Coast Guard Cutter Design, 1941–1990

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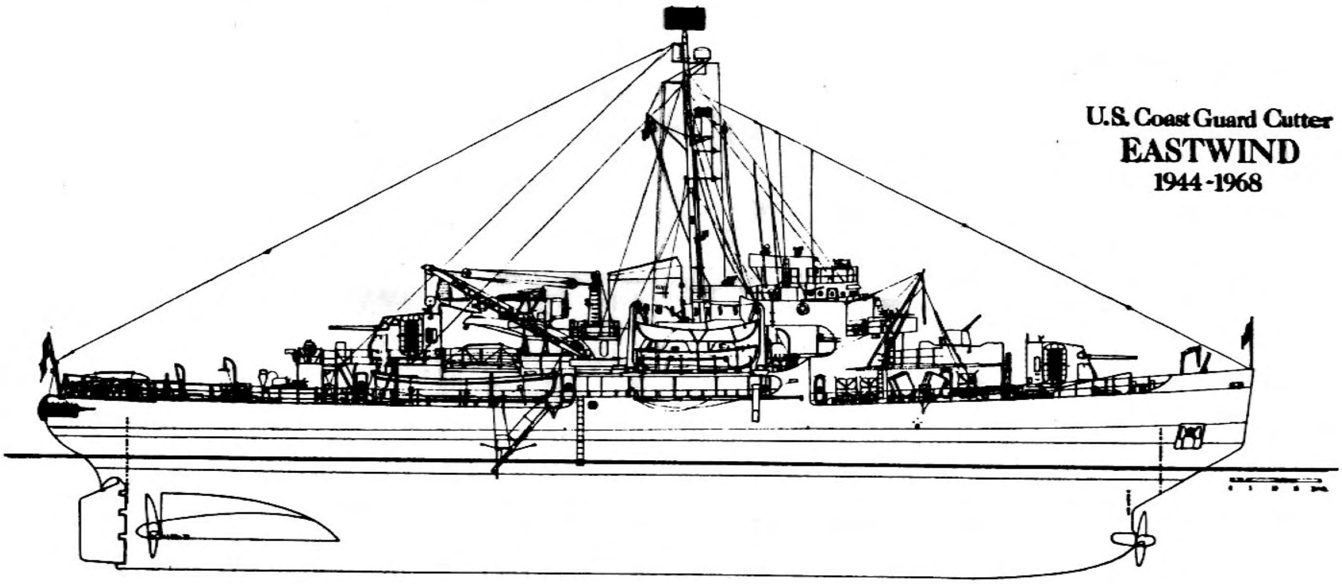


In 1940, the principal duties of the United States Coast Guard were listed as follows: Providing safety and security at sea through enforcement of the nation's navigation laws, saving life and giving assistance to vessels in distress, maintenance of aids to navigation, and icebreaking in domestic waters. In addition, the Coast Guard was a military force, intended to serve under the Navy Department in time of war or national emergency. To perform these duties, the service had a fleet of seagoing cutters, patrol boats, buoy tenders, lifeboats, and other small craft, of which the largest were the seven 20-knot, 327-foot cutters built in 1935–1937, ten 16-knot 250-footers completed in 1928–1930, four 15-knot, 240-foot ships commissioned in 1921 and 1922, and six 13.5-knot, 165-footers launched in 1932 and 1934. All were powered by steam, with geared turbines in the 327-footers and the 165-footers, and turbo-electric drive in the older ships.

According to Frederick A. Hunnewell, the Coast Guard's chief constructor at the time, ". . . under a basic requirement for reliability the major technical characteristics of a Coast Guard cutter can well be given the following sequence of priority: Seaworthiness, speed, cruising radius, deck equipment for assistance work and accommodations." While one might question the second priority, considering the moderate speeds of the last three classes, most of the cutters designed during the next generation would generally fit this pattern.

The Coast Guard's fleet suffered a serious diminution during the spring of 1941, when the ten 250-foot cutters were transferred to Britain by Lend-Lease. To replace these ships and three older, smaller vessels, Congress authorized the construction of 13 cutters "of the usual Coast Guard type . . . of heavy construction to permit of working in waters where ice may be encountered." The latter requirement ruled out repeat 327-footers--the CAMPBELL and the DUANE of that class had sustained critical screw damage in the ice off Greenland in 1940, and shorter vessels were thought to be handier when maneuvering among ice floes.

The new design owed little to the 327-foot cutters. It was instead a further development of the very successful 250-foot type, which had been based on the 240-footers of 1921. Unlike those ships, however, the new Owasco class cutters were strengthened for operation in the ice and their engineering plants were designed to obviate difficulty caused by ice or slush in condensers and sea chests. The use of welding made a unique hull design possible--the upper and lower chords of the girder had longitudinal framing, while transverse side framing enabled the decks to be utilized to provide additional strength to counter ice pressure.

While the two latest classes of prewar cutters were powered by geared turbines, the new ships reverted to the synchronous turbo-electric drive, which in the 250-footers had proven economical and reliable. Two Foster-Wheeler two-drum D-Type boilers, automatically controlled, top-fired with single burners, supplied steam to drive the impulse-reaction turbine directly connected to the 2,400 volt 5,400 rpm generator. The main propulsion motor had a continuous power rating of 4,000 shp at 180 rpm. This engineering plant was unusual in two respects: Boilers, main engine and motor, condenser, and auxiliaries were in a single compartment, and it incorporated pilot house control, which had proven dependable and popular in recent diesel-electric installations.

Because these 255-foot cutters were intended to work in waters where ice might inhibit speed and maneuverability, they originally mounted an extremely heavy armament: Four 5-inch 38-caliber dual-purpose guns in two twin mounts, two quadruple 40-millimeters, four 20-millimeters, a hedgehog ahead-throwing antisubmarine weapon, six K-guns, and two depth-charge tacks. None of them could be laid down before 1943, however, so they were not completed in time for World War II service; thus, their batteries were soon reduced to a single 5-inch gun and fewer small weapons.

The lead ship vibrated badly while running trials with a three-bladed screw. Substitution of a five-bladed screw alleviated this problem, but the pilot house control feature was less satisfactory; unless the switchboard was properly maintained and adjusted--difficult to assure in the immediate postwar period, when personnel changes were frequent--the motor would not pull into synchronization when going from ahead to astern. Hence, most of these ships operated with engine room control, using the pilot house control only as an annunciator.

