US COAST GUARD ICEBREAKER *GLACIER*
(USS *Glacier*)
(WAGB-4)
(AGB-4)
Suisun Bay Reserve Fleet
Benicia vicinity
Solano County
California

HAER CA-341
HAER CA-341

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
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U.S. COAST GUARD ICEBREAKER *GLACIER*
(USS *Glacier)*
(WAGB-4)
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HAER No. CA-341

Location: Suisun Bay Reserve Fleet, Benicia vicinity, Solano County, California

Rig/Type of Craft: Icebreaker

Class: *Glacier*

Trade: Multi-mission: icebreaking, oceanographic research, polar ice operations

Principal Dimensions:
Length (oa): 309'-8"
Beam: 74'-4"
Draft: 28'-3"
Displacement: 8,449 (fl) tons
(The listed dimensions are from 1996 when the ship was transferred to the U.S. Coast Guard, but it should be noted that draft and displacement were subject to change over time.)

Dates of Construction: 3 August 1953 – 27 August 1954

Commissioned: 27 May 1955 (U.S. Navy)
30 June 1966 (U.S. Coast Guard)

Designer: U.S. Navy

Builder: Ingalls Shipbuilding Company, Pascagoula, Mississippi

Present Owner: U.S. Maritime Administration

Disposition: Decommissioned 7 July 1987; currently on donation hold as the Glacier Society tries to raise the necessary funds to preserve the ship as a functioning museum.

Significance: The U.S. Coast Guard Icebreaker *Glacier* is significant as the last remaining vessel of the U.S. Navy's icebreaking fleet as well as the only extant diesel-electric, DC-powered icebreaker. The ship served in the U.S. Navy from 1955 until 30 June 1966 when the U.S. Coast Guard acquired

it. As a polar icebreaker, the *Glacier* undertook twenty-one deployments to the Antarctic and another ten to the Arctic. The ship proved critical in establishing permanent American bases in the Antarctic and resupplying them annually, which fostered scientific study. The *Glacier* is considered a prototype in icebreaker construction.

Historian: Brian Clayton, HAER Contract Historian

Project Information: This project is part of the Historic American Engineering Record (HAER), a long-range program to document historically significant engineering and industrial works in the United States. The Heritage Documentation Programs of the National Park Service, U.S. Department of the Interior, administers the HAER program.

The project was prepared under the direction of Todd Croteau (HAER Maritime Program Coordinator). Brian Grogan (Photography + Preservation Associates) and Jet Lowe (HAER Photographer) produced the large-format photographs. Todd Croteau generated the vessel drawings. Special thanks to Erhard Koehler (U.S. Maritime Administration), whose help and assistance greatly benefited the project.

Design and Construction

Executive Order No. 7521, issued 21 December 1936 by President Franklin D. Roosevelt, authorized the U.S. Coast Guard to undertake icebreaking operations to keep channels and harbors open for commerce. As a result, the Coast Guard began planning the design and construction of an icebreaking class. Commandant of the Coast Guard, Adm. R.R. Waesche, charged Lt. Cdr. (later Rear Admiral) Edward H. Thiele with the task of developing "the world's greatest icebreakers." Thiele traveled to Europe and inspected various icebreakers, particularly the Swedish icebreaker *Ymer*, which became the model for the 1941 *Wind* class ordered by Roosevelt. The 269' *Wind* class vessels (*Northwind*, *Southwind*, *Eastwind*, and *Westwind*), designed by Gibbs and Cox of New York with Lt. Cdrs. Dale Simonson and Edward Thiele as reviewers, were very much like the *Ymer* aside from having a deeper draft. Otherwise, the *Wind* class ships maintained the same features as the *Ymer*, including high horsepower diesel-electric motors, heeling and trim tanks, and bow propellers. These same features were later used in the design of the *Glacier*, aside from the bow propeller. The hulls of the *Wind* class vessels consisted of frames spaced only 16" apart with welded-steel plating measuring 1-$^5/_8$" thick that could resist 3,000 pounds per square inch. The Western Pipe and Steel Company of San Francisco was the only bidder on the contract to build the four icebreakers and consequently won it.[1] Workers laid the keels in 1942 and finished the four ships in two years.[2]

