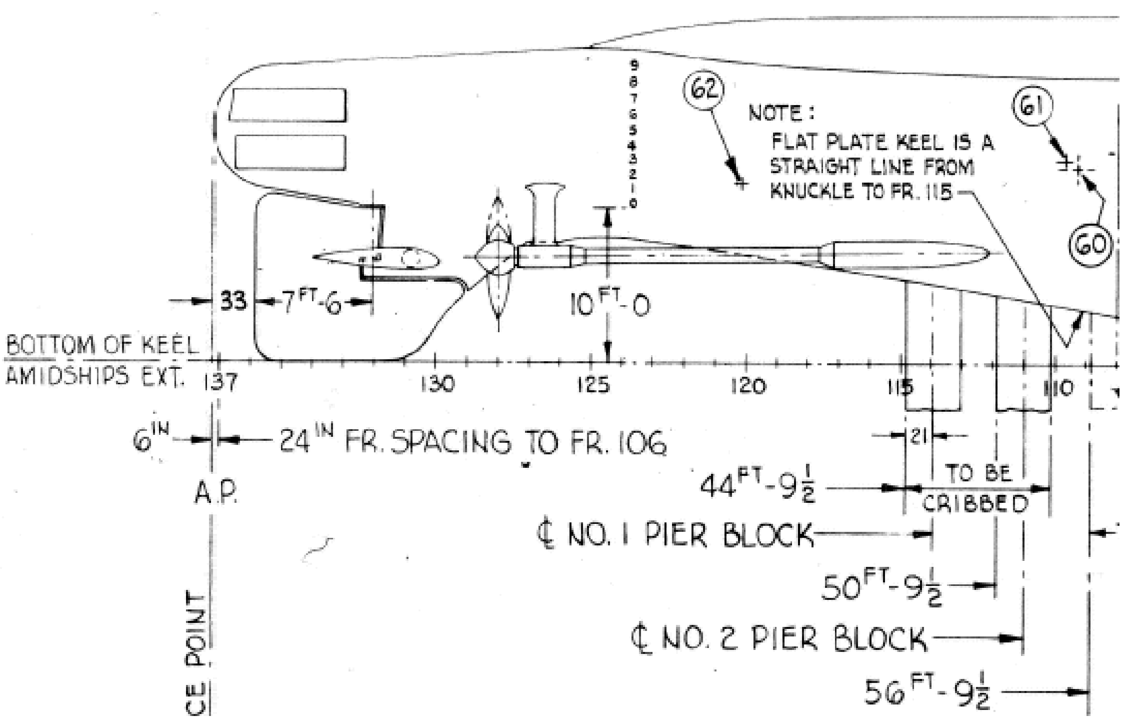
Shipyard Specification Package

U.S.S. CLAMAGORE (SS-343)



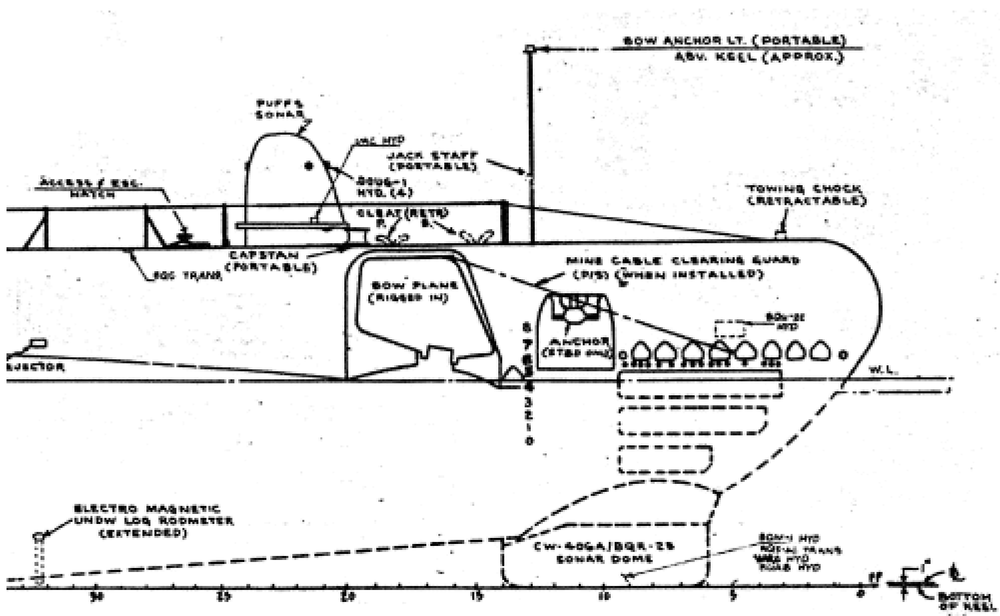
Joseph Lombardi

Ocean Technical Services, LLC.
Marine Surveyor & Consultant
10 Washington Street
Manchester, Massachusetts 01944

Member SAMS, ABYC, HNSA & SNAME

Hull Survey

U.S.S. CLAMAGORE
(SS-343)



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JOSEPH W. LOMBARDI

Marine Surveyor & Consultant

OCEAN TECHNICAL SERVICES, LLC.

P.O. Box 1576, Manchester, Massachusetts 01944 Office (978)-526-1894 Fax (978)-526-8390

Vessel Survey Report No. 2344

Vessel surveyed at:	Berth Site, Patriot's Point Museum, Mt. Pleasant, SC
Dates of survey:	19 - 28 April 2008
Vessel surveyed:	U.S.S. CLAMAGORE (SS - 343)
Survey commissioned by:	Mr. Bob Howard Patriots Point Naval & Maritime Museum 40 Patriots Point Road — Office 843-881-5978 Mount Pleasant, SC 29464 — Fax 843-881-5979
Purpose of survey:	Structural Survey

DISCUSSION

The Code of Federal Regulations (CFR), American Boat & Yacht Council (ABYC), International Marine Organization (IMO), National Fire Protection Association (NFPA), and the Society of Naval Architects and Marine Engineers (SNAME) are utilized in compiling this report; individual reference to subchapters of the above is not made within the body of this report. Other sources include the 'U.S. Navy Towing Manual', Naval Sea Systems Command, 'Manual on Ship Construction', George C. Manning: Van Nostrand Co., and 'Standards For Steel Hulled Vessels', American Bureau of Shipping, 'Stability and Trim for the Ship's Officer' by William E. George, Cornell Maritime Press and 'Ship Design and Construction' by the Society of Naval Architects and Marine Engineers.

VESSEL HISTORY

Keel Laid down by Electric Boat Division of General Dynamics Corp., Groton, CT 16MAR44;
Launched: 25FEB45 with Miss Mary Jane Jacobs sponsoring;
Commissioned: 28JUN45 with Cdr Sam Colby Loomis, Jr., in command;
Decommissioned: 12JUN75 and struck from the Navy List 27JUN75;
Serving as Museum Ship at Patriot's Point, Charleston, South Carolina.

World War II came to end while USS CLAMAGORE (SS-343) was on a training cruise off Panama. In January, 1946, CLAMAGORE became Flagship of Submarine Squadron FOUR based in Key West, Florida. CLAMAGORE carried the Squadron Flag until 1 August 1959.

U.S.S. CLAMAGORE at Key West, 1946, before conversions.

The U.S. Naval Shipyard, Philadelphia, Pennsylvania, was the site of CLAMAGORE's conversion to high speed GUPPY II (Greater Underwater Propulsion Power) submarine in the spring and summer of 1948. During this conversion, she received the snorkel installation.

During 1949 Fleet Tactical Exercise, CLAMAGORE was accorded the honor of being selected Flagship for Vice Admiral Duncan, USN, Commander Task Fleet, and Rear Admiral Fife, USN, Commander Submarine Force, U.S. Atlantic Fleet.

During 1955 CLAMAGORE made two trips to Guantanamo Bay, Cuba, rendering services to the Fleet Training Group for the periods 25 March to 25 April and 22 August to 16 September. Other ports visited during 1955 were Havana, Fort Lauderdale, and Pensacola, Florida. In November CLAMAGORE entered Charleston Naval Shipyard for installation of a new battery.

U.S.S. CLAMAGORE, post 1948 conversion to snorkel boat.

Upon leaving the shipyard in February, 1956, CLAMAGORE returned to Key West for operations. She visited Tampa, Mayport, and Miami, and Havana and Guantanamo Bay, Cuba; prior to entering the Charleston Naval Shipyard in September, 1956, for a regular scheduled overhaul.

