The Icebreaker

USS/USCGC *GLACIER*

USCG Photo

Nominated a Historic Mechanical Engineering Landmark

- Fairfield County Section -

The History and Heritage Program of ASME International

The History and Heritage Landmarks Program of ASME International (the American Society of Mechanical Engineers) began in 1971. To implement and achieve its goals, ASME formed a History and Heritage Committee initially composed of mechanical engineers, historians of technology, and the curator (now emeritus) of mechanical engineering at the Smithsonian Institution, Washington, D.C. The History and Heritage Committee provides a public service by examining, noting, recording and acknowledging mechanical engineering achievements of particular significance. This Committee is part of ASME's Council on Public Affairs and Board on Public Information. For further information, please contact Public Information at ASME International, Three Park Avenue, New York, NY 10016-5990, 212-591-7740.

Designation

Since the History and Heritage Program began in 1971, over 225 landmarks have been designated historic mechanical engineering landmarks, heritage collections, or heritage sites. Each represents a progressive step in the evolution of mechanical engineering and its significance to society in general. Site designations note an event or development of clear historic importance to mechanical engineers. Collections mark the contributions of a number of objects with special significance to the historical development of mechanical engineering.

The Landmarks Program illuminates our technological heritage and encourages the preservation of the physical remains of historically important works. It provides an annotated roster for engineers, students, educators, historians and travelers. It helps establish persistent reminders of where we have been and where we are going along the divergent paths of discovery.

The 120,000-member ASME International is a worldwide engineering society focused on technical, educational and research issues. ASME conducts one of the world's largest publishing operations, holds some 30 technical conferences and 200 professional development courses each year, and sets many industrial and manufacturing standards.

INTRODUCTION

When commissioned May 27, 1955, *Glacier* was the free world's largest and most powerful icebreaker, designed to break ice up to 20 feet thick, and considered a prototype in icebreaker construction. The ship, named for Glacier Bay off the Alaskan coast, was built for the U.S. Navy by the Ingalls Shipbuilding Corporation of Pascagoula, Mississippi and launched August 27, 1954. Her many innovations were state-of-the-art and her subsequent 33-year service history with the U.S. Navy and the U.S. Coast Guard demonstrated outstanding performance. *Glacier's* keel was laid on August 3, 1953. Her yard hull number was 580.

Built by Ingalls Shipbuilding, the Navy supervised all details of *Glacier's* design and construction. *Glacier* was the first icebreaker constructed in a U.S. shipyard following World War II. (USN Photo)

Glacier's curved bow is of the standard icebreaker shape that causes the ship to ride up on heavy ice and break it downward with the vessel's weight. The steel hull is 1-5/8 inches thick by the bow. The stern has a notch where the bow of a towed vessel can be entered to prevent ice from flowing between the two ships. Since *Glacier* was designed for extensive non-stop voyages, exceptionally good crew quarters and facilities were required along with large storage for fuel and provisions. The ship's hull is made up of a heavy exterior shell and a lighter interior shell. All-welded steel construction was used throughout. The shells are joined by strut framing, transverse, and longitudinal bulkheads. The tanks formed this way are used for fuel and water storage, heeling operations, and voids. This construction also provided a smooth surface on the interior of the vessel. Her intended Arctic missions necessitated a cargo hold, an oceanographic research office, a helicopter flight deck, and hangar. Since she was a warship, *Glacier* was originally armed with guns for anti-aircraft and surface firing.

The 8,915-ton displacement vessel is 309.6 feet in length with a beam of 74 feet, draft of 28.5 feet, maximum propulsion of 21,000 horsepower, and propellers of 17-1/2 feet in diameter. The ship has a top speed of 18.6 knots and a range of 29,200 nautical miles at 12 knots.

Glacier's first homeport was Boston, Massachusetts. Her Navy service extended to June 30, 1966. At that time, she was transferred to the Coast Guard following a

Nicknamed "The Mighty G", USS *Glacier* (AGB-4*)* was a key early explorer of the Arctic and the Antarctic in the late 1950s and 1960s as a result of state-of-the art design features. (USN Photo)

1965 agreement that all icebreaker operations would be more efficient consolidated under one service. Her new homeport became Long Beach, California until 1985 when she relocated to Portland, Oregon. *Glacier* continued service of the Arctic and Antarctic regions under the U.S. Coast Guard until decommissioning in May 1987.