In 1953, the U.S. Navy designed the *Glacier* and contracted Ingalls Shipbuilding Corporation in Pascagoula, Mississippi, to build it. Established in 1938, the company was located on the Pascagoula River at the Mississippi Sound and produced a miscellaneous group of vessels for the U.S. Merchant Marine that included cruise liners, cargo vessels, and tankers. By the 1950s, Ingalls Shipbuilding Corporation had shifted some of its shipbuilding capacity to producing navy vessels like the *Glacier*. In the 1970s, it began delivering various ships like cruisers, destroyers, nuclear submarines, and submarine tenders to the U.S. Navy.[3]

The *Glacier*'s design was based in part on the earlier *Wind* class with the addition of an impressive array of machinery and new concepts. The Ingalls Shipbuilding Corporation constructed the ship out of high-tensile steel and reinforced its hull with 1-$^5/_8$" steel plating. Tight frame spacing (16") increased the rigidity of the hull. The basic design used was the "Maier Ship's Form," which consisted of regular triangular frames on both the bow and the stern that resembled wedges. This form reduced friction and worked well with icebreakers because it allowed the boat to slide up on the ice and used the weight of the vessel to crush it. The design

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[1] Western Pipe and Steel Company was one of only four companies with the necessary equipment to create the thick steel hull plating. Since the company's shipyard was in San Francisco and the equipment was in Los Angeles, a new yard specifically for the construction of icebreakers was built in San Pedro. See Robert Erwin Johnson, *Guardians of the Sea: History of the United States Coast Guard, 1915 to the Present* (Annapolis, MD: Naval Institute Press, 1987), p. 216.

[2] Information on the development of icebreakers comes from Johnson, *Guardians of the Sea*, pp. 214-217, and Donald L. Canney, "Icebreakers and the U.S. Coast Guard," unpaginated, available at http://www.76fsa.org/cgta/history.htm, accessed June 2007.

[3] "Ingalls Shipbuilding," http://www.fas.org/man/company/shipyard/ingalls.htm, accessed 13 June 2007; see also "Ingalls Shipbuilding, Pascagoula, Miss.," http://www.globalsecurity.org/military/facility/ingalls.htm, accessed June 2011.

also helped protect the hull when beset in ice since the curvature of the sides helped push it out of the water.[4]

Description

The *Glacier* measured 309'-8" in overall length with a 74'-4" beam and a draft of 28'-3" at the time of its transfer in 1966 from the U.S. Navy to the U.S. Coast Guard. The steel-hulled ship displaced 8,449 tons of water when fully loaded. The twin-screw propulsion plant (diesel-electric) created 21,000 shaft horsepower for a top speed of 17 knots. Flank speed allowed the ship a radius of 16,000 nautical miles and 29,280 nautical miles at cruising speed. At 95 percent capacity, the fuel tanks held 822,173 gallons of diesel fuel for the main engines and auxiliary generators.[5]

The machinery spaces contained an assortment of equipment. Ten Fairbanks-Morse (12-cylinder opposed-piston) diesel engines rated at 2,400 horsepower apiece and located in two engine rooms powered ten Westinghouse generators that produced a 900-volt direct current (DC). The generators powered two Westinghouse motors rated at 10,500 horsepower, which drove two 17-$^1/_2$' propellers manufactured by Bethlehem Steel Company. The 15'-diameter, 108-ton propulsion motors were the "largest DC motors built into a vessel in the world and…represented the greatest diesel power aboard any ship built in the United States up to that time."[6] The aft steering compartment housed electric-hydraulic steering rams manufactured by Western Gear Works.[7]

Diesel-electric propulsion was chosen over direct drive or clutched diesel engines for two important reasons: maneuverability and compartmentalization. It eased control between forward and reverse, which was necessary because icebreakers like *Glacier* normally ran into thick ice and had to back up and ram the ice to break it apart. Diesel-electrics also benefited from not having alignment problems between the engine and shaft, which added to better compartmentalization or watertight integrity.[8]

Auxiliary power for the ship came from four Westinghouse service generators and one emergency auxiliary. Although the main motors used DC power, the rest of the ship used alternating current (AC) power. The four primary generators, which were 300-kilowatt Fairbanks-Morse diesel generators, were on the hold level in three separate compartments. The emergency generator was a 200-kilowatt Westinghouse diesel generator. These generators

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[4] "The Icebreaker USS/USCGC *GLACIER*," nominated a National Historic Mechanical Engineering Landmark, Fairfield County Section, available at http://sections.asme.org/FAIRFIELD/USSUSCGC%20Glacier%20Description.pdf, accessed June 2011 [hereafter cited as "Icebreaker USS/USCGC *GLACIER*," landmark nomination]. The American Society of Mechanical Engineers approved the designation of the *Glacier* as a Historic Mechanical Engineering Landmark pending the ship's conversion to a permanent exhibit, which is still in process.