The overhaul was completed in February, 1957, and CLAMAGORE went to New London Connecticut and Newport, Rhode Island prior to returning to Key West. A trip to Guantanamo Bay, Cuba preceded an extended cruise to Portsmouth, England, which was followed by liberty in Argentina, Newfoundland, on the return to Key West in December.

In February, 1958, CLAMAGORE participated in ASWEX 1-58. From June to August, CLAMAGORE was in Charleston Naval Shipyard for a battery renewal. During the local operations from Key West, V visited Savannah, Mobile, Alabama; and Tampa and Fort Lauderdale, Florida.

Local operations from Key West and a trip to Guantanamo Bay, Cuba were made from January to April, 1959. In April, CLAMAGORE participated in Exercise LANTBEX 1-59 and returned to Key West in June. The arrival of CLAMAGORE at Charleston Naval Shipyard for an overhaul on 29 June coincided with the change in home port of Submarine Squadron FOUR to Charleston. Overhaul was completed in December. From April to July, 1960 CLAMAGORE served with the U.S. Sixth Fleet in the Mediterranean.

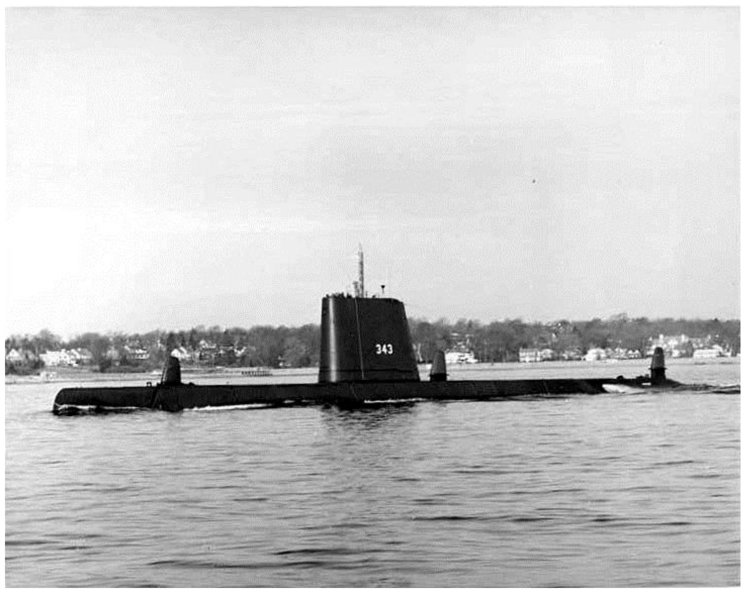
During January and February, 1961, CLAMAGORE participated in operation Springboard in the Caribbean. From August to December, 1961, CLAMAGORE participated in Operation UNITAS II which was a-joint antisubmarine warfare training exercise with eight South American countries: Argentina, Brazil, Chile, Colombia, Ecuador, Peru, Venezuela and Uruguay. During this cruise CLAMAGORE steamed around the southern tip of the South American Continent.

CLAMAGORE entered Charleston Naval Shipyard in May, 1962, for conversion to a GUPPY III type submarine. During this conversion, the ship was cut in half and a 15 foot, 55 ton section was added. The latest and most sophisticated electronics and fire control system were also installed.

VESSEL HISTORY (cont.)

On 2 July 1962 the new hull section was christened by Miss Ann Beshany, 16-year-old daughter of Captain P.A. Beshany, then Commander Submarine Squadron FOUR.

The conversion to a GUPPY III was completed in February, 1963. On 1 June 1963 CLAMAGORE changed homeports to New London, Connecticut at which time she was transferred from Submarine Squadron FOUR to Submarine Squadron TWO. During January and February of the following year, CLAMAGORE participated in Springboard, 1964, visiting San Juan in Puerto Rico and Saint Croix in the Virgin Islands. In late May she entered Portsmouth Naval Shipyard for battery renewal. Leaving the shipyard in July, CLAMAGORE visited Portsmouth, England in September, 1964. After an extended cruise, CLAMAGORE returned to New London in November, 1964.



U.S.S. CLAMAGORE departing New London, post GUPPY III conversion.

In early April, 1965, CLAMAGORE departed New London for a joint NATO operation south of Iceland with British, Dutch, American, and French submarines and aircraft. Upon completion of the very successful exercise, CLAMAGORE visited Londonderry in Northern Ireland in late May, 1965, for a wash-up conference. Following her return to New London in June; CLAMAGORE entered the Philadelphia Naval Shipyard on 23 July 1965. During this overhaul, CLAMAGORE received an extensive repair of its hydraulic system, the installation of the STEINKE Escape System, the modernization of its fire control system, and the overhaul of its main propulsion motors and generators. These and other repairs cost approximately $1,650,000. This shipyard overhaul was completed on 19 January 1966.

In early 1966 the CLAMAGORE was devoted to Springboard deployments and various other operational tasks. In March of 1967 CLAMAGORE entered Portsmouth Naval Shipyard for main battery renewal. Upon leaving the shipyard she rejoined the fleet for a Mediterranean deployment. She returned to New London in late 1967 and in March 1968 left for extensive operations in the North Atlantic. Her efforts resulted in her eight Battle "E".

After the 1968 overhaul in Philadelphia CLAMAGORE was engaged in type training, SSBN training cruises and local operations. In August, she headed south toward Bermuda where she participated in SUBASWEX 4-69. After more local operations out of New London, she returned to the Virgin Islands for a Weapons System Acceptance Trial.

VESSEL HISTORY (cont.)

1970 began with another Springboard deployment followed by a battery renewal. Another Mediterranean deployment followed the shipyard period where she operated extensively with aircraft, surface craft, and submersibles from various allied navies. CLAMAGORE then operated up and down the coast from Halifax, Nova Scotia to the Virgin Islands during much of 1971. September of 1971 found her engaged in operations in the Norwegian Sea. She spent the remainder of the 1971 in New London in upkeep and preparation for her scheduled overhaul. The 1972 overhaul was accomplished in Philadelphia. This major effort was completed in June, one month short of schedule.

The remainder of 1972 was devoted to a two-month deployment to the Caribbean encompassing refresher training, type training and a highly successful Weapons System Acceptance Trial. November 1972 saw the satisfactory completion of Successful Nuclear Weapons Acceptance Inspection.

In 1973, a month of local operations preceded a restricted availability at Portsmouth for main battery renewal and a main engine replacement. During the availability, preparations were begun for the upcoming UNITAS XIV deployment.

***Clamagore* (SS-343) against pier, *Tiru* (SS-416), *Blenny* (SS-324) & *Albacore* (AGSS-569), circa early 80's at the Philadelphia Navy Yard.**

CLAMAGORE decommissioned 12 June 1975 and was struck from the Navy List on 27 June 1975 and now serves as a Museum Ship at Patriot's Point, Charleston, South Carolina.

THE BASIC STRUCTURE OF NAVAL SUBMARINES

The structure of a modern submarine consists of a watertight envelope, which is designed to resist the pre-determined operational hydrostatic pressure. The principal elements are stiffened cylindrical sections, stiffened conical sections and the noncircular sections of the stiffened pressure hull, and closed end sections. Additionally, there is a secondary structure, which does not with stand the submerged sea pressure, called the non- pressure hull or outer hull.

The primary structural components, as in any ship, are the hull plating, hull stiffeners, and bulk heads. In the case of submarines, however, the thickness of the pressure hull plating is considerably greater than the hull plating for a surface ship since it is designed to resist the hydrostatic loads of depths above 400 feet. This heavy steel shell, approaching 7/8 inch thick, is further strengthened by circular ring frames positioned externally and/or internally depending on location. These hull frames are of either T or H cross section and are either rolled or welded-up shapes. They are generally spaces at 0.1 to 0.2 diameters apart.

Further wing bulkheads are placed to form tank boundaries, and additional stiffening with the shaped-end closure bulkheads complete the watertight hull.

To further delineate the study of submarine structure, we must first consider the structure in several main categories.