Nicknamed "Big Red", USCGC *Glacier* (WAGB-4*)* was in 1973 the first icebreaker to be painted red to improve visibility in the Arctic regions. (USCG Photo)

Glacier made ten voyages to the Arctic and twenty-nine to the Antarctic logging over 944,000 miles in support of scientific research by opening vital channels to allow supply ships to reach research stations and remote settlements.

In 2001, the U.S Department of Transportation transferred *Glacier* to the Glacier Society, a non-profit educational foundation headquartered in Bridgeport, Connecticut.

HISTORICAL SIGNIFICANCE

Glacier was the only ship of its class and is the only remaining icebreaker afloat of the original U.S. Navy's icebreaker fleet. She is the only remaining diesel-electric, DC-powered icebreaker.

Glacier represented the "Glacier" class of icebreakers, a scaled-up version of the "Wind" class, and had extended range, heavier ice-breaking capability and extended mission duration. The ship supported numerous polar scientific explorations, made several Antarctic landings and penetrations not previously accomplished, and performed a number of international ship rescues.

Each year, Operation Deep Freeze is conducted to provide operational and logistical support to the scientific outposts in Antarctica. On her maiden voyage, *Glacier* participated in the first Operation Deep Freeze (1955-1956) and served as the flagship for noted polar explorer Rear Admiral Richard E. Byrd, USN, during his final trip to the Antarctic. The objectives of the operation were to establish bases for the scientific work of the International Geophysical Year of 1957 to 1958, which was dedicated to research in Antarctica.

Rear Admiral Richard E. Byrd planning for Operation Deep Freeze in 1955. *Glacier* served as his flagship. (USN Photo)

Glacier was key to the many Deep Freeze expeditions to Antarctica and in establishing and re-supplying bases there. Her roles included breaking ice for thinner-skinned ships to penetrate Antarctic regions, launching helicopters for advanced scouting, mapping coastlines,

and providing logistic support for aviation and construction personnel. Because of her greater ability to break ice, *Glacier* permitted establishment of the McMurdo baseline camp in 1955, which has become the largest settlement in Antarctica.

Glacier made the earliest seasonal penetration in history through the almost perpetual ice belt surrounding the Antarctic continent by breaking through 800 miles of almost solid pack ice in nine days to reach McMurdo Sound during Deep Freeze II in 1956. Also that year, *Glacier* made the first landing in history on the Princess Martha and Princess Astrid coasts in the Antarctic. During Deep Freeze in February 1960, *Glacier* became the first ship to penetrate the Bellinghausen Sea in Antarctica and to make landfall on Thurston Island.

Aaron Peter Maps

In Pine Island Bay of Antarctica, *Glacier* penetrated ice floes further than any ship in history...more than 100 miles of previously unsounded waters to the glacier at the head of the bay during Deep Freeze 1985. Scientists who accompanied *Glacier* were the first humans to set foot on Pine Island Bay Glacier. Also in 1985, *Glacier* assisted in the discovery of the Van Allen radiation belt above the earth. This is a belt of high-energy particles, mainly protons and electrons, held captive by the magnetic influence of the earth.

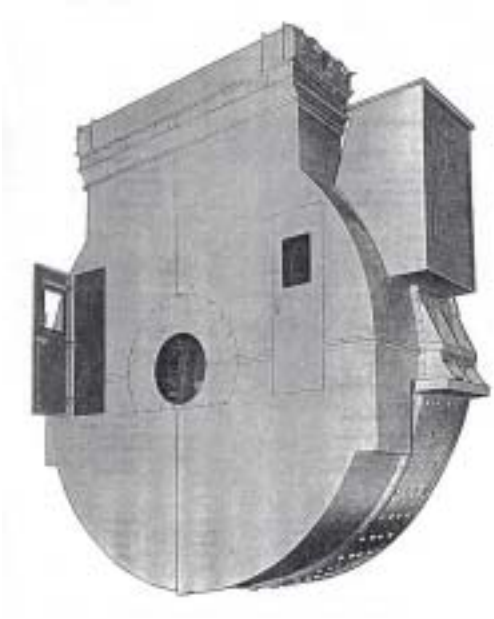
ENGINEERING FEATURES

Glacier was designed with special features to make her more effective in tackling the toughest ice-breaking chores. The following engineering concepts, features and characteristics made this vessel unique.