All of the Owasco class cutters, the last steam-propelled ships designed for the Coast Guard, were retired from service after the ocean station program was discontinued in the mid-1970s.

The first buoy tenders designed for the Coast Guard, to which the former Lighthouse Service had been transferred in 1939, were the 180-foot Cactus class vessels. Earlier tenders had usually been designed for service in a specific area, but the JUNIPER, the last tender laid down by the Lighthouse Service, was intended to be the prototype for a class of oceangoing tenders. She was 177 feet long and embodied the characteristics considered the most desirable in a tender: Shallow draft--less than 9 feet--twin screws, for maneuverability; diesel-electric propulsion for quick response when in close proximity to the navigational hazard often marked by buoys; relatively low freeboard for ease in handling buoys; and a turtleback forecastle to insure visibility close aboard.

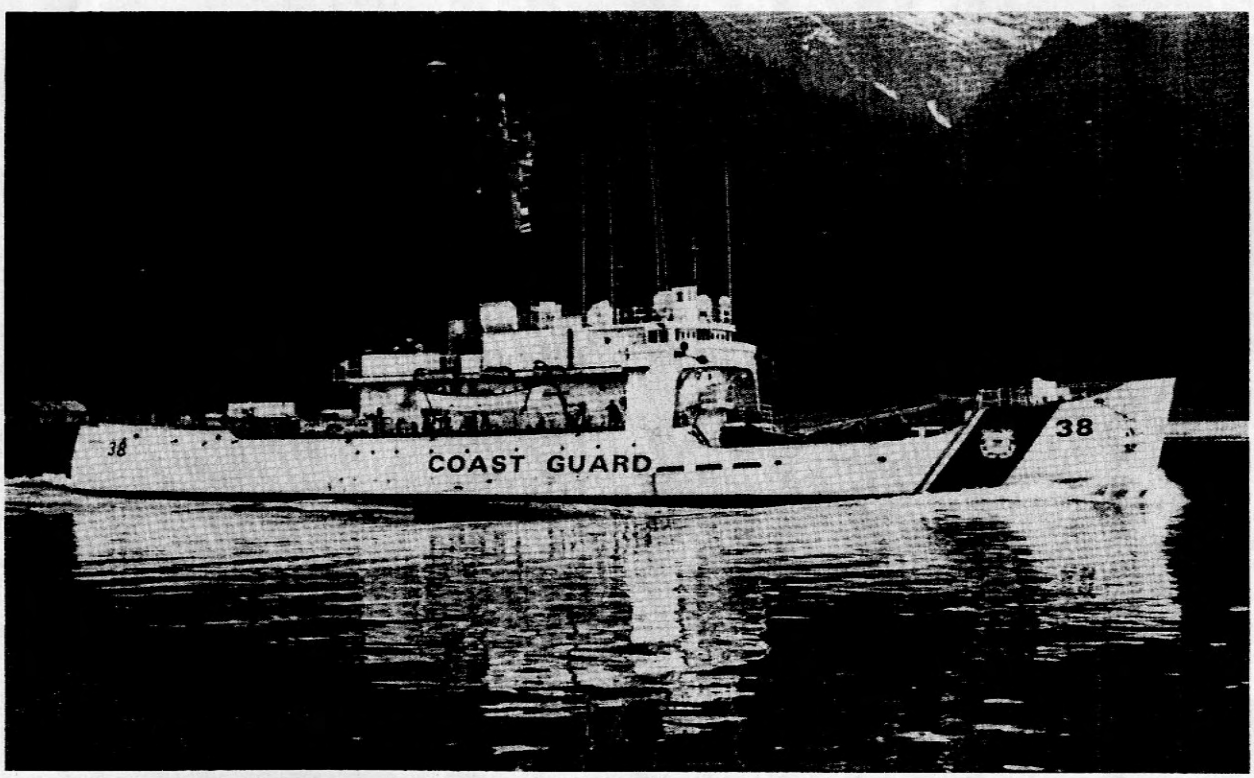
The Coast Guard, however, required that its cutters be capable of undertaking a variety of mission, so the 180-footers retained little more than the diesel-electric drive of the JUNIPER. Higher forecastle and freeboard enhanced their ability to conduct search and rescue missions, and all had icebreaker hulls with cutaway forefoot, 12-foot draft, and a single screw, the last to minimize the danger of ice damage. Indeed, the Cactus class hull was a further development of the very successful 110-foot Raritan class icebreaking tugs of 1939. Thirty-nine tenders were built to this design--nine of them had hulls further strengthened for icebreaking. They were divided into A, B, and C classes, the principal difference being that ships of the later classes had 1,200 shp--the A class had 1,000 shp--and double topping lifts on their 20-ton booms to provide greater control than the single topping lift with manual vangs of the A class boom.

Unlike the 255-foot cutter, the 180-foot tenders were completed during World War II, the first in September 1942 and the last two years later. Predictably, the former Lighthouse Service personnel criticized these vessels for their departures from the JUNIPER design, but within a few years the Cactus class had established a reputation as the mainstay of the aids to navigation force and as the most versatile of the Coast Guard's cutters. Perhaps the strongest evidence of the design's success is the Service Life Extension Program (SLEP) begun in 1979, under which 180-footers would be re-engined and otherwise extensively renovated to extend their "lives" for another 10 to 15 years.

As Greenland's strategic importance to the United States became more apparent in 1940 and 1941, the requirement for a supply vessel with icebreaking capability led to the construction of the 230-foot STORIS, a larger version of the 180-footers with a 1,800 shp diesel-electric plant. Like her smaller near-sisters, the STORIS proved very successful in a variety of roles; now classed a medium endurance cutter, she too will probably serve past her 50th birthday.