PRESSURE HULL

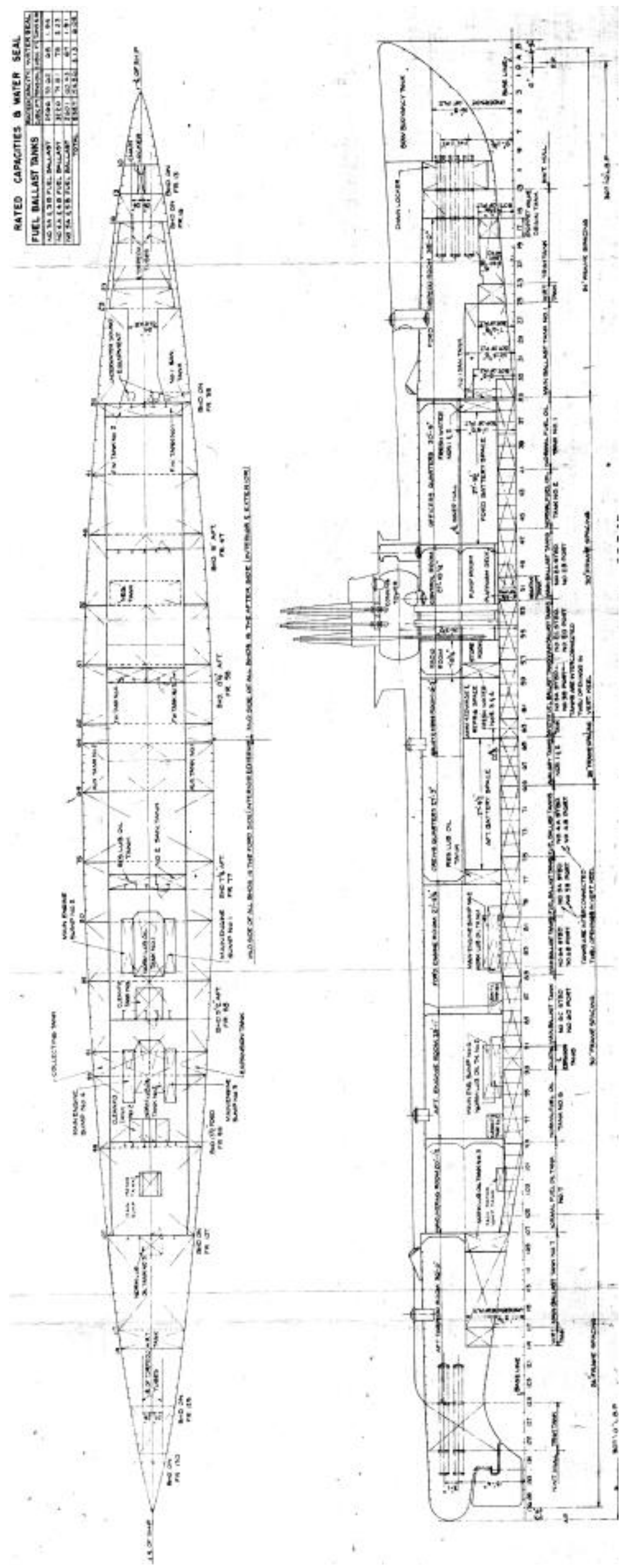
The pressure (strength) hull or the inner hull, as it is commonly referred to, must be comparatively strong and heavy to withstand hydrostatic pressures of deep submergence (test depth pressure). The principal structure associated with the pressure hull include the transverse bulkheads, which subdivide the submarine's length into watertight compartments, and circular transverse frames, both inside and out, which strengthen the hull and prevent collapsing when subject to test depth pressures. The pressure hull must form a watertight shell completely enclosing the operating spaces of the ship.

OUTER HULL

The outer hull forms the external boundary of the submarine except for appendages such as the superstructure, conning tower, and fairwater (sail). The principal outer hull structure includes a system of frames and bulkheads to subdivide the enclosed volume into tankage compartments. Certain portions of the outer hull, however, are subject to test depth pressures. These tanks (hard tanks) have heavily constructed frames and bulkheads which are almost a continuation of pressure hull framing rather than the lighter structure always found in the portion of the outer hull forming external boundaries for tanks not subject to sea pressure. The outer hull structure also includes the vertical and flat plate keels.

APPENDAGES

Appendages are structural items, control surfaces, piping, and other gear external to the outer hull. It should be noted that the total volume displaced by a submerged ship equals the volume displaced by the outer hull plus the volume of the appendages.



SUPERSTRUCTURE AND FAIRWATER

The superstructure and fairwater are constructed of lightweight plating and fiberglass panels bolted to the steel frames, as they are not subjected to any severe stresses and are not an integral part of the vessel's strength members. The form of the superstructure and fairwater provides an easy flow of water around blunt projections, thereby de-creasing submerged resistance to forward motion. It is important to note that the void space en-closed by the superstructure and fairwater has nothing to do with the ship's submersible properties as it is completely vented and free flooding.

TANKAGE

Generally, submarine tankage can be separated into two main classes: high-pressure tanks and non-pressure tanks. High pressure tanks are heavily constructed tanks built to withstand test depth pressures. During normal submerged operations, these tanks are completely full either with sea-water, fuel oil, or a combination of both. Non-pressure tanks are of light construction and, though exposed to the sea, are not subject to hydrostatic pressures. During normal submerged operations, these tanks are always completely full either with seawater, fuel oil, or a combination of both. Non-pressure tanks not directly connected to the sea, such as normal fuel oil tanks, are equipped to admit seawater and maintain pressure equilibrium.

Another division of the principal tankage is by groups according to their function. The abbreviations HP and NP in the following list refer to the high pressure and non-pressure classification:

1. Diving ballast, NP, (soft)
   a. Main ballast tanks
   b. Fuel ballast tanks - used as such when converted to be a part of the main ballast system

2. Variable ballast, HP, (hard)
   a. Forward trim tank
   b. Auxiliary tanks
   c. After trim tank
   d. Variable fuel oil tanks

Safety and negative tanks can also be used in the variable ballast system.

3. Fuel tanks
   a. Normal fuel tanks, NP
   b. Fuel ballast tank, NP - used as such when not part of the main ballast system
   c. Variable fuel oil tanks, HP
   d. Fuel oil collecting and expansion tanks, NP

4.) Special purpose tanks
   a. Bow buoyancy tanks, NP
   b. Safety tank, HP
   c. Negative tank, HP

Test Depth and High Yield

A definition of HY steel, (high yield) as well as the relation between test depth and crush depth is in order. It is difficult to discuss these concepts without also discussing hull strength. These explanations are sandwiched between narratives of harrowing dives that took American submarines far below their test depths.

The following provides some basic information on submarine hull strength including the definition of test depth and high yield:

Test depth is a theoretical number corresponding to the amount of area pressure that can be applied to a hull before it is violated by either distortion, warping, buckling or cracking. The pressure hull acts to prevent an equalization of pressure on both sides of the hull surface. When pressure is equal on both sides of a hull, such as is the case in a submarine's external ballast tanks, there is no need to attend to the problem of potential collapse.

