NPS Form 10-900
(Rev. 8-86)
OMB No. 1024-0018

United States Department of the Interior
National Park Service

National Register of Historic Places Registration Form

This form is for use in nominating or requesting determinations of eligibility for individual properties or districts. See instructions in *Guidelines for Completing National Register Forms* (National Register Bulletin 16). Complete each item by marking "x" in the appropriate box or by entering the requested information. If an item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, styles, materials, and areas of significance, enter only the categories and subcategories listed in the instructions. For additional space use continuation sheets (Form 10-900a). Type all entries.

1. Name of Property

historic name USS Albacore, (AGSS-569)
other names/site number

2. Location

street & number ☐ not for publication
city, town Portsmouth ☐ vicinity
state New Hampshire code NW county code zip code

3. Classification

Ownership of Property	Category of Property	Number of Resources within Property		
		Contributing	Noncontributing	
[X] private	☐ building(s)			buildings
☐ public-local	☐ district			sites
☐ public-State	☐ site	1		structures
☐ public-Federal	[X] structure			objects
	☐ object			Total

Name of related multiple property listing:

Number of contributing resources previously listed in the National Register

4. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this ☐ nomination ☐ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property ☐ meets ☐ does not meet the National Register criteria. ☐ See continuation sheet.

Signature of certifying official | Date

State or Federal agency and bureau

In my opinion, the property ☐ meets ☐ does not meet the National Register criteria. ☐ See continuation sheet.

Signature of commenting or other official | Date

State or Federal agency and bureau

5. National Park Service Certification

I, hereby, certify that this property is:

☐ entered in the National Register.
☐ See continuation sheet.
☐ determined eligible for the National Register. ☐ See continuation sheet.
☐ determined not eligible for the National Register.
☐ removed from the National Register.
☐ other, (explain:)

Signature of the Keeper | Date of Action

6. Function or Use

Historic Functions (enter categories from instructions)

Government-Naval
Engineering (Testbed)
Defense (Naval)

Current Functions (enter categories from instructions)

Museum

7. Description

Architectural Classification
(enter categories from instructions)

Materials (enter categories from instructions)

foundation N/A
walls Hull Low Carbon Steel(STS)
roof
other

Describe present and historic physical appearance.

The experimental, unarmed, diesel-electric submarine USS *Albacore* is the feature exhibit at the Port of Portsmouth Maritime Museum on the shoreline of the Piscataqua River in Portsmouth, New Hampshire. She is in a permanent dry berth and is accessible at deck level through her pressure hull forward and aft. *Albacore* is maintained by the Portsmouth Submarine Memorial Association as she looked after her last rebuilding when she reached her peak of performance.

Albacore as Built and Modified

USS *Albacore*, (AGSS-569), is constructed of welded low-carbon STS steel to a novel design developed from research begun in 1944 into hull forms based on "bodies of revolution." Hull forms of this design have a round cross section everywhere along their length. *Albacore* is 203.1 feet long, 27.1 feet in beam, displaces 1692 tons surfaced and 1908 tons submerged. A narrow deck forward and aft of the sail allowed line handlers a safe working space. The sail is placed about one third of *Albacore*'s length from her bow. All deck fittings were designed to retract into the hull to minimize underwater drag. [1]

Beginning at the bow belowdecks, *Albacore* was fitted with a sonar array outside the pressure hull but inside the outer hull, crew quarters over auxiliary machine space no. 1, officers' quarters over the forward battery space, the control room over auxiliary machinery compartment #2, crew's quarters over the after battery space, the propulsion machinery compartment housing two "pancake" diesel generators and two large electric motors, auxiliary machinery space, after trim tank, tailplanes, and screws. Three hatches give access to the interior of the hull. The forward escape trunk opens into the forward crew compartment. The control room hatch enters the sail, and the aft escape trunk connects the engineroom and the deck aft of the sail (see Figures 1 and 2). [2]

[X] See continuation sheet

8. Statement of Significance

Certifying official has considered the significance of this property in relation to other properties:

☐ nationally ☐ statewide ☐ locally

Applicable National Register Criteria ☐ A ☐ B ☐ C ☐ D

Criteria Considerations (Exceptions) ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G

Areas of Significance (enter categories from instructions)

Architecture (Naval)

Military

Science

NHL IX: Political and Military Affairs After 1945

Period of Significance

1949-1972

1949-1972

Significant Dates

1949, 1953, 1955, 1960

1965, 1969, 1970

1949-1972

Cultural Affiliation

Significant Person

RAdm Charles B. Momsen

Architect/Builder

Portsmouth Naval Shipyard

State significance of property, and justify criteria, criteria considerations, and areas and periods of significance noted above.