None of these vessels was an icebreaker per se. The first of these were the Wind class, built by presidential order in 1942-1944. While the Coast Guard had the benefit of experience with its own icebreaking tugs and its constructors and engineers had surveyed the large Russian icebreaker KRASSIN, completed in 1917, the most important influence on the Wind class design seems to have been the Swedish YMER of 1932, the first large icebreaker with diesel-electric propulsion. Rear Admiral Harvey F. Johnson, the Coast Guard engineer in chief, wrote later that the YMER embodied the two characteristics thought most important: The installation of considerable power in a relatively short ship, and a 2:1 power displacement ratio. Although the Wind class vessels would be slightly larger, more heavily constructed, and more powerful, the principal difference between them and the Swedish ship would be that of draft--the latter, intended to work in the shallow waters of the Baltic Sea, drew 21 feet at normal displacement, while the Wind class drew 8 feet more.

Even at that draft, the designers could not provide a single screw capable of utilizing the desired 10,000 shp, so the YMER's screw arrangement was adopted as well. Two 17-foot cast steel propellers were located well



USCGC STORIS. (Official Coast Guard photo.)

inboard--their tips cleared the skeg by only 9 inches--to minimize the danger of ice damage. The propulsion machinery consisted of six 2,000 hp Fairbanks Morse diesel engines, each directly connected to a generator producing 900 volts at 810 rpm. These drove the main motors, each rated at a maximum of 5,000 shp. The YMER, built for use in Baltic Sea ice of fairly uniform thickness, also had a bow propeller that was useful in sucking water from under the ice, making it easier to break, and in dispersing the broken ice; when the bow screw was reversed, it threw water ahead of the ship, clearing the ice surface of snow that might cushion the bow effect. Reports that ice similar to that of the Baltic was found in West Greenland fjords during some seasons of the year led to the inclusion of the bow propeller in the Wind class ships; when it was in use, each of the propulsion motors developed 3,300 shp.

Like the YMER, the Wind class had the ability to induce a rolling motion to help free themselves when fast in the ice. This was done by heeling tanks and pumps capable of shifting 220 tons of ballast water rapidly from one side to the other, causing the ship to roll 10^{o} in 90 seconds. Longitudinal trim could be altered by transferring water ballast between forward and after peak tanks, which helped to obtain the most advantageous bow angle for icebreaking and to lessen the draft forward to facilitate backing off the ice. Heeling and peak tanks might also be used for fuel stowage, increasing the already extensive endurance.

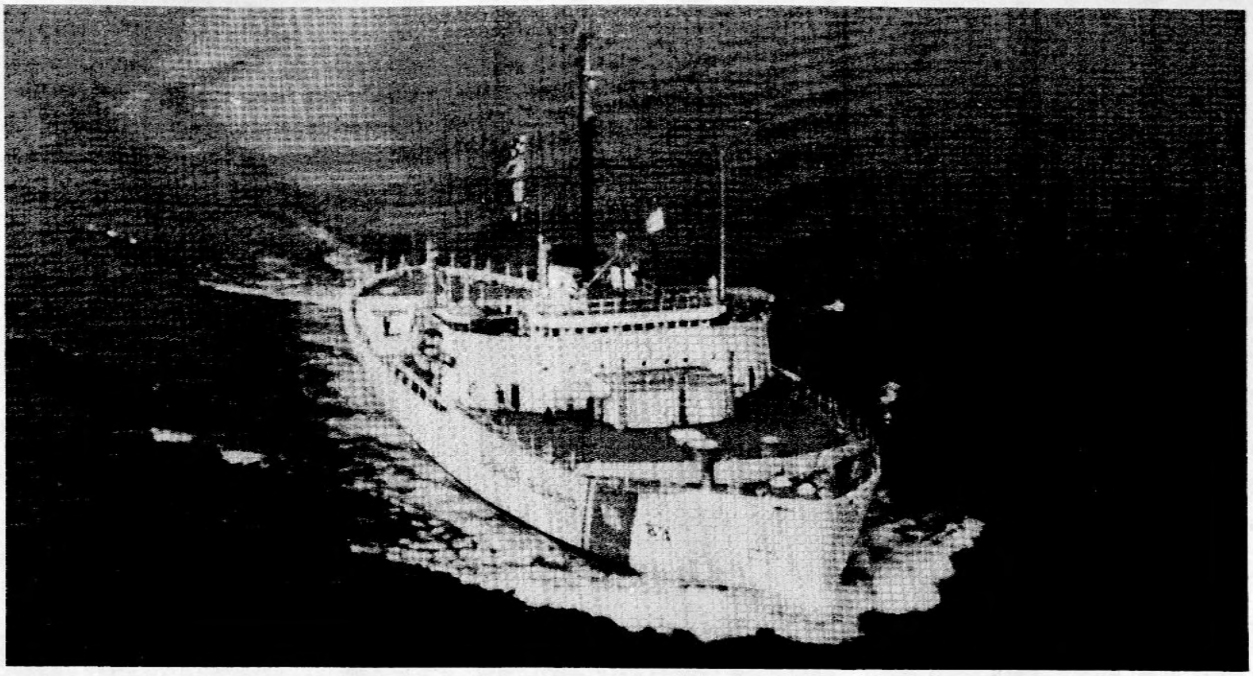
To obtain the necessary hull strength, the designers utilized very heavy scantlings and frames spaced 16 inches apart, the minimum distance consistent with access for construction and maintenance. An inner skin protected machinery spaces from flooding due to ice, collision, or grounding damage; this plating was employed as the inner chord of a truss, connected to shell frames by diagonal struts, thus providing transverse framing of unusual strength, Primarily because of its high yield strength, high tensile steel was chosen for the shell plating, which had a maximum thickness of 1.6 inches.

As completed, the first Wind class icebreakers mounted an extremely heavy armament, similar to that of the 255-foot cutters, and they carried a seaplane as well. When their armament was reduced drastically after the war, they received helicopter decks and hangars, an important acquisition because helicopter crews could identify leads that facilitated the vessels' passage through pack ice.

The first of the Wind class icebreakers was transferred to the Soviet Union by Lend-Lease when completed in 1944; her three sisters were commissioned in the Coast Guard, but two of them were also lent to Russia in 1945. In return, the Coast Guard received one of the three Wind class ships laid down for the U.S. Navy in 1944. When the Russians returned the three earlier icebreakers in 1950 and 1951, the Navy kept two and assigned one to the Coast Guard.