Diesel-Electric Propulsion (Twin Screw)

Glacier pioneered diesel-electric propulsion in icebreakers. Her two 15-foot diameter, 108-ton propulsion motors were the largest DC motors built into a vessel in the world and her diesel engines represented the greatest diesel power aboard any ship built in the United States up to that time.

The Westinghouse propulsion motors are of single armature construction, shunt wound, and directly reversible. They consist of one port and one starboard motor directly connected to the propulsion shafting. The armature shafts of the two deck-high motors are actually the propeller shafts with no reduction gears.



A pair of walk-in type doors is installed in the forward endbell of each of *Glacier's* two propulsion motor stators to permit maintenance of the commutator and brushes. Steps are needed to permit walking around inside the endbell since the large size of the brush rigging prohibits rotating it for brush maintenance. (Westinghouse Photo)

The motors have a continuous rating of 8,450 horsepower at 837 volts and a 4-hour rating of 10,500 horsepower at 900 volts. Power is supplied by five Westinghouse propulsion generators per motor, which may be connected in parallel depending on power requirements.

Ten Fairbanks-Morse opposed-piston 12-cylinder diesel engines each developing 2,400 horsepower drive the ten propulsion generators. Four 300-kilowatt Fairbanks-Morse diesel generator sets and one 200-kilowatt diesel emergency set provide auxiliary power.

Aloft Conning Tower

Glacier was the first icebreaker to have total pilothouse functions replicated in an aloft control station that could be operated by a single person. Previous vessels had the ship's telegraph and helm wheel enclosed in the pilot house on the main deck, while the aloft station was an exposed crow's nest with intercom to the bridge below, subjecting the crew member to weather elements. *Glacier's* station is located 74 feet above the waterline and designed to accommodate two crew members.

A flange is forged on the aft shaft extension of the propulsion motor armature (to the right in figure) for direct coupling to the propeller shafting. Each propeller weighs 17 tons. (Westinghouse Photo)

Helicopter Hangar (Two Aircraft)

Glacier's hangar is enclosed to protect the aircraft from arctic weather conditions. The hangar is steam-heated and insulated with a complete workshop, including an overhead crane, to service aircraft engines. Previous icebreakers had an exposed helicopter pad added to the aft deck, where maintenance crews worked outside in the extreme cold environment.

Ocean Floor Sampling Equipment

Glacier was the only icebreaker equipped with deep-sea coring and bottom sampling winches and equipment used for oceanographic studies.

Cargo Cranes

Glacier was equipped with two 25,000-pound cargo-lifting cranes, the largest DC-powered cranes built up to that time aboard icebreakers.

Thermal Insulation

Thermal insulation on *Glacier* is fiberglass rather than the cork material used on earlier icebreaking vessels. Moisture is prevented from passing through the insulation and becoming frozen by a moisture seal applied over the fiberglass.