The experimental, Diesel-electric submarine, USS <u>Albacore</u>, (AGSS-569), represents a revolution in naval architecture. <u>Albacore</u> was designed to be a true submarine, in which surface characteristics are subordinated to underwater performance. Her hull form was developed through a series of wind tunnel and hydrodynamic studies at the David Taylor Model Basin and the Langley Aeronautical Laboratory. <u>Albacore</u> was much quieter, faster, and more maneuverable than any earlier submarine and through a series of tests of various configurations she provided the model for all future United States Navy and most foreign submarines. Equipment developed and tested aboard <u>Albacore</u> was fitted on every subsequent United States Navy submarine. Antisubmarine excerises conducted with Navy surface forces forced warship designers to radically alter their estimates of submarine performance and thus the design of all vessels intended to counter them. Even the steel alloy of her hull was developed for her specifically and has been used in all U.S. submarine construction since. The hull form pioneered by <u>Albacore</u>, now wedded to the revolutionary nuclear power plant of the otherwise conventional USS <u>Nautilus</u>, allowed sustained underwater performance and gave rise to the first true submarine.

The preceding statement of significance is based on the more detailed statements which follow.

[X] See continuation sheet

9. Major Bibliographical References

SEE FOOTNOTES IN TEXT.

☐ See continuation sheet

Previous documentation on file (NPS):
- ☐ preliminary determination of individual listing (36 CFR 67) has been requested
- ☐ previously listed in the National Register
- ☐ previously determined eligible by the National Register
- ☐ designated a National Historic Landmark
- ☐ recorded by Historic American Buildings Survey # ______
- ☐ recorded by Historic American Engineering Record # ______

Primary location of additional data:
- ☐ State historic preservation office
- ☐ Other State agency
- ☐ Federal agency
- ☐ Local government
- ☐ University
- ☒ Other

Specify repository:
~~Portsmouth Submarine Memorial~~

10. Geographical Data

Acreage of property less than one acre

UTM References

	Zone	Easting	Northing
A	1 9	3 5 6 1 9 0	4 7 7 1 3 0 0
B			
C			
D			

☐ See continuation sheet

Verbal Boundary Description

All that area encompassed within the area defined by extreme length and breadth of the vessel.

☐ See continuation sheet

Boundary Justification

The entire vessel's area is encompassed within the boundary.

☐ See continuation sheet

11. Form Prepared By

name/title Kevin J. Foster, Historian
organization National Park Service (418) date July 28, 1988
street & number P.O. Box 37127 telephone (202) 343 - 9550
city or town Washington state D.C. zip code 20013

The test and evaluation program for Albacore was composed of five phases. In each phase different control surface and propeller arrangements were fitted. In Phase I, Albacore was fitted with large rudders and stern planes aft of a single small screw propeller. A thin rudder was also fitted to the aft side of the sail. Controls were consolidated so that one crewman controlled trim, ballast, and hydraulics and two more controlled depth, angle, speed, and heading (see Figure 3). [3]

In December 1955, after completion of Phase I testing, Albacore returned to Portsmouth Naval Shipyard for conversion to her Phase II configuration. This conversion changed the control surfaces and made Albacore quieter. The rudder and tailplanes were moved forward of the propeller and the auxiliary rudder on the sail was removed. Noise reduction studies were conducted and noisy machinery was isolated from the hull through the use of rubber pads. The ballast tanks and free flooding areas of the hull were coated with a new material called Aquaplas to absorb machinery noise and dampen flow noise in tanks and the superstructure. From November 1957 to March 1958, Albacore returned to the Portsmouth Naval Shipyard for engine maintenance followed by further noise reduction studies and tactical training with antisubmarine units. The bow diving planes were removed in October 1958 as part of noise reduction testing. This was so successful that they were not subsequently refitted. A larger 14-foot diameter screw was fitted in 1959. The last set of tests in Phase II involved a bow-mounted concave sonar dome (see Figure 4). [4]