[5] Robert L. Scheina, *U.S. Coast Guard Cutters & Craft 1946-1990* (Annapolis, MD: Naval Institute Press, 1990), p. 97.

[6] "Icebreaker USS/USCGC *GLACIER*," landmark nomination.

[7] Scheina, p. 97; see also J.A. Wasmund, "USS Glacier's Electrical Plant," *Marine Engineering* (July 1955), p. 37.

[8] Gregory Walsh, "Farewell to the Mackinaw," *Professional Mariner* no. 6 (March-April 1994): p. 34.

provided the ship with auxiliary power for multiple units: electronics, lighting, the galley, pumps, refrigeration, and steering.[9]

The heeling tanks were another significant feature on the *Glacier*, although not unique as they had been used on the earlier *Wind* class vessels and the *Mackinaw* (see HAER No. MI-121). When beset in ice, the *Glacier* could draw 320 tons of seawater into the heeling tank and transfer the water back and forth through four powerful pumps. The rocking motion would send the ship 10 degrees off center every 85 seconds until it could be freed from the ice. Additionally, fuel could be stored in the heeling tanks, which added to the ship's immense capacity.[10]

Although icebreaking was the *Glacier*'s primary mission, there were times when the ship had to tow another vessel through the ice. As a result, there was an Almon-Johnson constant tension-towing winch with a maximum pull rating of 80,000 pounds aft of the main deck. When crewmembers employed the winch, the cable went through a towing bit that contained a series of pullies to help maintain the direction of the cable and reduce friction. The stern had a padded rubber notch at the end of the ship to pull another vessel in close during a towing evolution.[11]

To assist in polar missions re-supplying the American base at McMurdo, the *Glacier* was equipped with cargo booms and a helicopter hangar. Near the bow were two cargo booms on the port and starboard sides that could lift intermediate objects up to 2,000 pounds. Two cranes manufactured by Western Gear Works and capable of lifting objects up to 25,000 pounds were located on the port and starboard sides, aft beside the helicopter hangar. These cranes were the "largest DC cranes built up to that time aboard hangars."[12] An enclosed and heated hangar stored the two helicopters used to transport crew and cargo as well to conduct scouting missions and mapping assignments.[13]

Crewmembers navigated the *Glacier* through the ocean and polar ice and operated the ship from the navigation bridge, which housed an assortment of electronics (radios, GPS, Loran-C, fathometer, and radars) and the helm. A gyro repeater and compass provided the bearings needed for navigation; the gyrocompass was located on the third deck. On the bridge, throttles regulated the speed of the ship through a series of linkages that were connected to the main engines. The same system was used on the helm and steering gear. Aft of the bridge was a combat information center (CIC) and a room for ice reconnaissance and operations.[14]

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[9] U.S. Coast Guard, "Ship's Characteristics Card: USCGC Glacier (WAGB-4)," available at U.S. Coast Guard Historian's Office, Washington, DC.
[10] Canney, "Icebreakers and the U.S. Coast Guard," unpaginated; Wasmund, p. 42.
[11] Canney, "Icebreakers and the U.S. Coast Guard," unpaginated; "USCGC *Glacier* WAGB-4," *Booklet of General Plans* (Baltimore, MD: U.S. Coast Guard Engineering Logistics Center, 2001), p. 4 (main deck) and p. 6 (general information).
[12] "ASME Designates USS/USCGC Glacier a National Mechanical Engineering Landmark," *The Icebreaking News*, Winter 2003/2004.
[13] *Booklet of General Plans*, p. 3 (01 level); "USCGC Glacier (WAGB-4)," nd, p. 5, in *Glacier* File, U.S. Coast Guard Historian's Office, Washington, DC.
[14] *Booklet of General Plans*, p. 3 (02, 03, 04, and 05 levels); "USS Glacier's Electrical Plant," July 1955, p. 38, in *Glacier* File, U.S. Coast Guard Historian's Office, Washington, DC.