In service, the Wind class vessels proved remarkably successful, considering that they were the first large ocean icebreakers designed and built in the United States. Together with the Navy's GLACIER, a larger and more powerful development of the Wind class design completed in 1955, they supported the nation's extensive postwar polar programs for 30 years and more. To be sure, there were problems: The bow propeller proved to be ineffective in the heavy floe and ridge ice encountered in the Arctic, and so vulnerable to ice damage that it was removed early from all and the bow tube capped. The after screws sustained frequent ice damage as well until they were replaced by steel alloy propellers developed during construction of the Distant Early Warning (Dewline) radar stations. The WESTWIND, one of two ships that served into the 1980s, was extensively damaged by pack ice in 1984 when she was sent into an Antarctic ice shelf; she and the NORTHWIND were decommissioned in 1989.

In order to extend the shipping season on the Great Lakes during World War II, the MACKINAW, a variant of the Wind class, was built at Toledo, Ohio, in 1943-1944. Her major differences from the ocean icebreakers were in hull design and material, and armament, of which the MACKINAW had none--she had the same bridge-controlled diesel-electric propulsion machinery with twin screws and a bow propeller. Her hull dimensions were determined by conditions on the Great Lakes--drydock facilities and the depth of water in the channels of major harbors and over canal lock



USCGC MACKINAW, Great Lakes Icebreaker. (Official Coast Guard photo.)

sills limited her draft to 19 feet. Channel widths precluded much maneuvering and the icebreaker would not have to negotiate leads through ice fields; so additional length was unobjectionable, while her beam had to be adequate to open a passage wider than the beamiest lake freighter. Thus, the MACKINAW was longer and wider than her oceangoing near-sisters, but she drew less water. Because she would encounter only new ice with none of the pressure ridges that posed such a challenge to polar icebreakers, the MACKINAW's shell plating was mild steel.

Like the Wind class vessels, the MACKINAW proved to be a valuable asset to the Coast Guard. Indeed, she outlived them all, and in 1990 she is being considered for a major refit to extend her service life.

Following World War II, many of the Coast Guard's older cutters were decommissioned and replaced by surplus naval vessels, of which salvage ships and fleet tugs were perhaps the most useful--three units of each type remained in commission in 1990. The 327-and 255-foot cutters were too few to man the ocean stations necessitated by transatlantic and transpacific air travel, so eighteen of the Navy's small seaplane tenders were transferred from the "mothball fleet"--as 311-foot cutters, they served until the ocean stations were discontinued in the 1970s.

When the Korean War necessitated harbor entrance patrols to examine Eastern Bloc ships seeking to enter American ports, Coast Guard constructors prepared the design for a steel 95-footer with diesel engines driving twin screws. The circumstances under which these "seagoing patrol cutters" were designed led to emphasis on antisubmarine and surface weapons, although the armament was reduced considerably in later units, which had better search and rescue capability. Thirty-six 95-footers were built, the first entering service in 1953. All were named for North American capes in 1964. The last of these cutters were decommissioned in early 1990 due to hull failures and the difficulty of maintaining their main engines.

Construction of the 95-footers was halted in 1959 in favor of an 82-foot patrol boat with steel hull and aluminum superstructure, which emphasized seagoing qualities and economy of manning--eight men instead of the 15 required to man a 95-footer. The smaller vessels also had twin screws--the earlier units were powered by two 600 hp diesel engines, while their later sisters had two 800 hp diesels. In service, the 82-footers proved their ability in rough water; an early patrol report concluded: "These boats are well built and could probably weather almost anything." The 82-footers were given geographical "Point" names in 1964. Twenty-six of these patrol boats were chosen for service with the "Market Time" naval interdiction campaign during the war in Vietnam. All were transferred to South Vietnam later as part of the "Vietnamization" of the war effort. No less than seventy-nine 82-footers were built by the time construction ended in 1970; a program to replace the main engines of the 53 remaining in Coast Guard service was begun in 1989.

Construction of the Coast Guard's standard motor lifeboat, the 36-footer, was continued after World War II, but by 1960 many of these craft required replacement. A survey of veteran lifeboat station personnel indicated dissatisfaction with the 36-footer's low speed, lack of towing capability, and poor steering station visibility. None of these deficiencies could be remedied easily, so a new design was prepared.

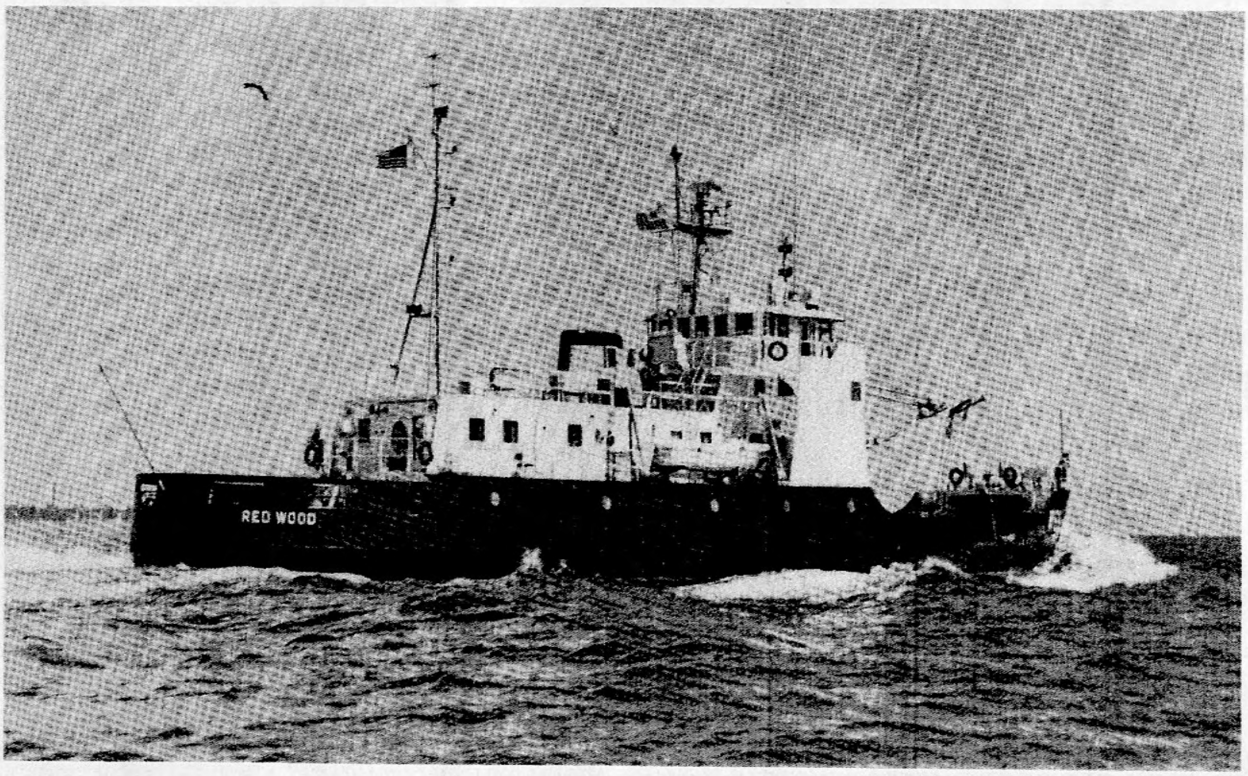
Following extensive model tests, the prototype 44-foot motor lifeboat, the CG 44300, was built in 1962. Self-bailing and self-righting, she had diesel engines driving twin screws to provide a maximum speed of 15 knots, twin rudders with power-assisted steering, an elevated steering station amidships, and a better location for the towing bitts. The welded steel hull, divided into seven watertight compartments, had both longitudinal and transverse framing and was sufficiently strong for working in ice, while a double bottom forward provided protection against grounding. The port engine drove a fire and salvage pump, while the starboard engine provided power for the hydraulic steering system.