Albacore entered Portsmouth Naval Shipyard in November for her conversion for Phase III testing. This work, completed in August 1961, included a radical "X" configuration for the stern planes, dive brakes, a large sail-mounted rudder, and a new bow dome for a high performance sonar. A succession of sonar and noise studies followed including testing of "Towflex," an early version of the towed sonar array carried by modern attack submarines (see Figure 5). [5]

The Phase IV overhaul lasted from December 1962 until March 1965. New electric motors were installed to drive two new propellers. These propellers are concentric--one left-handed and one right-handed, separated by a short spindle. The two screws turned in

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opposite directions. Still and motion picture cameras were installed to determine the cavitation characteristics of the various propeller sizes and spindle lengths tested. Two more modifications were made to the boat in Phase IV. New high capacity silver-zinc batteries replaced the traditional lead-acid type. These batteries allowed Albacore to operate longer at a high speed. The other modification was the installation of a new high pressure "emergency" ballast blowing system called "Subsafe." This would slam 3000 psi air from storage into the ballast tanks for a rapid return to the surface in the event of a power loss or other emergency (see Figure 1). [6]

Continuous testing in this test series saw the shortening of the distance between the two screws during an overhaul between August 1966 and August 1967 and further shortening in January 1968. A "fly-around-body" was tested in 1968. This is a sort of underwater kite which can be used to deploy antenna systems from a submarine's superstructure. [7]

A final series of tests made up Phase V. These involved installation of a classified system for attaining very high speeds.

Albacore was decommissioned and placed in the reserve fleet at Philadelphia in 1972. In 1984 Albacore returned to Portsmouth and was placed in the custom designed concrete cradle in an earthen basin where she now rests. Access is across a railed walkway from the edge of the basin to openings into her forward crew's quarters and egress is by way of another walkway from the propulsion machinery space aft. [8]

Albacore remains largely unaltered from her appearance at the end of her last series of tests. Phase V modifications have been removed and some control room and engine room instruments and gauges have been defaced due to Navy security restrictions.

NOTES

1
James C. Fahey, The Ships and Aircraft of the United States Fleet (Falls Church, Virginia: Ships and Aircraft, 1958), p. 21.

SEE CONTINUATION SHEET

2
"Inboard Arrangement Plan, Platform Deck Plan, Hold Plan," (ca. 1965) unpublished diagrams on file at Portsmouth Submarine Memorial Association.

3
Ships' Histories Section, Division of Naval History "Ships Named Albacore" (ca. 1962). Unpublished typescript on file in the Ships' History Section. David D. Merriman,Jr., "USS Albacore: Forerunner of Today's Submarines," Sea Classics, vol. 13, no. 1, (January, 1980), p. 21.

4
"Ships Named Albacore," pp. 4-5. Merriman, "Forerunner," pp. 21-23.

5
Eugene Almendinger, "Notes on the Significance of Albacore," Unpublished typescript on file at the Portsmouth Submarine Memorial Association. "Ships Named Albacore," p. 4. Merriman, "Forerunner," p.23.

6
Merriman, "Forerunner," pp. 26-28.

7
Merriman, "Forerunner," p. 28. Almendinger, "Notes."

8
"Historic Haul-out of the USS Albacore," (Portsmouth: Portsmouth Submarine Memorial Association, 1985), pp. 1-6.