Atop the bridge was a flying bridge and a mast containing an aloft conning tower. The Mark 56 gun director was on the flying bridge to aid in fire control for the twin 5"/38 dual-purpose guns on the bow. The mast housed an assortment of electronic equipment that connected to the bridge equipment. Additionally, the mast contained a conning tower that was heated and enclosed to protect crewmembers from the harsh elements of the weather. Controls in the aloft conning tower connected to the propulsion motors. The *Glacier* was the "first icebreaker to have total pilothouse functions replicated in an aloft conning station that could be operated by a single person."[15]

The navy equipped the *Glacier* with additional armament during its service, a reflection of Cold War hostilities between the United States and the Soviet Union. Besides the 5"/38 guns, there were six 3" twin guns in various locations around the ship and four 20-mm anti-aircraft guns. The U.S. Coast Guard removed the armament at various times after acquiring the ship and replaced them with smaller caliber weapons.[16]

Beneath the bridge (02 level) were the living quarters and cabin for the captain and an extra room for the flag officer. The two rooms shared a common bathroom and shower. In the commanding officer's cabin was a sitting area and mess table, as well as a private galley. The *Glacier* could carry a unit commander (flag officer) on board to direct a task force of ships within an operation.[17]

The main deck contained storerooms, mess halls and galley, lounges, berthing, and work areas. To improve the level of comfort for the crewmembers, fiberglass insulation was installed rather than the usual cork. An assortment of storerooms, including one for repair parts and a civilian clothes locker, were in the bow of the ship along with an exchange. Aft of the storerooms was the crew's mess and aft of that was the galley located on the centerline. Off the portside of the galley was the officer's ward room and lounge and aft of that were rooms for some senior officers, including the executive officer, operations officer, and aviator officer. Off the starboard side of the galley was the chief petty officer's mess. Just aft of this mess was the berthing area. Aft of the senior berthing were a crew's lounge and a ship's library on the starboard side. On the port side were engineering work areas. In between these two areas were machinery spaces and labs (both biological and geophysical) on the starboard side and wet labs (both physical and chemical) on the port side. The *Glacier* could accommodate up to twenty scientists while underway.[18]

Storerooms, quarters for the crew, and machinery spaces were on the second deck. The bow held storage space. Aft of this was half of the berthing area for the enlisted crew, along with bathrooms and a recreation room. Officer accommodations were between the heeling tanks and consisted of small staterooms with either single or double bunks. Behind the officer's berthing was the second half of the enlisted crew's berthing space. Another oceanographic room,

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[15] *Booklet of General Plans*, p. 3 (01 level) and (02, 03, 04, and 05 levels); quote from "USS/USCGC *GLACIER*," landmark nomination.
[16] *Booklet of General Plans*, p. 3 (02, 03, 04, and 05 levels).
[17] *Booklet of General Plans*, p. 4 (main deck).
[18] *Booklet of General Plans*, p. 4 (main deck).

equipped with a winch and assorted equipment needed for taking core samples of ice, was in the aft section of the ship. The steering room was in the lazarette.[19]

The dry provisions and reefers for the vegetables and meat were in the forward section of the ship on the third deck. These were generous spaces because the *Glacier* was often on extended missions. The icebreaker's longest cruise on record was 217 days during Operation Deep Freeze 1963, while the shortest was 128 days during Operation Deep Freeze 1980-1981. The *Glacier* normally carried enough supplies to last six months—longer cruises required re-supply.[20]

To the rear of the reefers was a mixture of storage rooms and machinery spaces. The gyroscope and emergency gyro were just aft of the reefers along with more space for storing linens, laundry equipment, and tools, as well as a post office and electrical shops. The main motors were just aft of these spaces in separate rooms designated "Motor Rm. No. 1" and "Motor Rm. No. 2." Since the motors were each 15' in diameter and weighed 108 tons, they took up most of the space in the rooms. The immense size of the brush rigging inside the housing prevented the rotation of the brushes, so two doors in the forward and end bells of each motor allowed mechanics access to the interiors for cleaning.[21]

Operational History

The U.S. Coast Guard Icebreaker *Glacier* was launched on 27 August 1954 and sponsored by Mrs. Roscoe F. Good. The ship was commissioned on 27 May 1955. The *Glacier* played a significant role in the U.S. Navy's support of the International Geophysical Year (IGY), a worldwide effort of scientists from forty nations to complete geophysical observations from July 1957 to December 1958. Part of that effort included the establishment of fifty-six research sites in Antarctica, and the U.S. Navy was tasked with supporting those sites and the scientists working at them. Designated "Operation Deep Freeze" and launched in 1955-56, the U.S. Navy made regular supply voyages to American bases in Antarctica on the *Glacier*.[22]