The 44300 was subjected to rigorous operational testing on both Atlantic and Pacific coasts, and her performance was reported to be "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 [Yaquina Bay, Oregon] bar and reefs." Design of the first postwar cutters proceeded simultaneously with that of the motor lifeboats. Intended to replace the 125-foot and 165-foot class B vessels that were nearing the end of their useful lives, the new ships were superior in most regards, designed to carry out search and rescue missions 500 miles off the coast and having 5,000 miles endurance at 15 knots. The inclusion of a helicopter deck required a waterline length of 200 feet and resulted in a design quite unlike earlier cutters. A high forecastle, that would help to keep the decks dry in heavy weather, extended seven-eighths of the vessel's length, its after portion forming the helicopter deck. A large, high superstructure incorporated the bridge, cabin, electronic spaces, and a helicopter workshop aft. The engine exhaust ducts led through the transom stern to avoid the turbulence of stack gas above the helicopter deck and to minimize corrosion of topside electronic gear. A single 3-inch 50-caliber gun constituted the armament, although the design provided space for antisubmarine weapons and sonar in wartime.

The first five of these Reliance class 210-footers had two controllable pitch screws, each powered by a 1,500 hp Cooper-Bessemer diesel and a 1,000 hp Solar Saturn gas turbine, which could be used singularly or in combination. While this combined diesel and gas turbine (CODAG) drive had been used in Europe, these cutters were the first American ships with it. The gas turbines had been tested in the 82-foot POINT THATCHER--she was nearly lost when both engines were swamped by salt water entering their air intakes during operation off Miami Beach, Florida, in the aftermath of a 1966 hurricane. By that time, however, it was clear that the gas turbines were suitable for marine use and that they could be operated and maintained by Coast Guard personnel.

Initial reports on the RELIANCE and her first few sisters were quite favorable--their habitability set a new standard for the Coast Guard, and twin rudders made them very maneuverable. All reached their designed 18 knots with ease, but paralleling engines having such different torque/speed characteristics as diesels and gas turbines presented unanticipated problems. In addition, the engine spaces were quite crowded. Only the first five 210-footers were completed with that propulsion system, and their gas turbines were removed during the 1970s. Subsequent vessels were powered by two 2,500 hp Alco diesel engines, which were somewhat heavier but more compact and less expensive. Although 29 of these cutters were planned

USCGC RELIANCE (Reliance class). (Official Coast Guard photo.)



USCGC RED WOOD, Buoy Tender. (Official Coast Guard photo.)

originally, only 16 were built. The last, the ALERT, was commissioned in 1969.

Beginning in 1984, these ships underwent major maintenance availability, during which the five former CODAG units were re-engined with 2,500 hp Alco diesels and the engine exhausts of all were trunked into rectangular stacks just above the bridge. The long, saltwater cooled, horizontal exhaust ducts and their expansion joints have proved very expensive to maintain. Air tunnel model tests indicated the optimum stack height to reduce stack gas problems at deck level. Ballast was added to improve stability and trim and to provide an adequate service life margin.

Construction of the first postwar buoy tenders began in 1963. With a maximum draft of 7 feet, low freeboard, and diesel engines turning twin controllable-pitch propellers, these 157-footers represented a return to the Lighthouse Service idea. Nonetheless, their hulls were strengthened for light icebreaking as well. To facilitate servicing aids to navigation, steering and engine controls were located in both bridge wings as well as in the unusually high pilot house. The sail area of the latter and the shallow draft made these vessels very leewardly, a tendency alleviated in part by a bow thruster. Five ships of this "Red class" were built; the first, the RED WOOD, entered service in 1964, and the last, the RED OAK, was completed in 1971.

On 1 January 1966, the Coast Guard adopted a new classification system for its cruising vessels, describing the larger units as high endurance cutters (WHEC) and the 210-footers and older class B ships as medium endurance cutters (WMEC). No high endurance cutters had been built since the 255-footers, but the first ships of a new class were under construction when the new classifications went into effect.

Intended for a multiplicity of duties--mid-ocean search and rescue, law enforcement, manning ocean stations, and oceanographic research, the Hamilton class cutters were 378 feet long overall and had a cruising range of 12,000 miles at 20 knots. Flush-decked, with sharply raked bow and transom stern, the design featured an elongated aluminum superstructure, the after 80 feet of which formed the helicopter deck. Twin side-by-side stacks were located immediately forward of this "flight deck," with an aerological balloon shelter--sometimes erroneously described as a helicopter hanger--between them. Military readiness was attested by the armament: A 5-inch 38-caliber dual purpose gun, two 81-mm mortars, two 50-caliber machine guns, two Mark 10 hedgehogs, two Mark 32 triple antisubmarine torpedo tubes, a Mark 56 fire control system, sonar, and electronics countermeasures gear. In keeping with the ship's endurance, habitability features had an important priority.