DEVELOPMENT OF THE SUBMARINE

For hundreds of years shipbuilders have experimented with methods to allow them to attack enemy warships from beneath the sea. During the American Revolution the inventor, David Bushnell, built a one-man, hand-propelled submersible and attempted to sink a British ship-of-the-line in New York harbor. He was not successful. During the American Civil War a group of Confederate citizens designed and built a cigar-shaped submarine named H.L. Hunley to sink Union Navy vessels. Two crews died during testing and the third died at the moment they became the first submariners to sink an enemy vessel, USS Housatonic, when their victim sank on top of H.L. Hunley. [1] Progress continued and by 1897 an American, John Holland, had launched a vessel named Holland that combined most of the elements vital to submarines built over the next 50 years. Holland had water ballast tanks, an electric motor for underwater propulsion, a gasoline motor for propulsion on the surface, and self-propelled torpedo armament.

By the beginning of the First World War submarines were in many navies but were designed only for harbor and coastal defense and were considered the weapon of weaker powers. The concept of economic warfare designed to disrupt an entire economy came into force as the war progressed and submarines were ideally suited to pursue commerce warfare. The biggest improvement in technology during the war was the adoption of diesel compression-ignition engines to replace less efficient gas engines. By the end of that war, submarines and their role in wartime had grown to become an important part of naval warfare. During the period between the World Wars, submarines grew larger and assumed an even more aggressive role in war plans. When the Second World War broke out, submarines were the major naval weapon of Germany and important in the Japanese, British, and United States Navies. The most important innovations in this war were larger, more powerful batteries; stronger, deeper diving hulls; scientific streamlining; and snorkels which allowed submarines to use diesel engines to charge batteries while submerged. [2]

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ALBACORE AS DESIGNED, BUILT, AND MODIFIED

During the war, U.S. naval planners worked to design for the future. Soon after the end of the war, plans were made for two experimental submarines to be built to test some of the theories formulated using wartime data. One design was to test a prototype nuclear power plant and was to become USS Nautilus and the other was to test a new hull shape designed for extremely high speeds. This second sub was to be called USS Albacore. [3]

The hull forms in use during the Second World War were long and slim, usually about 11 times longer than they were broad. This is a hull form designed for high surface speed. Rear Admiral Charles B. Momsen pushed for a new hull designed for maximum underwater performance. To avoid compromises to satisfy various bureaus, Momsen kept Albacore's design within the Bureau of Ships and limited the requirements to achieve high-submerged performance. To garner support from outside the submarine community she was described as a "high speed target." [4]

In 1949 many of the best naval architects and scientific laboratories began to work on the ideal submarine hull form. Working at the David W. Taylor Model Basin in Carderock, Maryland, engineers and scientists built a series of models ranging in size from seven to 75 feet. From this testing, one form was developed and built as a model in two versions: one single screw and the other twin screw as in most earlier submarines. The two models were then tested at Langley Aeronautical Laboratory, Langley Air Force Base, Virginia, in the Full Scale Wind Tunnel to calculate drag and lift. Since air and water have comparable flow characteristics, the two models could be measured accurately and the data converted at the same time it was being used to predict full size performance. The single screw design was chosen and final plans for the full size boat completed. [5]

On November 24, 1950, Albacore was ordered from the Portsmouth Naval Shipyard in Portsmouth, New Hampshire. This yard specialized in submarine building and maintenance and was uniquely suited to building experimental submarines. Albacore cost $20 million and took 33 months to build. The hull was built of a new alloy called "low carbon steel STS" which was later

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renamed HY-80 and used in all subsequent U.S. submarines. She was launched on August 1, and commissioned December 5, 1953. After completion of her initial trials, Albacore began work on Phase I testing. This involved a thorough testing of performance and excercises with anti-submarine forces. Albacore proved to be fast, agile, and quiet enough to usually avoid detection. [6]

In December 1955 Albacore returned to Portsmouth for conversion for Phase II testing. The thin rudder was removed from behind the sail and the tail configuration was changed by removing the heavy tailplane and rudder system from behind the propeller and placing light rudders and tailplanes forward of the screw. This was the first modern application of this rudder first arrangement. It has since become standard on most submarines. Other changes were aimed at reducing noise by isolating noisy machinery from the hull with rubber pads and coating some surfaces with a sound dampening material. Later a 14-foot diameter screw replaced the smaller screw fitted earlier and the bow diving planes were removed to lessen flow and cavitation noises. Another test involved fitting a concave sonar dome on the bow. This, like the large propeller, was only fitted for a short while.