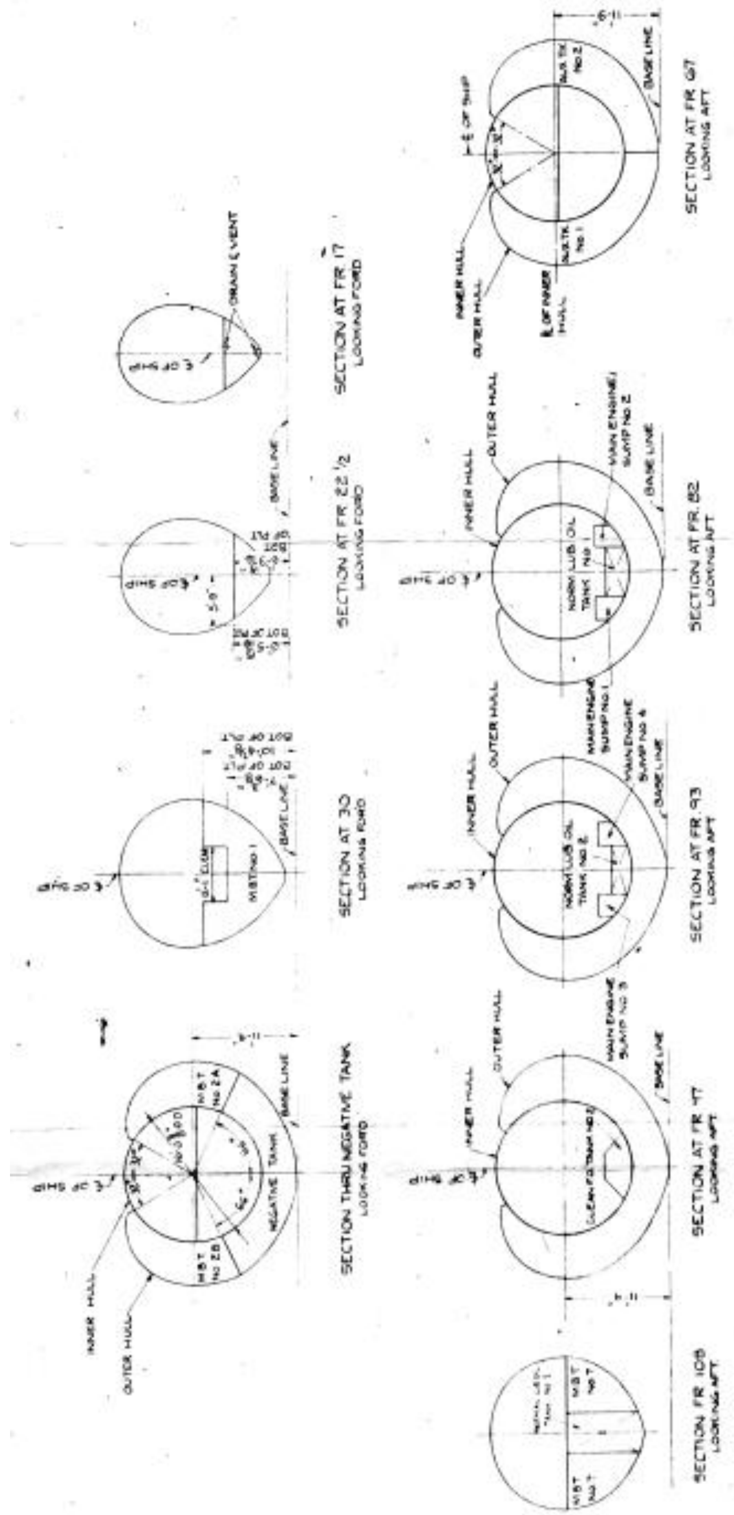
Test depth can be thought of as an engineering estimate of what pressure will be required on one side of a hull to breach the hull, taking into account such factors of hull strength as hull diameter, hull thickness, framing, and intrusions. Naval engineers tend to be conservative in their estimates and the varied factors tend to render an estimate as just that, an estimate. The engineers back into the problem by first estimating the crush depth of a hull, then creating the theoretical test depth by a applying a decimal factor to the crush depth. Different national navies apply varying factors. The United States Navy has used a factor of 1.5, but this has changed many times. Of course, computers are able to make such estimates much more trust-worthy, however, the accounts described "Steep Angles and Deep Dives" are, for the most part, in hulls designed before the advent of the computer.

In the U.S. Navy, hull designers depend on the experience of submarines to verify their estimates. Buships requires a submarine captain to immediately notify both Buships and the Chief of Naval Operations in writing when a boat under his command exceeds test depth. The captain's professional career may be jeopardized by a zealous attention to recording a dive that went wrong. Only in wartime can a captain reasonably explain the need to exceed test depth. For this reason submarines exceeding test depth sometimes fail to make note of the dive in their deck logs.

The simplest application of determining hull strength is the hull thickness. The thicker the hull metal the stronger the hull and the deeper the test depth, assuming all other factors are constant. Prior to the Balao class U.S. submarine, hulls were built of mild steel (MS) which had a maximum tensile strength of 60,000 pounds per square inch and a yield strength of 45,000 psi with 23 percent elongation. The thickness of hull plating until about 1943 was specified in terms of the weight of a square foot of plate rather than the actual thickness, and this was gradually increased from 20 pound plate (approximately one half inch) to twenty seven and a half pounds per square inch in the Salmon (SS-182).

Another change in the Balao class was the change in material used for hulls. High tensile steel was a chromium-vanadium alloy with a maximum tensile strength of 50,000 psi with 20 percent elongation. When the composition was changed to titanium-manganese alloy, because of wartime shortages, the strength dropped to 45,000 psi. The Salmon's hull was about seven eighths of an inch thick giving her a test depth of 250 feet. Conning tower shells were thicker as protection against surface guns.

The thick-skinned boats came along in 1942 with a test depth of 412 feet. These boats had the same seven eighths inch thick hull as Salmon, but the quality of hull steel ie., high tensile strength steel had significantly improved. The crush depth of these boats was estimated to be around 450 feet. Fleet type submarines built during the Second World War were to last through much of the cold war. These boats have careers that have lasted over fifty years with several still being used by foreign navies.



Hull sections for CLAMAGORE.

THE BASIC STRUCTURE OF NAVAL SUBMARINES (cont.)

After the war the Navy built several fast attack submarines. These had hulls about an inch and a half thick. They had a test depth of 700 feet. The same hull thickness and quality of steel was used on the early nuclear submarines.

A modern nuclear powered submarine normally has a test depth of over 2000 feet. This huge increase in operational depth came about from increasing the thickness of a hull, from strides in improving the quality of steel, from improvements in the manufacturing process and in hull framing.

Steel is an alloy made up of several metals other than iron. These may include chromium, nickel, manganese, titanium and a host of others. Metallurgy is the science of combining these elements to produce an iron metal that meets a specific need, in this case a hull which is resistant to sea pressure. During the Second World War Krupp of Germany and others used advanced techniques to produce hull plating of unusually high quality. America inherited some of the formulae and steel mills benefited by the German experience.

The key to producing metal hulls suitable to deep diving submarines is the quality of yield strength in combination with compression strength. Accurately controlled element content and relatively high percentages of alloy additives produces strength. The compression strength curve is relatively flat until it reaches a point where the molecules can no longer bind, then the metal fails by cracking and splitting. On the other hand it is possible to produce a metal hull that has the quality of bending rather than rupturing. It yields under pressure where its elasticity, (elongation) gradually succumbs to increasing pressure. The trick for the metallurgist is to strike a compromise and to use the correct ratio of alloy elements to gain a hull plate that resists pressure to the maximum through high compression strength, but yields enough to forestall the rupturing of the metal.

Steel strength is often measured by tensile strength. In this test the metal is pulled on both ends until it parts. Tensile strength is related to compression strength even though the tests are opposite, one pulling and the other pushing. For this reason submarine steel strength is often measured in tensile strength, not withstanding the nature of sea pressure as a compression force.

ALBACORE was constructed of HY-80 steel, the first of its kind to utilize this material.

Current American submarines such as the SEAWOLF and VIRGINIA use HY (high yield) 100 metals.

These designators attend to the elements used in the submarine hull's alloy where essentially the higher the number the more resilient and resistant the metal is to pressure.

The combination of elements to produce an alloy with great strength is only half the story of producing submarine hulls. The second factor in the manufacturing process is the tempering of the steel and shaping of the plates into a final form. Once again, the basic concept is that a slow-cooling steel tends to be resilient and a quick cooling steel tends to be brittle. Metallurgists in the middle ages learned this early on and after shaping a red hot sword on an anvil plunged it into water. This gave the sword a fine cutting edge resistant to chipping and dulling. The down side was that when struck by another sword it tended to shatter rather than yield. Thus, a submarine's hull plating is cooled at a specific rate designed to produce the best combination of stress and yield factors.

The shaping of the plate in the factory is accomplished with huge hydraulic rollers. The shaping process is also a compromise. Some alloys are cold rolled. This is the optimum in terms of preserving the alloy's strength in the shaping process, however, as the thickness of the plate increases the effect of the rolling becomes less and less. The modern mill now uses computers to cold roll submarine hull plates. Each pass through the rollers bends the steel a small amount until after many (in some cases hundreds) of such passes through the rollers the plate conforms to the correct hull curvature.

In determining the diameter of the pressure hull the engineer takes into account the metal thickness that will be required to meet a given strength level. The less the diameter the thinner the metal can be. The size of machinery largely determines the diameters of submarines. As the design of the submarine progresses the diameter of the hull inevitably increases. (Modern Trident missile submarines have a forty three foot diameter pressure hull) This necessitates a thicker hull where the alloys used and the shaping process is constant. Once again, the hull design process is one of compromise where interplaying factors are balanced against one another until a final design with an estimate of test depth is reached.

The curved plates of metal to make up the submarine's hull are further strengthened by frames. Lateral framing was known to the Vikings, although they started with a hull shape and only after the strakes had been laid did they imbed the frames into the preformed hull. Submarine hull strength is in large part a function of frame strength and spacing. Cross sections of frames are normally "T" shaped and can be within the pressure hull, on the exterior of the pressure hull, or both. The externally braced hull was the standard in submarine design, because piping and conduit cannot penetrate frames without compromising strength. With modern welding techniques it has been possible to grip the hull plate to the frame with such force that external framing is successful.