The U.S. Navy was tasked with supplying the Antarctica bases because it had made several voyages to the area prior to Operation Deep Freeze. The first took place during the Charles Wilkes expedition of 1838-42. The navy's next trip to the Antarctica took place in 1929 when Adm. Richard E. Byrd explored the interior continent. Byrd used aircraft to survey the land and transited over the South Pole. He returned to Antarctica again in 1934-35 and in 1940. Although these expeditions allowed the navy to familiarize itself with Antarctica, a majority of the continent remained unexplored. The next major naval expedition to Antarctica was Operation High Jump, a hastily planned mission to the South Pole in 1946-47. The navy originally planned a training exercise for the North Pole, but as winter approached, the expedition turned south to Antarctica (since the seasons are opposite). The mission was two-fold: winter warfare training and "to establish a basis for claiming sovereignty over as much of

[19] *Booklet of General Plans*, p. 5 (third deck).
[20] *Booklet of General Plans*, p. 5 (third deck).
[21] *Booklet of General Plans*, p. 5 (third deck); Wasmund, "USS Glacier's Electrical Plant," p. 37.
[22] Ellery D. Wallwork and Kathryn A. Wilcoxson, *Operation Deep Freeze: 50 Years of U.S. Air Force Airlift in Antarctica, 1956-2006* (Office of History, Air Mobility Command, Scott Air Force Base, Illinois, October 2006), Prologue.

the polar continent as possible" (a classified objective but the primary goal). At the same time, foreign relations between the United States and the Soviet Union were deteriorating, and there was a fear that the Soviets would attack the United States over the North Pole. Operation High Jump resulted in the successful photo mapping of Antarctica and charting of most of the coastline, as well as the establishment of a base called Little America IV near the Bay of Whales.[23]

During Operation Deep Freeze I (1955-56), the U.S. Navy laid out several key objectives for the planned exercise. The most important was the logistical supply for the mission, including men, materials, and provisions, so that permanent stations could be constructed, as well as an airfield, which allowed the U.S. Air Force to furnish heavy aircraft to augment the ship supplies brought to Antarctica the following year. After clearing a channel and leading a group of ships to Kainan Bay to construct the Little America V base, the *Glacier* headed towards the Ross Ice Shelf to assist in the construction of a naval air station at McMurdo Sound. After breaking a channel for the supply ships, the *Glacier* performed mapping missions, both air and hydrographic, in Weddell and Vincennes Bay. The ship returned to its homeport in Boston, Massachusetts, on 6 May 1956, after successfully completing the first of many Deep Freeze missions. During Operation Deep Freeze II (1956-57), the *Glacier* made the earliest penetration through the ice.[24]

For the next three decades, the USS *Glacier* continued running yearly operations to the Antarctic and providing a variety of services during the Deep Freeze operations. The *Glacier*'s primary job was icebreaking, since cleared channels permitted the entry of other auxiliary vessels to the standing areas to offload cargo, equipment, materials, men, and provisions. The ship broke ice using what the crew referred to as the "Modified Herringbone" method, which involved "making three parallel runs into the ice, spaced anywhere from one-half to two ships-width apart, depending on the desired width of the channel. The center run is made in the desired direction of progress. Because of the angles involved, each successive run is able to displace ice into the area broken by the previous run, thus allowing steady and continuous progress."[25] If the ice could not be broken, the crew could make the ship rise to the top and, by bringing down its weight, smash the ice. The *Glacier*'s yearly missions coincided with the "austral" summers in Antarctica, which permitted deep penetration to the staging areas close to the bases of operation (McMurdo Air Station later became the logistical focal point). After clearing a channel, the *Glacier* performed other tasks as dictated by its schedule. Routine operations for the icebreaker included mapping and scientific missions, carrying out special projects that were deemed helpful to the Antarctic program, assisting other agencies, and performing search and rescue operations.[26]

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[23] Quote from Dian Olson Belanger, *Deep Freeze: The United States, the International Geophysical Year, and the Origins of Antarctica's Age of Science* (Boulder, CO: University Press of Colorado, 2006), p. 4; Paul Hoversten, "Operation High Jump," *Air & Space Magazine* (July 1, 2007), available at http://www.airspacemag.com/history-of-flight/highjump-QandA.html, accessed 9 August 2007.