Two 3,500 shp Fairbanks-Morse diesel engines drove twin controllable-pitch propellers for speeds up to 20 knots; above that, the diesels were clutched out and two 18,000 shp Pratt and Whitney FT-4 gas turbines provided "burst" speed of 29 knots. Unlike the CODAG drive of the early 210-footers, this combined diesel or gas (CODOG) system proved quite satisfactory, although the reduction gears (manufactured by Philadelphia Gear) of the lead ship, the HAMILTON, had chronic alignment problems. The Western Gear reduction gears of the eight later ships of the class were much more successful, as were those of the three cutters of the Hero class. The latter differed from the earlier 378-footers principally in having synchro-self-shifting clutches and a main propulsion control console system of later design. All were fitted with a retractable 350 hp diesel bow propulsion unit that provided maneuverability for precise station-keeping when making oceanographic soundings; it was very useful in docking as well.

The Coast Guard initially planned to replace all of its high endurance cutters with 378-footers, 36 of which were to be built. The termination of the ocean station program and the unexpected longevity of the old 327-footers, however, limited the number of larger ships to 12, the last of which, the MIDGETT, was completed in 1972.

Beginning in 1986, cutters of the Hamilton Hero class underwent Fleet Rehabilitation and Modernization (FRAM), which included reconfiguration of crew's quarters to accommodate ship's companies composed of both sexes, remanufacture of main diesel engines, overhaul of gas turbines and auxiliary machinery, installation of Hero-type control

USCGC HAMILTON (Hamilton class). (Official Coast Guard photo.)

consoles and clutches, and the installation of a telescoping helicopter hangar. The last enabled the vessels to embark the Navy's LAMPS antisubmarine helicopter. The 01 level deckhouse was extended forward to accommodate the Mark 75 76-mm gun that replaced the old 5-inch mount, and the Mark 92 fire control system was installed. A Phalanx Mark 15 close in weapon system and two Harpoon missile launchers were to be added upon completion of the FRAM program; two ships were so fitted in 1990.

In 1965, Coast Guard and Navy agreed that the former should take over the Navy's four aging Wind class icebreakers and the newer, larger GLACIER to become the nation's sole icebreaking service. An icebreaker rehabilitation program extended the service lives of five of the Wind class vessels by a few years, while the NORTHWIND and the WESTWIND were re-engined and fitted with bows of Captain Roderick White's design (described below) in 1973-75. Nonetheless, new icebreakers were obviously needed.

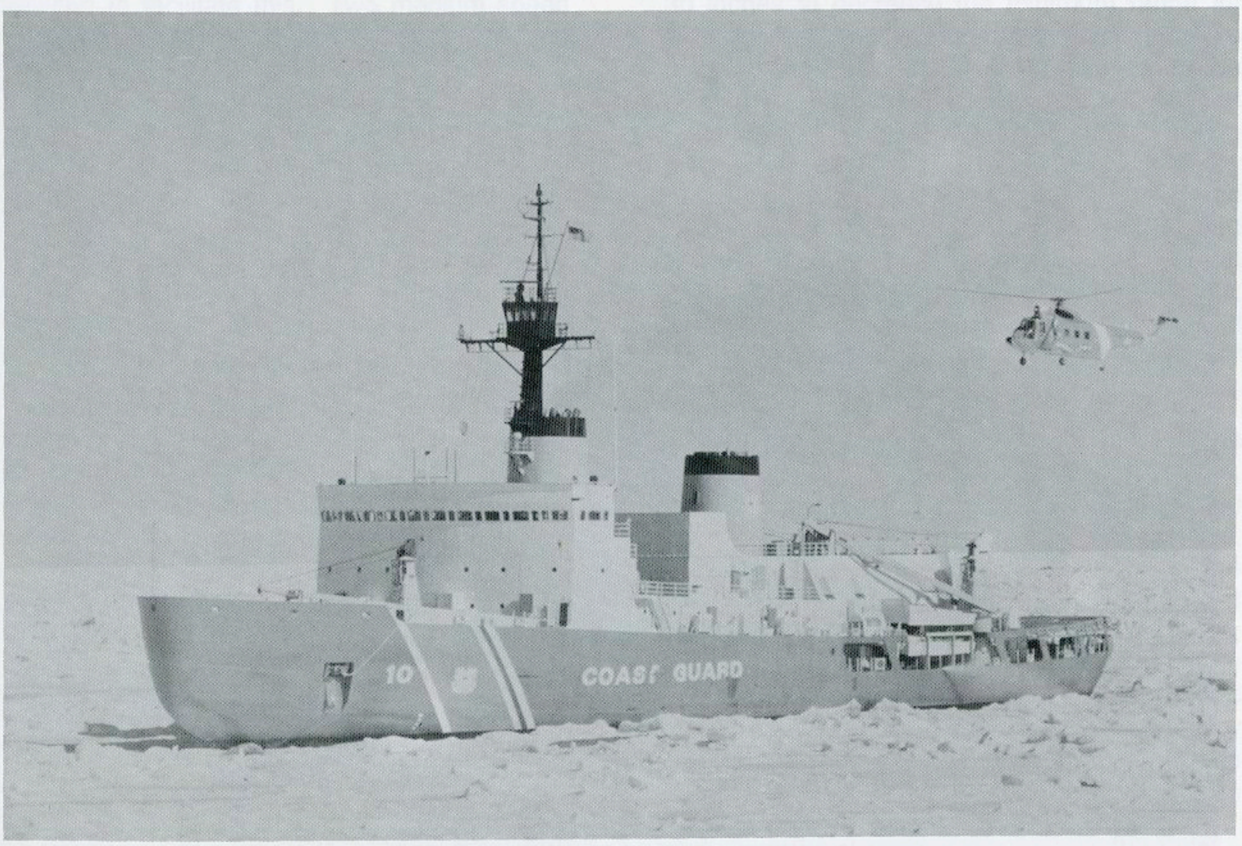
The first of these, the POLAR STAR, was begun in 1972, after extensive model tests with a variety of hull forms. The bow design, adapted from that developed by Captain White and first used in the tankship MANHATTAN during her historic transit of the Northwest Passage in 1969, was the most noticeable departure from the Wind class. Whereas the latter's bow struck the ice at nearly a 45° angle, the "White" bow eased onto it at 15°, allowing more of the ship's weight to ride up on the ice to break it in shear. At 399 feet overall, the new ship was a good deal larger than her predecessors, to accommodate two helicopters and their hangar as well as the laboratories necessary for the variety of scientific missions she would undertake.