Albacore entered Portsmouth Naval Shipyard for conversion to Phase III configuration in November 1960 and emerged in August 1961 with a radical new "X" shaped stern plane arrangement, dive brakes around her middle, a large rudder behind the sail, and a new bow dome housing BQS-4A active sonar and BQR-2B passive sonar for testing. Extensive sonar testing was undertaken in Phase III. The bow sonar was modified and exchanged and a towed sonar array called "towflex" was tested. Towed sonar arrays have since become standard on many modern submarines.

Phase IV changes took Albacore back to the yard from December 1962 to March 1965. A pair of concentric, counter-rotating propellers replaced the single screw. These small high-speed propellers were tested to ascertain whether they could be used to directly harness the power of nuclear driven steam turbines without noisy reduction gearing. Still and motion pictures were taken of the screws to study flow and cavitation. The distance between the two screws was originally 10 feet but this was shortened to 7 1/2 and later 5 feet as testing proceeded. Two

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other modifications were made during Phase IV--high capacity silver-zinc batteries replaced the usual lead-acid batteries, doubling the capacity to allow longer operation at high speed. The other modification was the installation of most of the "Subsafe" system required after the Thresher disaster. The most important part of the system is an emergency ballast blowing rig that could flood ballast tanks with bouyancy-producing air in seconds during an emergency to return the boat to the surface. One of the equipment systems tested temporarily in Phase IV was a hydrodynamically deployed antenna labeled mysteriously a "fly around body" that acted as a sort of underwater kite to carry a communication antenna to just below the water surface. [7]

Phase V required modification for a final series of tests of a classified system designed to increase speed beyond what had been attained earlier. The nature and the results of this test remain classified at the time of this nomination. Ship design expert Norman Friedman gives Albacore's top speed when built as 26 knots and 33 knots when equipped with the silver-zinc batteries. The top speed of Albacore or any other submarine is stated by the Navy as "in excess of 20 knots." One former Albacore officer, forbidden to state any specific speed, said "Albacore has gone more in excess of twenty knots than any other submarine." [8]

Albacore was decomissioned and placed in the reserve fleet in 1972. In 1984 she returned to the place of her birth where she entered a specially dredged channel across a highway and railroad embankment and was placed in a custom designed berth where she now rests outside the Port of Portsmouth Maritime Museum. During her 19 years of service on the forefront of naval technology, Albacore lived up to her motto, "Praenuntius Futuri," forerunner of the future. [9]

NOTES

1
Alex Roland, Underwater Warfare In The Age Of Sail, (Bloomington: Illinois University Press, 1978). Dictionary of American Naval Fighting Ships Vol. II, (Washington, D.C.: Government Printing Office, 1963).

SEE CONTINUATION SHEET

2
Norman Friedman, Submarine Design And Development (Annapolis: Naval Institute Press, 1984), pp. 32-61.

3
Ibid, pp. 80-82.

4
Richard E. Winslow, Portsmouth Built: Submarines of the Portsmouth Naval Shipyard (Portsmouth: Portsmouth Marine Society and Peter E. Randall, 1985), pp. 138-140.

5
Alex Roland, Model Research: The National Advisory Committee for Aeronautics, 1915-1958 Vol. 2 (Washington: National Aeronautics and Space Administration, 1985), p. 513. Donald D. Baals and William R. Corliss, Wind Tunnels of NASA (Washington: National Aeronautics and Space Administration, 1981), p. 23. Cornelius Ryan, "I Rode the World's Fastest Sub," Collier's (April 1, 1955), p. 5. Winslow, Portsmouth Built, p. 140.