[24] "Antarctica: Operation Deep Freeze I: 1955-56," available at http://www.history.navy.mil/ac/exploration/deepfreeze/ctf.htm, accessed 13 June 2007; U.S. Navy, *Dictionary of American Naval Fighting Ships* (Washington, DC: Naval Historical Center, 1991), p. 102.

[25] "The Icebreaker in Deep Freeze," *All Hands*, July 1961, p. 60.

[26] "Antarctica: Operation Deep Freeze I: 1955-56."

During the initial exploratory phase of the Antarctic program, mapping missions were a top priority. Since the *Glacier*'s design included a helicopter pad and hangar, the mission planners utilized the helicopters in mapping out uncharted areas of Antarctica. The unique ability of the ships to travel off the coast into uncharted territory allowed the ship to launch and recover helicopters in predefined areas, while a photo lab onboard the ship allowed personnel to develop and print film. The *Glacier*'s sonar and fathometer were helpful assets that allowed mapping of underwater topography in the areas the ship traveled as well as the production of hydrographic data that was later used to produce marine charts of Antarctica's coast.[27]

Equally as important as the mapping missions were the scientific experiments conducted from the icebreaker. Science labs onboard the ship were devoted to performing various experiments in the Antarctic. Scientists recorded penguin and seal mammal studies, studied ecology, and took ice-coring samples, among other things. There were accommodations onboard the ship for the team of scientists carrying out the experiments.[28]

The ship was also loaned out for special projects at different agencies. One such project took place in 1957-58 when the National Aeronautics and Space Administration (NASA) used the ship to carry out "rockoon" tests. In these experiments, balloons carried rockets that were launched from the ship's deck. At a specific altitude, the rockets ignited into space, which later helped inform the design of satellite Explorer 1. During summer 1958, the *Glacier* shifted to the Arctic to assist with the logistical supply to the Distant Early Warning (DEW) stations positioned along the 69th parallel—radars used to detect Soviet bombers coming over the North Pole.[29]

Other important missions undertaken by the *Glacier* were search and rescue operations (SAR). The Antarctic is one the most inhospitable places on Earth, and when personnel or ships required immediate assistance, the *Glacier* could provide relief. There were many incidents when ships, both foreign and domestic, became beset in the ice and were unable to free themselves. The *Glacier* assisted many vessels by breaking a channel and freeing the ice around them, sometimes traveling hundreds of miles. Since ships were often on prolonged missions and far from operational bases where treatment could be obtained, the *Glacier* was equipped with an operating room and berthing for a surgeon and dentist. Medical staff performed a range of procedures, from appendectomies to root canals.[30]

Although the *Glacier* assisted many vessels in distress, it also encountered problems. In order to prevent the ship from becoming beset in ice, the ship's crew deployed the helicopters to survey ahead and spot leads in the ice. There were some occasions when the helicopters worked to no avail, the heeling system failed, and the ship became embedded in the ice. This occurred in 1970

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[27] "Ship's History," 31 May 1966, in *Glacier* File, U.S. Coast Guard Historian's Office, Washington, DC.
[28] *Booklet of General Plans*, p. 4 (main deck and second deck).
[29] U.S. Navy, *Dictionary of American Naval Fighting Ships* , p. 103; Belanger, *Deep Freeze*, p. 27. Cold War military planning suspected that the Soviet Union would attack the United States over the North Pole using long-range bombers. The military countered this threat with a network of air defense radars, but they soon became antiquated after the development of inter-continental ballistic missiles, which nullified the counter balance.
[30] "USCGC Glacier: 32 Years of Polar Service," nd, p. 4, in *Glacier* File, U.S. Coast Guard Historians Office, Washington, DC.

when the Argentine icebreaker *General San Martin* called the *Glacier* for assistance after ice beleaguered the ship in the Weddell Sea. While traveling to the stranded ship, the *Glacier* became trapped in the ice and was immobilized from 23 February to 5 March. The *Glacier* was eventually released and able to free the *San Martin*. Another issue that required constant attention was damage to the propellers, particularly bent and broken blades, which could be caused by large pieces of ice. The most hazardous threat facing the *Glacier* was running aground in uncharted waters around Antarctica, which occurred more than once.[31]