The Polar class had triple screw aft, each driven by a diesel-electric unit comprising two 3,000 shp diesel engines driving generators that provided current for the 5,000 shp main propulsion motor. For surge power when breaking heavy ice, Pratt and Whitney FT-4 gas turbines developed 20,000 hp on each shaft took the place of the diesel-electric drive, although mixed-plant operation such as diesel-electric on the wing shafts and turbine on the center shaft would prove to be successful in less severe ice conditions.

The gas turbines required the use of controllable-pitch propellers, the first ever fitted to an icebreaker. On the POLAR STAR's first icebreaking mission, to the Chukchi Sea in 1976, both wing shafts malfunctioned, and she limped back to Seattle on the center screw. When the propellers were removed, it became apparent that the pitch-changing mechanism in the hubs had almost literally been destroyed. Damage to the center propeller was less serious, presumably because of its relatively sheltered location. The three screws, which had been manufactured in Pennsylvania under license from the West German designer, were returned to the factory for redesign and rebuilding, to make the mechanisms as strong as possible.

More than a year later, the POLAR STAR went to Antarctica, where she demonstrated superior icebreaking capability--until monitoring instruments indicated contamination of the hydraulic fluid in the propeller-pitch mechanism and pitch-changing became increasingly sluggish. Again, the big icebreaker had to return to Seattle before her mission had been completed. There, she joined her slightly younger sister, the POLAR SEA, whose strengthened screws had developed similar symptoms while breaking ice in the Bering Sea. Ultimately the problem was solved by having two sets of propellers for each of the two Polar class vessels. These were changed periodically, those that were removed being rebuilt and then returned to use during the next dry-docking.

The superiority of the Polar class icebreakers is evident. Since 1989, when the last of the Wind class vessels were decommissioned, they have been the nation's only polar icebreakers. Despite their size, extensive use of automation



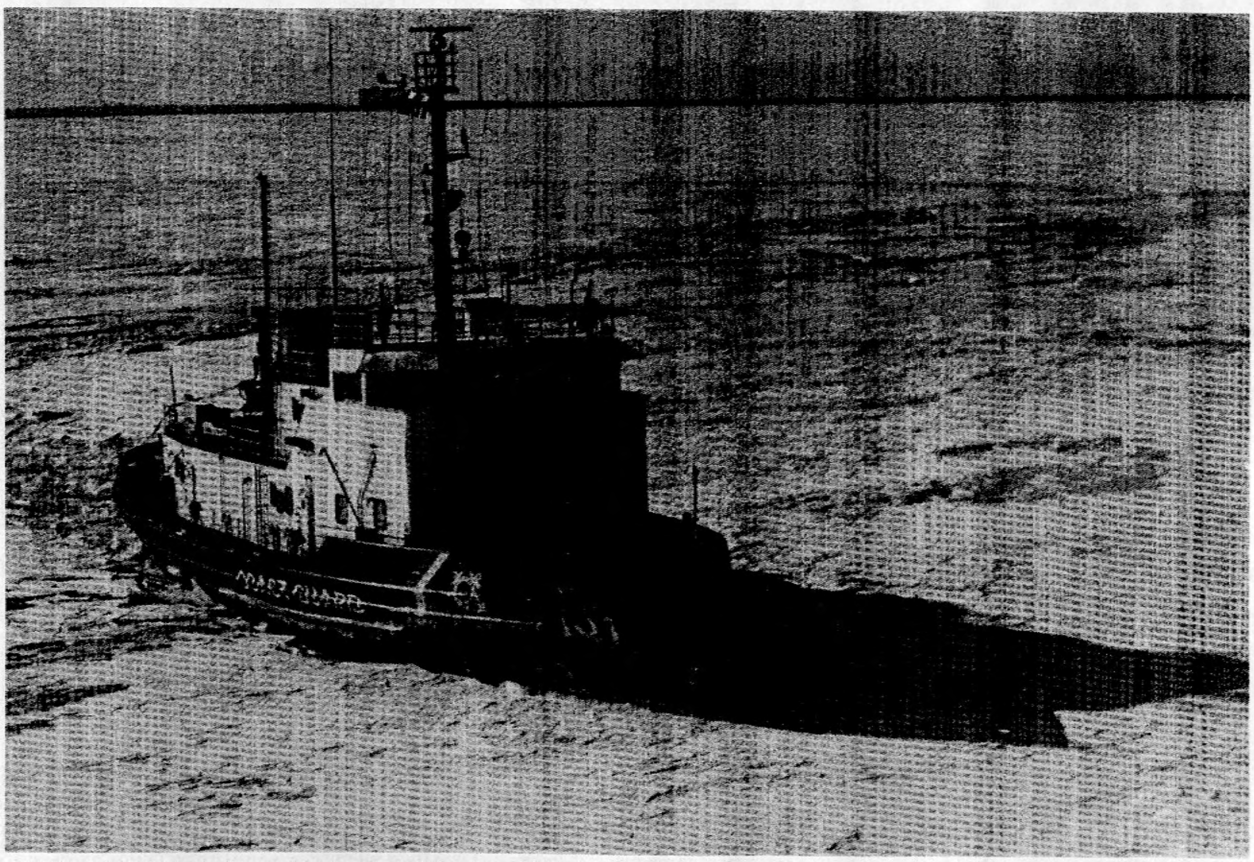
USCGC POLAR STAR (Polar class). (Official Coast Guard photo.)

permits their operation by smaller crews than the Wind class required--although manning on a minimum scale necessitated the establishment of an Icebreaker Support Facility at Seattle, home port for both ships.