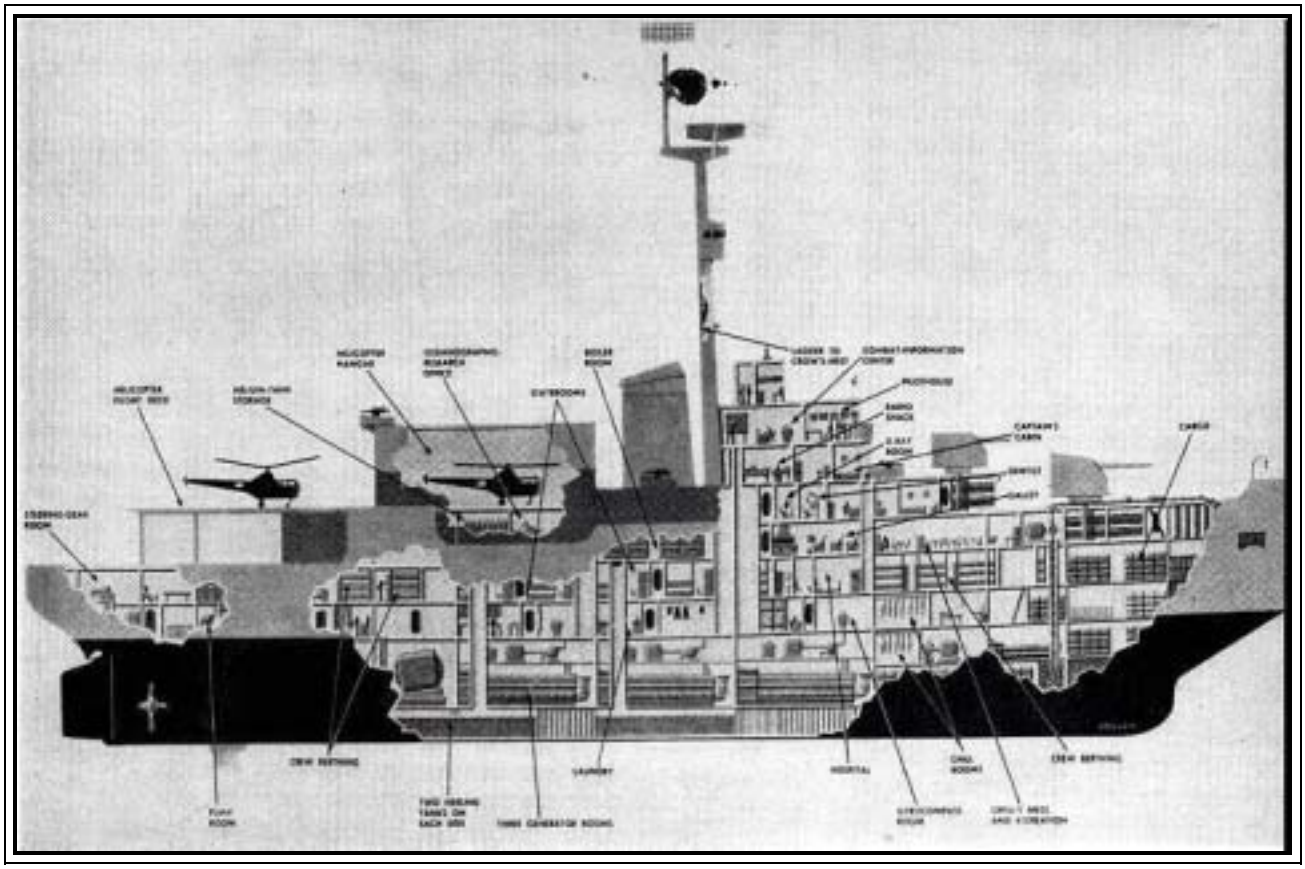
Window Anti-Icing/Anti-Fogging

Polar operations require that good visibility be maintained at all times. The glass windows of *Glacier's* pilothouse and conning station were treated with an invisible current-conducting film to permit electrical anti-icing and anti-fogging capabilities.

Ship Heeling System

Icebreakers can become locked in the ice creating not only a locking action but also significant increases in skin friction. To break free, they have a ballast system that can induce a list by transferring seawater from side to side. *Glacier's* heeling system is capable of transferring approximately 320 tons of seawater in 85 seconds and can roll the ship 10 degrees.

USCGC *Glacier* clears a channel for McMurdo Station. Due to her high hull strength and propulsion power, *Glacier* was able to open up areas in the Antarctic and Arctic previously inaccessible to navigation. *Glacier* can break ice 4 feet thick continuously at 3 knots. (USCG Photo)



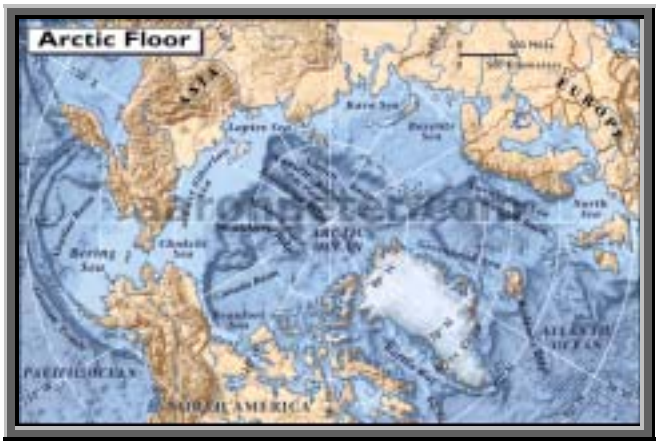
USS *Glacier* (Marine Engineering, July 1955)

Steering Gear

Glacier's steering gear is capable of moving the rudder from hard-over (35 degrees) left or right to 30 degrees on the opposite side in 20 seconds when the ship is going ahead at 17.1 knots or astern at a speed that will develop the equivalent rudder torque (rudder torque at 17.1 knots is 7,500,000 inch-pounds but the steering gear can resist 23,000,000 inch-pounds of rudder torque without exceeding 70% of the yield point of any component part).