Each year, the *Glacier* re-supplied the Antarctic bases, which brought a set of challenges. The biggest difficulty was preparing the ship and crew for extended periods at sea. Crew morale was important because of the long separation endured from family and friends. To stave off boredom, various activities were planned throughout the tour, including movies and popcorn, games, and communication home via a ham radiotelephone. Another way to occupy the time was training drills and service-wide exams to promote crew members up the chain of command. A well-stocked library provided reading options for the crew. Finally, ports of call relieved stress and gave the crew short vacations in such exotic locations as Cape Town, Montevideo, and Rio de Janeiro.[32]

The *Glacier* underwent many changes during its long career. The most significant was the title transfer from the U.S. Navy to the U.S. Coast Guard on 30 June 1966. Previously, on 7 May 1965, Defense Secretary Robert S. McNamara approved the transfer of five navy icebreakers (the navy's entire icebreaking fleet) to the Treasury Department and the Coast Guard too k over the responsibility for all icebreaking missions.[33] Minor alterations to the ship included the removal of its 5"/38 dual-purpose guns and painting the hull red instead of white so helicopter pilots could distinguish it more clearly against the white of ice and snow. The admission of women onboard was another significant change; the first woman scientist boarded in 1973 followed by the first women crewmembers in 1980.[34]

Conclusion

The *Glacier* greatly assisted the polar operations in the Arctic and Antarctica, most notably the missions supporting Operation Deep Freeze. When the *Glacier* began service, the ship was the most powerful icebreaker in existence and proved its worth many times over, such as when it made the earliest and longest penetration into Antarctica's ice field. The *Glacier* also demonstrated its value in mapping Antarctica (both aerial and underwater) using helicopters and sophisticated equipment. SAR missions saved many ships and personnel from the perils of the polar environment.

The ship's endurance validated the work of the naval architects and shipyard. It was a self-contained ship providing many services since supply bases were distant from its areas of

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[31] "USCGC Glacier: 32 Years Polar Service," p. 4.
[32] "Arctic West Summer 1977 Operations," 21 September 1977, pp. 51-52, in *Glacier* File, U.S. Coast Guard Historian's Office, Washington, DC. The office maintains extensive Deep Freeze mission summaries since the Coast Guard began operating the ship in 1966.
[33] Johnson, *Guardians of the Sea*, p. 329.
[34] "USCGC Glacier: 32 Years of Polar Service," pp. 7-8.

operation. The ship's design allowed it to break up ice as thick as 20' and travel non-stop for extended periods of time. Habitability influenced the ship's designers to create top-of-the-line crew's quarters and facilities, as well as using fiberglass thermal insulation instead of cork, as was used in previous designs. The equipment and storage onboard allowed the ship and crew to direct all their efforts toward the scientific endeavors being conducted in the Antarctic and the permanent bases there. Currently, the *Glacier* is on donation hold in Suisun Bay, California, as the Glacier Society strives to raise the necessary funds to preserve the icebreaker as a museum.

Appendix A: **Glacier Statistics 1955 – 1987**[35]

Antarctic Deployments	29
Arctic Deployments	10
Longest Deep Freeze (Days)	217
Longest Deep Freeze (Miles)	40,103
Shortest Deep Freeze (Days)	128
Shortest Deep Freeze (Miles)	19,460
Average Deep Freeze Mileage	29,527
Average Arctic Mileage	9,013
Total Nautical Miles Sailed	944,050
Panama Canal Transits	19
Most Helicopter Tours	374.3
Most Passengers Carried	249
Most Helicopter Cargo Carried (Tons)	70
Total Cargo Handled (Tons)	7,208
Total Helicopter Cargo Handled (Tons)	5,160
Total Passengers Carried	3,579
Total Helicopter Passengers Carried	6,240
Total Helicopter Hours Flown	7,770
Diesel Fuel Expended (Gallons)	38,526,906
Lube Oil Expended (Gallons)	739,676
Aviation Fuel Used (Gallons)	439,102
Potable Water Used (Gallons)	48,333,331
Beef Consumed (Pounds)	1,208,333
Pork Consumed (Pounds)	322,258
Poultry Consumed (Pounds)	370,545
Flour Used (Pounds)	443,055
Coffee Consumed (Pounds)	225,550
Bread Used (Loaves)	203,000
Eggs Used (Dozens)	181,250
Milk Used (Gallons)	238,931
Ice Cream Consumed (Gallons)	153,324

[35] "USCGC Glacier: 32 Years of Polar Service," p. 12.

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