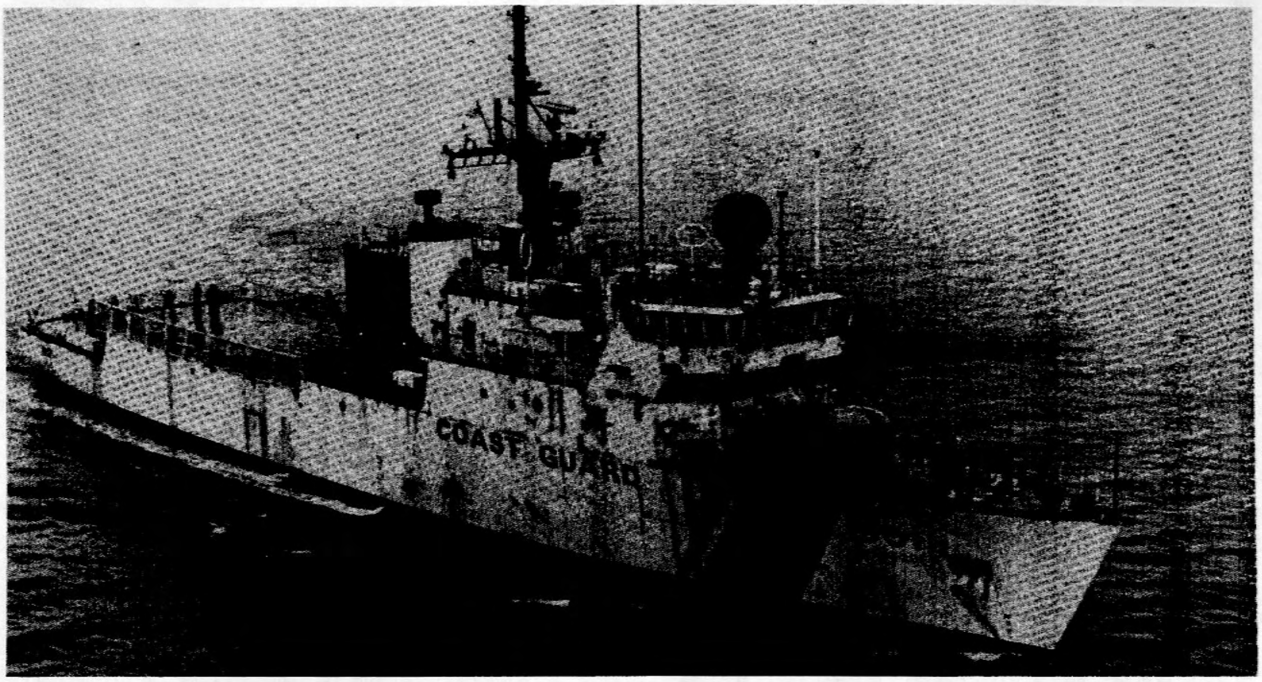
The 110-foot tugs of prewar design, that had proven so useful for breaking ice in domestic waters, also required replacement. As usual, the ships built to assume their duties were more capable, and larger--the Bay class icebreaking tugs are 140-feet long--and with two Faibanks-Morse diesels driving the generators to provide current for the 2,500 hp Westinghouse motor turning the single shaft, more than twice as powerful. Their top speed is 14.7 knots, but they can attain 12 knots with only one engine and generator, so except for heavy icebreaking and search and rescue missions, full power is rarely used. Icebreaking capability is enhanced by a hull air lubrication (bubbler) system housed in a portable van on the fantail. Hull air lubrication has been used by European icebreakers for years; this seems to have been its first U.S. application.

Like the Polar class ships, Bay class tugs are manned on a minimum scale; unlike the larger vessels the KATMAI BAY and her eight sisters, completed during the period 1979-1988, proved successful from the beginning. Indeed, the major complaint lodged against them was that they could not provide berthing for any personnel temporarily assigned. Their low freeboard and extensive superstructure, however, would seem to make them vulnerable to icing in heavy weather with freezing temperatures.

Adoption of the 200-mile economic resources zone by the United States in 1977 made the construction of additional medium endurance cutters necessary, especially since the venerable 327-footers were finally approaching the end of their service. A contract for four Famous class 270-footers was let in 1977, with the first to be completed in 1980. Like the 210-footers, this design had an extended forecastle, with the after end forming the helicopter deck--indeed, the ability to operate a helicopter during a two-week patrol was a principal design



USCGC KATMAI BAY (Bay class) icebreaking tug. (Official Coast Guard photo.)



USCGC BEAR (Famous class). (Official Coast Guard photo.)

requirement, and active fin stabilization was provided to facilitate this. Two medium speed 3,500 shp Alco diesel engines drove the twin controllable-pitch propellers for a maximum speed of 19.7 knots and 10,250 miles endurance at 12 knots. A single Mark 75 76-mm gun mounted forward composed the armament, although the usual space was reserved for antisubmarine weapons and sensors. During construction, however, builder's and service life weight margins and reservations were consumed, so no changes or additions can be made without adequate compensation.

When the first of these cutters, the BEAR, was departing San Francisco while en route from her builder's yard in Tacoma, Washington, to San Diego for shakedown and training, she struck a large wave, damaging the Mark 75 gun mount irreparably and the superstructure forward less seriously. She returned to Tacoma for repair and was finally commissioned early in 1983.

Nine additional Famous class cutters were authorized; their construction was delayed by lawsuits resulting from the original contract. The lengthy period between keel-laying and commissioning for all 13 of these ships--4 to 5 years for most--the last, the MOHAWK, completed and operational in 1991 --is explained in part by a post-delivery availability during which the Mark 75 gun mount was raised 30 inches to decrease the minimum range for fire over the bow and electronic systems were upgraded. The most important of these is the command and control (COMDAC) system that automatically processes information from navigational systems and radar to display continuous running positions of the ship and others that are under surveillance on bridge and combat information center consoles. Its value in fisheries patrol and drug interdiction is obvious; it has also proven very effective in search and rescue missions in which the 270-footer assumes on-scene control.

Famous class cutters gained a reputation as poor seaboats. As usual in such cases, however, experience with the ships alleviated some of their apparent shortcomings. Thus, they pitch considerably and the location of the gun mount and superstructure so far forward limits their ability to be driven into head seas; heading them off the sea enables the fin stabilizers to be effective in roll reduction and avoids deck wetness. And while the helicopter deck makes proper location of towing bitts impractical, rigging a towing bridle provides adequate towing capability.

As drug interdiction came to be accorded greater importance among the Coast Guard's