The distance between frames is crucial to determining test depth since this distance is where a compressed hull will yield or fail. The distance is a design function taking into account the factors described in this section.

The cylinder is the optimal shape for a submarine hull. A sphere is better still, however, the shape of a sphere does not accommodate a moving vessel through water. Only in experimental and exploration vehicles is the spherical hull shape used. A submarine is in essence, a long cylinder, made up of many sections welded together.

The tapered ends of the fleet type submarine (forward torpedo room and after torpedo room) called for innovation since the cylindrical form had to be compromised. These compartments were flattened for hydrodynamic reasons. Fleet type boats had exterior framing, however, in these end compartments the frames were interior as well as exterior. The deviation from circularity although small, produced a bending moment putting the shell plating under compression and the face plate of the frame under tension. Thus, the mass-produced fleet type boats had framing partly on the inside and partly on the outside of the pressure hull.

Three dimensional curvature for modern hemispherical bows require conical shaping, and tapered hull plating that in turn requires extensive welding.

The welding of the many plates and commensurate framing necessitates the greatest care. The weld seam must have the same strength as the abutting hull plates. This means that if welding is accomplished by hand the welder must be of the highest technical competence. Although a submarine may be similar to others in its class each is essentially hand built. Automation is limited, but computerization is extensive.

Hull butting is exact. Each cylindrical hull section must precisely match the adjoining section. Each cylindrical section has its edges ground to an approximate forty five degree knife edge. When two sections are mated the two edges form a trough. Actually, there are two troughs, one on the inside of the cylinder and the other on the outside. The welder (or machine) places the first bead at the deepest point of the trough. The next weld layer is placed on top of the deeper layer. As the process continues and the wedge shaped trough widens, more and more beads are placed side by side to fill the trough. Many hundreds of beads are required to bring the level of beading to the surface of the abutting hull sections. It is a long and tedious job and quality inspections are constant. Unfortunately, a perfect cylindrical hull with precise welding and engineered frame spacing must be punctured to allow various pipes, coaxial cables and rotating shafts access to the exterior of the hull.

Wherever such a hull opening occurs the hull must be reinforced by building up the thickness of the surrounding area. The larger the opening (such as for hatches) the stronger must be the build-up. Even when every effort is made to compensate for the loss of strength from a hull opening the point of violation will be the point of failure when the hull exceeds test depth.

Time destroys the hull from several directions. The metal itself fatigues over time. Additionally, the sea takes its toll with corrosion eating at the metal. Hull modifications requiring welding, heat the hull and thereby reduce the effectiveness of the initial tempering. Nicks, gouges and scrapes collectively take their toll.

GUPPY III CONFIGURATION

A problem that became evident in the mid-1950 operations was the increasing amount of electronic equipment that was required on a submarine. The ESM equipment, the sonar equipment and the new fire control computer took up a lot of space. Certain boats, which already had the majority of the Guppy conversion work done (already Guppy II) and were in decent condition, were taken into the shipyard, cut in half and lengthened with a new 15 foot section.

The extension was in the forward end of the control room and created a new space for sonar. (TIRU was only lengthened 12.5 feet instead of 15.) The Conning Tower was renewed with an additional 5 foot section to accommodate the Mk 101 fire control system and Mk 37 director.

The Guppy III conversion was accomplished as a part of the Fleet Rehabilitation and Modernization (FRAM) program. These four-battery, four-engine boats became Guppy III. The "Northern Sail" was also added, as it was on other classes of Guppys, in order to get the bridge higher which allowed it to be manned in severe weather. TIRU retained its three engine arrangement.

PREAMBLE

A structural survey of the U.S.S. CLAMAGORE was conducted at her berth (afloat) at the Patriot's Point naval & Maritime Museum in Mount Pleasant, South Carolina. The purpose of this inspection is to ascertain the true condition of the vessel and to understand the issues impacting her long term preservation.

This walk-through survey, performed at the request of Mr. Bob Howard, entailed a cursory, walk-through visual inspection of the overall physical condition and appearance of the vessel, with focus on its structural integrity, firefighting requirements, de-watering systems, and conditions that could lead to serious injury.

Inspections of the outboard ballast and inboard fuel tank system, interior fuel and ballast tanks and voids were not done; this is a shipyard evolution requiring the gas-freeing of spaces with proper ventilation and manning to Code of Federal Regulation (29 CFR) requirements. Where possible, visual inspections from tank manhole covers was accomplished and limited inspection of voids that had been opened previously were carried out.

The following chapter, hopefully, will guide the reader in the overall characteristics of this unique class of stretched Balao-class submarine.

The body of this report shall include a textual format with embedded digital images in a deck-by-deck report of inspection outlining the conditions found, lighting, degree of cleanliness, structural condition and suitability as a space for public access.

Recommendations and observations (if needed) for each space will be included within the text in **bold** type face obviating the requirement for a separate 'Recommendations' section.

Recommendations in **bold red** type indicate a safety issue or danger to visiting public or crew.

VESSEL DATA

The designer's waterline is parallel to the base line. It is located 15' 00" above the base line and corresponds only approximately with the designed normal load and draft.

The forward perpendicular is 2' 02" forward at the intersection of the designer's waterline with the stem. The aft perpendicular is tangent to the stern profile, at the intersection with the after end of the designer's waterline. The mid-perpendicular is located half way between the end perpendiculars (6.5' forward of Frame # 69). The section at the mid-perpendicular is the mid-ship section.

The molded base line is 1 inch above the bottom of the keel. The datum line from which drafts are measured is at the bottom of the keel.

The designer's waterline is 18' 06" above the baseline.

The actual mean draft in surface normal conditions is 15' 11 ½" and the trim is 5 ¾" by the stern.

SONAR DOMES

There are three BQG-4 sonar domes (PUFFS) located on the main deck centerline. These are designated No. 1 , No. 2, and No. 3 from forward aft. No. 1 contains six SD-2 hydrophones and an AN/UQC transducer. No. 2 & No. 3 each contain six SD-1 hydrophones. No. 1 PUFF is located between 4" forward of Frame 20 and 10" aft of Frame 24. No. 2 is located between 14" forward of Frame 68 and 10" forward of Frame 72. No. 3 is located between 6" forward of Frame 119 and 16" forward of Frame 124.

The AN/BQR-2B fixed dome is located between Frames 6 to 14 centerline underneath the vessel with its underside on a line with the baseline. This dome contains an AN/UQC transducer centered at Frame 13 centerline and a BQM-1 test hydrophone.

RODMETER

The rodmeter or electro-magnetic log is located 14" forward of Frame 33, 5' 06" starboard of centerline. In its down position it extends 3' 04 ½" below the shell, or 10 ½" below the baseline of the vessel.

This appendage should be inspected prior to movement of vessel.

Specifications:

Displacement:

Surfaced:	1,731 tons
Length (overall):	322' 05 1/4"
Length between perpendiculars:	322' 01 1/4"
Extension of vessel beyond forward perpendicular:	04"
Extension of vessel beyond aft perpendicular:	None
Length of designer's waterline:	319' 10"
Breadth, molded, maximum at designer's waterline:	26' 00 ½"
Breadth, extreme:	27' 04 1/8"

VESSEL DATA (cont.)