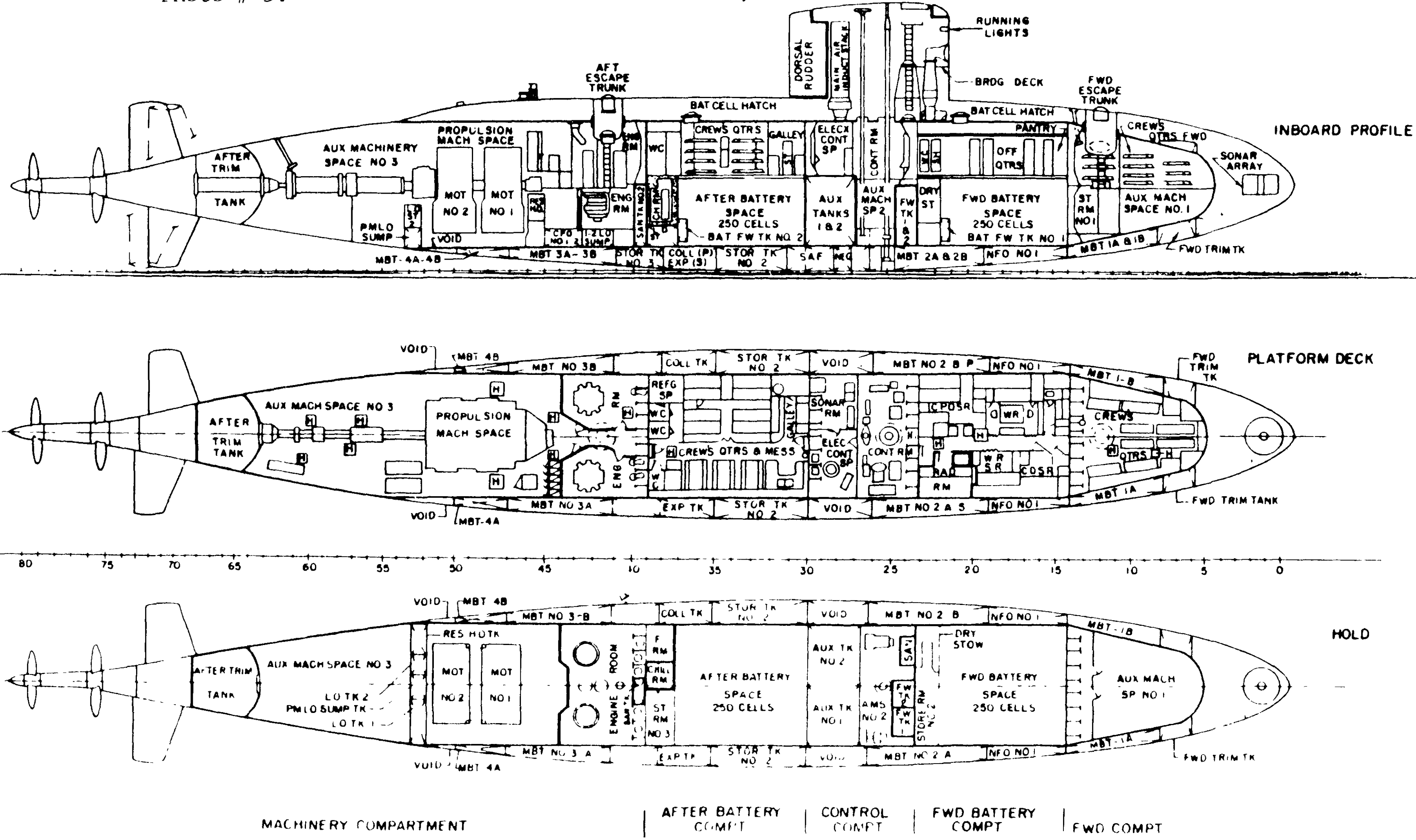
6
James C. Fahey, The Ships and Aircraft of the United States Fleet (Falls Church, Virginia: Ships and Aircraft, 1958), p. 21.

7
David D. Merriman, "USS Albacore: Forerunner of Today's Submarines," Sea Classics vol. 13, no. 1, (January, 1980), pp. 21-28.

8
Eugene Almendinger, " Notes on the Signicance of Albacore," Typescript on file at the Portsmouth Submarine Memorial. Friedman, Submarine Design," p. 82. Merriman, Forerunner, p. 26.

