maine coast. Maximum practicable operational evaluation and observation was then made by this crew and other personnel concerned with lifeboat operations. As a continuation of the extensive evaluations conducted along the East Coast, the boat was cruised along the Pacific Northwest Coast to Yaquina Bay, Oregon, for final rough water evaluation in the heavy breaking surf conditions peculiar to that area. Boat performance was outstanding in all types of seas from large ground swells offshore to strong ebb chop, moderate breaking seas and large extremely dangerous seas on the bar and reefs.

During this extended and exhaustive evaluation period the CG-44300 was cruised approximately 3,000 miles at an average speed of 11.1 knots with an overall fuel rate of 20.4 gallons per hour.

Concluding the construction-evaluation project in the development of the 44 foot Motor Lifeboat, the most outstanding features are:

1. Strong rudder action and power steering enabling maneuvers with great rapidity within a small area.

2. Exceptional hull design which enables the boat to negotiate large breaking seas and run into large seas without excessive pounding, and which gives a ride practically free from roll and pitch.

3. Quick acceleration enabling the operator to better position the boat in large seas.

4. Crew comfort and safety afforded by seakindliness, livability, berthing, padded interiors, and adequate compartment heat.

5. Helmsman shelter consisting of covered helm station, adjustable seat with safety belt, truck-type steering wheel, one-hand engine control, and instrument location.

6. Towing bitt and hawser arrangement enabling one man to work the towline hookup; the location of the towing bitt which allows the boat to pivot under the hawser while towing under a strain.

7. Hull construction and corrosion protection system.

The all-weather capabilities evidenced throughout this comprehensive development project are considered to rank the United States Coast Guard 44 foot Motor Lifeboat as one of the finest rescue craft of its type in the world.