Depth, molded, amidships baseline to maindeck amidships:	23' 00 3/8"
Midship section is:	6.5' fwd. of Frame 69
Freeboard at bow:	9' 09"
Freeboard at stern at Frame 135:	3' 03"
Frame spacing (except from Frame 35 to Frame 62 & Frame 69 to Frame 105 where the spacing is 30"):	24"
Number of Frames:	143
Bottom of keel to molded baseline:	1"
Capacity of normal fuel oil tanks including clean oil tanks @ 95%:	57,846 gallons
Capacity of reserve fuel oil tanks (rated capacity):	62,474 gallons
Total capacity of fuel oil tanks:	120,320 gallons
Capacity of normal lubricating oil tanks @ 95%, sumps 75% Incl. main motor lube oil sumps @ 75%:	4,791 gallons
Capacity of reserve lubrication oil tank @ 95%:	1,848 gallons
Total capacity of lube oil tanks:	6,639 gallons
Capacity of potable water tanks:	8,246 gallons
Capacity of battery water tanks:	1,517 gallons
Inclination of shafts (down & aft);	0.1764"/ft.
Divergence of shafts, each shaft 0.5904 (outboard and aft):	1.1808"/ft
Area of rudder:	100 sq. ft.
Capacity of main ballast, fuel ballast & safety tanks, corrected to sea water for lead ballast and residual water:	562 tons
Capacity of variable ballast tanks incl. WRT and negative tanks:	178.17 tons

Heights above Normal Waterline

Highest point of fixed portion of vessel:	36' 06 ½"
Center of anchor light forward:	17' 02 ¾"
Center of masthead light:	27' 09 34"
Center of searchlight:	19' 06 3/8"
Center of sidelights:	21' 04 1/8"
Center of anchor light aft:	15' 08 ¾"
Center of stern light:	14' 08 3/4"
Control room platform deck:	4' 02 3/8"
Conning tower platform:	5' 07 ¼"
Bridge platform:	26' 10 ¾"
Bridge tower hatch submerges:	20' 01 ¾"

Calculated Data

Tons per inch immersion:	12.8 tons
Area of water plane:	10,820 sq. ft.
C.G. of water plane:	0.98" fwd. of Fr. 69
Moment to change trim 1":	237 ft. tons
C.B. above bottom of keel:	9.43'
C.B. forward of Frame 69:	5.87'
Transverse metacenter above C.B.:	2.69'
Transverse metacentric height:	1.27'
Longitudinal metacenter above C.B.:	386.6
Longitudinal metacentric height:	367.2
Area of amidships section:	358 sq. ft.
Wetted surface:	13,650 sq. ft.

VESSEL DATA (cont.)

Ratio, length between perpendiculars to beam molded:	11.78
Block coefficient (to 15' 11 ½" W.L.):	.514
Prismatic coefficient (to 15' 11 ½" W.L.):	.626
Midship section coefficient (to 15' 11 ½" W.L.):	.821
Waterplane coefficient (to 15' 11 ½" W.L.):	.635
Lead ballast:	12 tons

MAIN BALLAST TANKS (VENT PIPES INCLUDED)

Name	Location Frame	Cu.Ft.	Gallons	Tons Oil	Tons F.W.	Tons S.W.
1	25-35	1,729	12,933		48.03	49.40
2A & 2B	46-M1	1,527	11,422		42.42	43.62
2C & 2D	50-57	2,794	20,899		77.61	79.82
3A & 3B*	57-62	2,598	19,433		72.17	74.23
4A & 4B*	69-75	3,298	24,669		91.61	94.23
5A & 5B*	75-80	2,661	19,904		73.92	76.03
6A & 6B	80-85	2,334	17,458		64.83	66.69
6C & 6D	85-91	2,511	18,782		69.74	71.74
Safety	62-64	813	6,081		22.58	23.23
TOTAL		20,265	151,581		562.91	578.99

* Fitted for use as reserve fuel oil tanks.

NOTE: No deductions have been made for residual water or for lead ballast stowed in any of the main ballast tanks.

VARIABLE BALLAST TANKS

Name	Location Frame	Cu.Ft.	Gallons	Tons Oil	Tons F.W.	Tons S.W.
Aux.No. 1	64-69	1,077	8,057		29.92	30.77
Aux.No. 2	64-69	1,077	8,057		29.92	30.77
Negative	50-52	414	3,097		11.50	11.83
Fwd.trim	13-23	851	6,366		23.64	24.31
Fwd.W.R.T.	23-25	173	1,294		4.81	4.94
Aft trim	125-130	699	5,229		19.42	19.97
Aft W.R.T.	117-119	177	1,324		4.92	5.06
No.1A Var. Fuel Oil Tank	M3-50	884	6,614	20.54	24.56	25.26
No.1B Var. Fuel Oil Tank	M3-50	884	6,614	20.54	24.56	25.26
TOTAL		6,236	46,652	41.08	173.25	178.17

VESSEL DATA (cont.)

FUEL OIL TANKS

Name	Location Frame	Cu.Ft.	Gallons	Tons Oil	Tons F.W.	Tons S.W.
Normal No. 1	35-41	1,524	11,401	35.41	42.36	43.54
Normal No. 2	41-46	1,754	13,122	40.75	48.72	50.11
Normal No. 6	93-99	2,032	15,201	47.21	56.44	58.06
Normal No. 7	99-107	1,458	10,907	33.87	40.50	41.66
Collecting	91-93	400	2,993	9.30	11.11	11.43
Expansion	91-93	400	2,993	9.30	11.11	11.43
Clean Oil No. 1 (95 percent)	86-88 (Internal	82	611	1.90	2.28	2.34
Clean Oil No. 2 (95 percent)	97-99 (Internal	83	618	1.92	2.31	2.37
TOTAL	(Normal)	7,733	57,846	179.66	214.83	220.94

RESERVE FUEL OIL TANKS (RATED CAPACITIES)

Name	Location Frame	Cu.Ft.	Gallons	Tons Oil	Tons F.W.	Tons S.W.
Fuel Ballast 3A & 3B	57-62	2,530	18,924	58.77	70.27	72.28
4A & 4B	69-75	3,220	24,089	74.81	89.44	92.00
5A & 5B	75-80	2,601	19,458	60.43	72.25	74.32
TOTAL (Reserve)		8,351	62,471	194.01	231.96	238.60
TOTAL(Maximum) (at 6.96 lbs./gal.)		16,084	120,317	373.67	446.79	459.54

LUBRICATING OIL TANKS

Name	Location Frame	Percent	Cu.Ft.	Gallons	Tons Oil	Tons F.W
No. 1	76-77	95	161	1,201	4.13	4.47
No. 2	80-85	95	119	893	3.06	3.32
No. 3	107-109	95	139	1,037	3.56	3.86
Main eng.sump No.1	80-85	75	51	382	1.31	1.42
Main eng.sump No.2	80-85	75	51	382	1.31	1.42

VESSEL DATA (cont.)

LUBRICATING OIL TANKS - (Cont'd)

Name	Location Frame	Percent	Cu.Ft.	Gallons	Tons Oil	Tons F.W.
Main eng.sump No. 3	91-96	75	51	382	1.31	1.42
Main eng.sump No. 4	91-96	75	51	382	1.31	1.42
Main motor L.O.sump	101-103	75	18	132	0.46	0.50
TOTAL (Normal)			641	4,791	16.45	17.83
Reserve L.O. No. 1	57-59	95	124	924	3.17	3.43
Reserve L.O. No. 2	57-59	95	124	924	3.17	3.43
TOTAL (Reserve)			248	1,848	6.34	6.86
TOTAL (Maximum) (at 7.67 lbs./gal.)			889	6,639	22.79	24.69

SANITARY TANKS 100% CAPACITY

Name	Location Frame	Cu.Ft.	Gallons	S.W. Tons
No. 1	34-35	58	434	1.66
No. 2	76-77-1/2	90	673	2.57
No. 3	110-111	50	375	1.43
TOTAL		198	1,482	5.66

FWD. BATTERY FRESH WATER TANKS

Location		Pounds	Gallons	F.W. Tons
Frame	Side			
36-39	S	893	107	0.40
40-43	S	893	107	0.40
36-39	P	893	107	0.40
40-43	P	893	107	0.40
43-46	P	893	107	0.40
	SUBTOTAL	4,465	535	2.00
48-51	S	768	92	0.34
48-52	P	1,002	120	0.45
	SUBTOTAL	1,770	212	0.79
	TOTAL (FWD)	6,235	747	2.79

(AFT) BATTERY FRESH WATER TANKS - Cont'd

Location				
Frame	Side	Pounds	Gallons	F.W. Tons
59-63	S	919	110	0.41
63-67	S	919	110	0.41
68-71	S	919	110	0.41
72-75	S	919	110	0.41
61-64	P	919	110	0.41
65-69	P	919	110	0.41
69-72	P	919	110	0.41
(AFT) SUBTOTAL		6,433	770	2.87
TOTAL (FWD & AFT)		12,668	1,517	5.66

SHIP'S FRESH WATER TANKS

Name	Location		Cu.Ft.	Gallons	F.W. Tons
	Frame	Side			
No. 1 Starboard	35-36		112	838	3.11
No. 2 Port	35-36		112	838	3.11
No. 1A Stbd.	M1-M3	S	439	3,285	12.20
No. 1B Port.	M1-M3	P	439	3,285	12.20
TOTAL			1,102	8,246	30.62

VARIABLE FUEL OIL TANKS (100% FULL)

Name	Location Frame	Cu.Ft.	Gallons	Tons Oil	Tons F.W.	Tons S W
No. 1A Var. Fuel Oil Tank	M3-50	884	6,614	20.54	24.56	25.26
No. 1B Var. Fuel Oil Tank	M3-50	884	6,614	20.54	24.56	25.26
TOTAL		1,768	13,228	41.08	49.12	50.52