PLANNED MISSIONS

Glacier will be restored, preserved, and operated by the Glacier Society as a functioning museum. A stated mission of the Glacier Society is to provide assistance to the indigenous peoples in the Arctic Basin of the eight circumpolar countries by delivering needed medical care to remote coastal areas together with supporting polar medical and environmental research and conducting educational programs. These services are to be delivered by the restored and reconfigured former USS/USCGC *Glacier* to be known as the MV *Glacier GB4*.



Aaron Peter Maps

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2. "USCGC *Glacier* (WAGB-4)"; History Data, U.S. Coast Guard Headquarters; Washington D.C.
3. "Rugged, Powerful USS *Glacier*, Navy's Answer to Arctic Ice Packs"; Marine Engineering, July, 1955.

Achievements of engineers from many organizations contributed to the total design, development, and production of Glacier. The following is a list of manufacturers and the equipment they provided.

Main propulsion diesel generators
Fairbanks, Morse & Company with Westinghouse Electric Corporation generators

Main propulsion motors
Westinghouse Electric Corporation

Auxiliary generators
Fairbanks, Morse & Company with Westinghouse Electric Corporation generators

Emergency generator
Fairbanks, Morse & Company with Westinghouse Electric Corporation generator

Propellers
Bethlehem Steel Company

Steering gear
Western Gear Works

Main bearings
Kingsbury Machine Works

Switchboards
General Electric Supply Company and I.T.E.Circuit Breaker Company

Pumps
Blackmer Pump Company, Chicago Pump Company, DeLaval Steam Turbine Company, Nash Engineering Company, and Worthington Pump & Machinery Corporation

Auxiliary motors
Electro Dynamic Division

Power and lighting panels
I.T.E. Circuit Breaker Company

Oil purifiers
DeLaval Separator Company

Heating boilers
Babcock & Wilcox Company

Hot water heaters
Sepco Corporation

Refrigeration plant
York Corporation

Air conditioning
York Corporation

Distilling plant
Griscom Russell Company

Lubricating oil heaters
Harrison Radiator Corporation

Spark arrestor and dust catcher
Engineering Specialties Company

Towing machine
Almon A. Johnson Incorporated

Anchor windlass
Western Gear Works

Watertight and weather tight doors
Julius Mock and Sons

Boat handling, cargo, and helicopter cranes
Western Gear Works

Boat davits and winches
Welin Davit & Boat Division

Accommodation ladders and gangway
Washington Aluminum Company

Mooring line reels
New England Trawler Equipment Company

Windows, window wipers, and windshields
Kearfott Company

Air and steam whistles
Leslie Company

Laundry equipment
American Laundry Machine Company

Commissary and galley equipment
S. Blickman Company

Garbage grinder
Gruendler Crusher & Pulverizing Company

Insulation and lagging
Shook & Fletcher

Joiner work
Hopeman Brothers

Fuel filters and lubricating oil strainers
Purolator

ACKNOWLEDGEMENTS

The Fairfield County Section of the ASME gratefully acknowledges the efforts of all who participated in the landmark nomination of the USS/USCGC *Glacier*. We wish to extend a special thank you to Bernard G. Koether II, Director of the Glacier Society and to his staff for their support and many contributions to the nomination research.

USS/USCGC GLACIER

BUILT BY INGALLS IN 1954, GLACIER WAS THE FREE WORLD'S LARGEST AND MOST POWERFUL ICEBREAKER BUILT TO BREAK ICE UP TO 20 FEET THICK. GLACIER'S DESIGN PIONEERED DIESEL-ELECTRIC PROPULSION IN ICEBREAKERS. THE SHIP'S TWO 15-FOOT DIAMETER, 108-TON, 900-VOLT PROPULSION MOTORS, EACH OF 10,500 HORSEPOWER, WERE THE LARGEST SINGLE ARMATURE DIRECT CURRENT MOTORS BUILT INTO A VESSEL ANYWHERE IN THE WORLD UP TO THAT TIME. WITH GREATER ABILITY TO BREAK HEAVY ICE, GLACIER MADE SIGNIFICANT ANTARCTIC PENETRATIONS AND LANDINGS NOT BEFORE ACCOMPLISHED. DURING SERVICE FROM 1955 TO 1987, GLACIER DIRECTLY SUPPORTED MANY POLAR SCIENTIFIC EXPLORATIONS AND RESEARCH STATIONS OF GLOBAL IMPORTANCE.