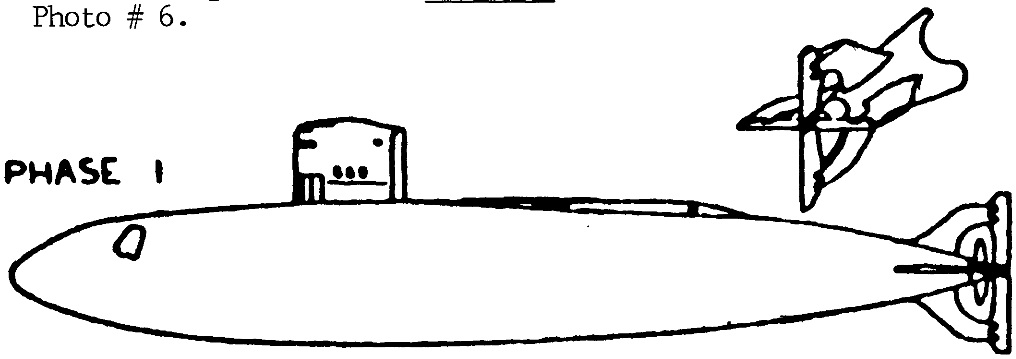
9
"Historic Haulout of the USS Albacore," (Portsmouth Submarine Memorial Association, 1985), pp. 1-6.

USS Albacore, Portsmouth, New Hampshire
Historical Illustration by Portsmouth
Maritime Museum and Submarine Memorial.
Portsmouth Maritime Museum.
Hull Section, Main Deck, Machinery Deck
Plans for Albacore.
Photo # 5.



USS Albacore, Portsmouth, New Hampshire
Historical illustration provided by Portsmouth Maritime Museum and Submarine Memorial.
Portsmouth Maritime Museum.
Figures II-V, showing various phases of test configurations for Albacore.
Photo # 6.

PHASE I



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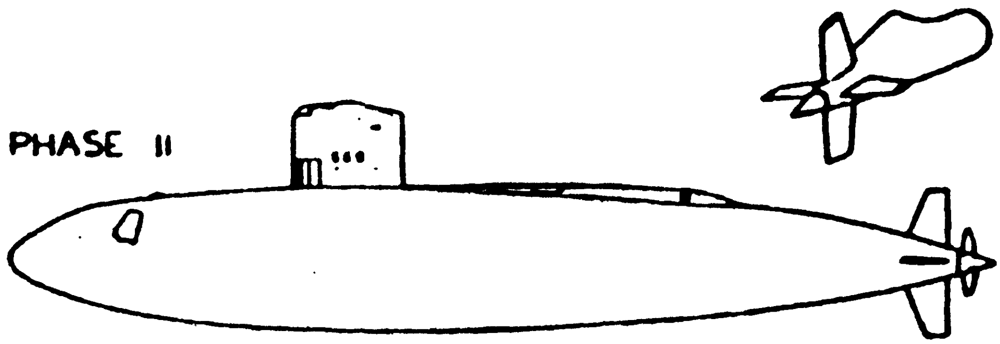
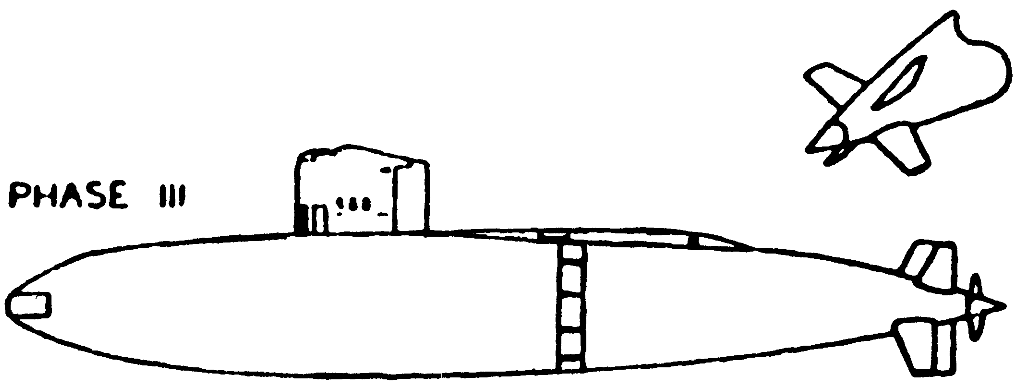


PHASE III



PHASE IV