MISCELLANEOUS TANKS

Name	Location	Cu.Ft.	Gals.
Hydraulic system supply & vent tank	Control room Frs. 47-48P	7.09	53
Reserve hydraulic oil tanks	Frs.22-25P (3 tanks) Frs.25-27P (2 tanks)	30.21	226
Torpedo alcohol	Frs. 22-23S	6	45
Torpedo oil	Frs. 23-24S	6	45
Vapor compressor L.O. tank (1)	Fwd. engineroom		10
Hydraulic system vent tank	Fwd. torp. room Aft. torp. room		2 5
Hydraulic system air tank	Radio room	5	
Hydraulic system leakage tank	Control room		5
Hydraulic system vent tank	Conning tower		2

PROPELLING MACHINERY

(1) Diesel Engines - Main Generator engines: Number - 4

Manufacturer: General Motors Corporation, Cleveland Diesel Engine Division

Type: Mechanical injection, 2 cycle, single acting, oil cooled pistons, air starting, model 278-AS 8-3/4 by 10-1/2 inches

Number of cylinders: 16

R.P.M.: 750

Brake horsepower: 1600

(2) Main Generators

Number: 4

Manufacturer: General Electric Company, Schenectady, New York

Type: Single armature, totally enclosed, separately excited, self-ventilated, water-cooled air cooling system, compensated type, shunt wound

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Ratings:

Duty	Continuous Full Power	80 Percent Power	50 Percent Power
Volts	415	381	350
R.P.M.	750	675	600
K.W.	1100	880	550

(3) Main Control
Number: 2 (Split type)
Manufacturer: General Electric Co. - Model 3W59B1
Volts: 250-500 D.C.
Amperes: 3000 AMPS - Continuous Duty
(Operating Limits) 3600 for 90 min (overload)

(4) Main Motors
Number: 2
Manufacturer: General Electric Company, Schenectady, New York
Type: Double armature, enclosed, separately excited, self-ventilated through closed system with water-cooled air coolers, reversing, compensated type, compound wound

Ratings:

Volts	- 415	Armatures	-	2
Amps	- 2650	No. of Poles	-	8
HP/Shaft	- 2700	R.P.M.		42 - 360
Time	- Cont.	Enclosure - Watertight to shaft. Water proof above shaft.		

(5) Storage Batteries
Number: 4
Number of cells each: 126
Manufacturer: Exide Storage Battery Company
Type: MAW-65
Voltage (open circuit): 261
Ampere hours: 4340 at 1 hour rate at 1.265 sp.gr.

(6) Propellers
Number: 2
Type: Adjustable - manganese bronze
Number of Blades: 4
Diameter: 7 feet 6 inches
Pitch (Designed at .7R): 7.6[illegible] ft.
Shaft diameter at propeller: 9 inches - line shaft 9 inches O.D. by 5-inch bore
Weight of propeller & hub: Stbd 2440# Port 2390#

Reference:
SS-203-1899638 Prairie Propeller - 4 blades - Details GUPPY III Class SS351-416-425

For complete information and instruction concerning the propelling machinery, see the instruction books published by General Motor Corporation and the General Electric Company.

VESSEL DATA (cont.)

TORPEDO TUBES

There are two nests of fixed torpedo tubes for 21 inch or 19 inch torpedoes, one nest of six in the bow and one of four in the stern.

PRESSURE HULL CLOSURE PLATES

All closure plates are of 35 lb or 7/8" H.T.S. plate, have rounded corners (3" or 4" radius) and are welded flush with the pressure hull, using a continuous double-Vee butt weld.

Fr. 43-44	S	17" x 26-3/4"	Welded	Wardroom Passage Way
Fr. 48-51	P	33-1/2" x 40-1/2"	Welded	Control Rm.
Fr. 72-74	P	32-1/4" x 26-3/4"	Welded	Crew's quarters
Fr. 85-87	C.L.	7'-4" x 5'-0"	Welded	Fwd engine rm.
Fr. 96-98	C.L.	7'-4" x 5'-0"	Welded	Aft engine rm.
Fr. 103-106	Amid.	5'-4" x 5'-5	Welded	Maneuvering rm.

Reference Plans:

BUSHIPS No. SS-S1101-804450 - Welded Type Hull Closure Plates.

BUSHIPS No. SS313-S1101-781436 - Closing Plate Pressure Hull - Fwd Mach Compt

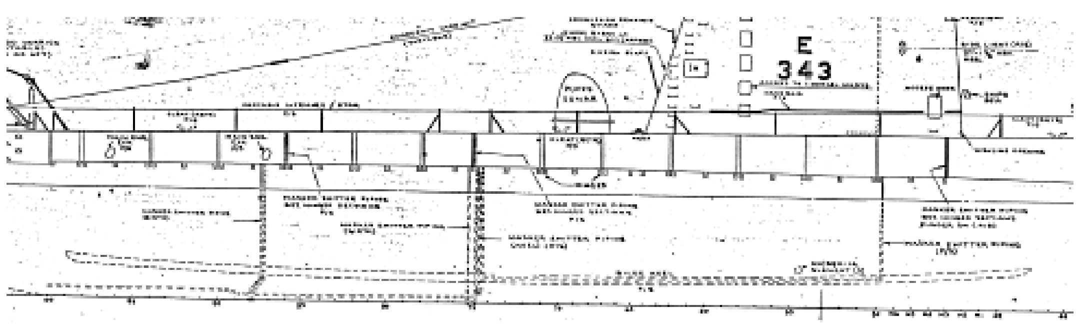
BUSHIPS No. SS313-S1101-781437 - Closing Plate Pressure Hull - Aft Mach Compt

BUSHIPS No. SS346-845-1521610 - Compartment & Access - Modifications

BILGE KEELS

The bilge keels are of 17.85 pound plate. They are 15" deep and designed to follow the stream lines of the vessel as far as practicable from Frame 41 to Frame 99.

These were not inspected at time of survey being underwater.

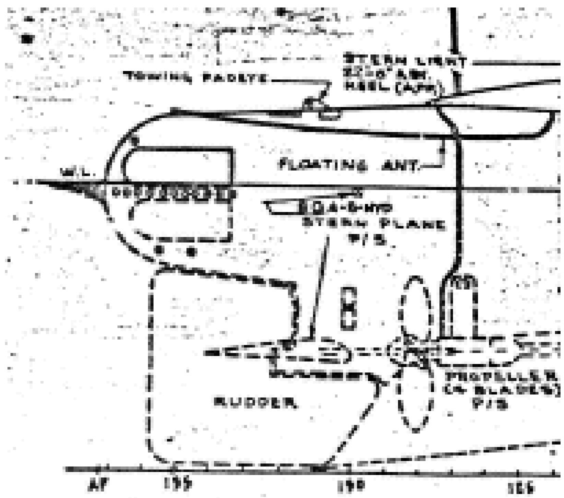


Bilge keel, located at near the bottom of the hull, arc fashion.

HULL INSPECTION EXTERIOR

RUDDER

The rudder is a built up structure of the balanced type. The cast steel frame is covered with 12.75 pound side plating (5/16”) rabbetted and welded watertight. The inside is filled with white pine and vegetable pitch poured in hot. Waterline sections through the rudder are streamlined. The area of the rudder is approximately 100 square feet and its weight, including the rudder stock, is approximately 15,500 pounds.



Rudder and underwater running gear appendage adjacent to rudder.

The frame is bored through it’s axis for the rudder stock. Along the axis, the frame is made with three openings. The middle opening, at about the center of the rudder, takes a stern casting step which is fitted with a lignum vitae lined bearing for the rudder stock. The upper and lower openings, in which the rudder stock nuts are secured are filled with wood and tallow and closed with four 12.75 pound (5/16”) portable plates which are secured with 1/2” diameter rolled naval brass screws.

The frame is bored above both nuts on tapers with the smaller diameters toward each other. The upper taper is fitted to the stock and keyed to it with two 1 ¼” x 1 ¾” keys 19” long which are secured to the stock. The lower taper is for a split composition M tapered bushing which the lower nut wedges against the stock.

The rudder stock nuts, the upper 8 3/4” I.D. and the lower 5 1/2” I.D., are each secured with a locking pin which is center punched to keep it in place. The rudder stock, which is 11’ 4 3/8” long and weighs 2,342 pounds, extends up through the lignum vitae lined stern bearing and into the non-watertight hull structure to be fitted with the bolted halves of the steering crosshead which is keyed to the stock with two 1 1/2” x 2 1/4” keys 14 1/2” long. At the top of the rudder, hard-over steel stops cast on the rudder frame take up the stern post casting to limit the travel of the rudder to 38 degrees each side of the centerline.

The upper end of the stock is fitted with a thrust collar which places the weight of the rudder on a bearing race supported by the framing of the non-watertight stern. Any vertical movement of the rudder is limited by a fitted composition washer on the stock between the rudder frame and the underside of the stern casting step.

RUDDER (cont.)

The steering gear, when using the main sources or source of power (manual), is capable of moving the rudder between the angle of which the limit stops come into action. The steering gear is of the electro-hydraulic type and under the usual condition of steering by power the steering rams are operated by oil delivered by the main steering pump located in the after torpedo room.

The direction and amount of rudder movement is controlled by the position of the tilting box of the pump. The position of the tilting box is controlled by the following two arrangements:

1.) A size 5, A-end speed gear pump is provided on the conning tower steering stand. By operation of this steering pump by hand, oil is delivered to the control cylinders in the after torpedo room.

2.) A "jury rig" arrangement permits local control of the main steering pump by means of a manually operated lever attached to the mechanism which controls the pump stroke. The lever is portable and is removed and stowed nearby when not in use. When local control of the main steering pump in the after torpedo room is required, place the "jury rig" arrangement into operation by attaching the portable lever to the pump control mechanism, by opening the control cylinder bypass valve, by closing the hand and emergency cut-out valves in the main cut-out manifold, and by starting the steering motor with the three position snap switch installed adjacent to the motor controller cabinet. Movement of the attached lever as required for right or left rudder replaces the action supplied by the control cylinders during normal "power" steering and regulates the flow of oil from the main pump to the main rams by changing the position of the tilting box of the pump. The lever must be returned to neutral for holding the rudder at any desired position. A mechanical rudder angle indicator driven from the port steering ram connecting rod, is located in the after torpedo room.

There are four methods of steering the vessel, viz:

a.) power (conning tower)
b.) hand (conning tower)
c.) emergency (control room)
d.) "jury rig" (aft torpedo room)

The rudder (underwater) and steering appendage was not observed at the time of the survey. The rudder post and steering rams are locked in the fixed fore and aft position.

FOWARD BOW DIVE PLANES

The bow diving planes, located at frames # 16-17 port and starboard, are supported by separate stocks and connecting rods but are identical installations.

The cast steel plane frame is covered with 10 pound (1/4") steel plating, rabetted and welded. The inside is filled with white pine and pitch and has about 730 pounds of lead fitted inside the forward edge to secure a balance in sea water around the axis of the stock. The area of each plane is 57 1/2 square feet and it's weight, including lead ballast, is 5,420 pounds.

At about the center of the plane a steel tapered pin carries a cast nickel copper alloy spherical ball. The ball is held within a compositional seat in the end of the connecting rod, which lifts the plane on the 2" x 10 1/4" hinge pin from the horizontal to the rigged-in position. When in the rigged-in position the planes are brought up hard against rubber bumpers on the side of the

FOWARD BOW DIVE PLANES (cont.)

superstructure.

Detail of forward plane to starboard, showing wasted superstructure deck framing and face plating.

Forward plane to starboard, showing wasted superstructure deck framing and face plating.

The two bow planes appear to be in fair condition in that the hinges for both planes (what is visible) appear in tough condition. The foundations/bases for these planes are deteriorating badly. Additional reinforcement will be needed. There is interior degradation of the planes with wastage holes at the bottoms of both planes.

HULL INSPECTION EXTERIOR (cont.)

STERN DIVING PLANES

The stern diving planes are a pair of built-up structures, balanced on a common axis. The cast steel frame is covered with 10.2 pound plating (1/4”+), rabetted and welded. The inside is filled with white pine and vegetable pitch poured in hot, except in way of the forward edge, which has about 1,700 pounds of lead fitted inside to secure a balance of sea water around axis of stock. Vertical sections through the planes are of airfoil shape. The area of each plane is 52 square feet and the total weight of both planes, including stock and lead, is 11,312 pounds.

The planes are carried on the ends of a horizontal athwartship stock 8’ 02” long, which passes through two composition M bearings in the stern casting. The stock is fitted with composition sleeves in way of the stern casting bearings and the ends enter the frames of the planes on a taper carrying two horizontal 1 1/8” x 1 1/2” keys that are 11” long. A compositional thrust ring is carried on the stock on each side between the plane and the stern casting bearing. A vertical tapered key is fitted in each end of the stock to wedge and secure the planes onto the stock. Two cover plates, rabetted into the frame of each plane, are fitted in way of the ends of the tapered keys, and secured with screws.

Both the tiller arm and cap are keyed to the stock at its center, between the two composition sleeves for the stern casting bearings. The tiller extends upward at a right angle to the plane of the diving planes. The hard rise and hard dive stops on the stern casting take up the forward and after side of the tiller arm to limit the travel of the planes to 27 degrees each side of the horizontal.

Both of these stern plane units are underwater and are in the slight up angle trim. Not observed at time of survey.

CONNING TOWER/SAIL

The conning tower is a built-up cylindrical shape 8’ in diameter, mounted horizontally amidships on the strength hull. It is located between frames 49-56, and the length is 24’ 00 3/4”. The entire structure is made of special treatment steel (STS), and the ends are fitted with convex heads.

Maindeck access to sail with assorted shore power boxes and transformers.

Looking aft in sail just above maindeck. Notice careless storage of gear and paint.

HULL INSPECTION EXTERIOR (cont.)

CONNING TOWER/SAIL (cont.)

A 21 x 27 inch oval hatch provides access to the control room and a 25 inch diameter W.T. hatch access to the bridge via an access trunk and another 25inch diameter W.T. hatch. The hatch to the bridge is fitted with a contact maker to indicate the dogged condition for submerging.

Upper flat of sail, looking aft.

Conning station windshield.

The conning tower is designed to be a control and steering station for both submerged attack and surface cruising. This structure is in fair/good cosmetic and excellent structural shape.

Remove all debris, properly stow all shipboard items, remove paint and rags from space.

Properly fence off all sail access panels to prevent pigeon/wildlife from creating a home for themselves. Utilizing a firehose, clean all standing dirt/debris from sail.

Free-up drainage limber holes to prevent standing water and develop schedule of regular flushing of space.

HULL INSPECTION EXTERIOR (cont.)

SUPERSTRUCTURE OR MAINDECK

The superstructure deck, called the *main deck*, extends virtually from the tip of the bow to near the stern rudder/plane assembly. The deck is generally level on the centerline but with a marked camber on each side. Beginning from aft the deck rises very gradually in the direction of the bow, to a height approximately 10 feet above the waterline.

The superstructure or main deck is attached to the exterior hull by means of the framing and rounded sides forward and aft. Limber holes in the sides allow sea water to enter all the hollow spaces in the superstructure and the deck when diving, and drain off when the submarine is surfaced. The sonar dome is fitted forward followed by the tapered portion of the pressure hull gradually flaring to the full width pressure hull aft.

Foredeck profile, showing area forward of the sail.

The maindeck also has temporary outboard handrails/railings with lifelines fitted along the length of the deck facilitating passage from the access hatches. A painted semi-non-skid finish has been applied to the steel deck for footing; this is in relatively good condition with rust/scale at the perimeters of hardware and hatches.

Minor trip/fall hazards abound with the uneven decking throughout the length of the maindeck. Not suitable at this time for public access.

Lifelines are not suitable for public access without major modification that would spoil the lines of the vessel.

The foredeck features one of two main access scuttles with vertical ladder for access to the forward crew berthing/torpedo room.

HULL INSPECTION EXTERIOR (cont.)

SUPERSTRUCTURE OR MAINDECK (cont.)

Maindeck, aft, looking toward stern tubes.

The forward access hatch has much standing water with wasted/scaled deck covering. Design adequate drainage portals; repair as needed and prime/paint.

HULL INSPECTION EXTERIOR (cont.)

SUPERSTRUCTURE OR MAINDECK (cont.)

Hull fairing at bow to starboard, looking aft.

Overall view of port bow of CLAMAGORE, showing wasted plating for superstructure fairing.

The vessel's hull fairing forward has been intermittently immersed in standing warm salt water for many years. This has caused a failure of the vessel's paint coating system and resulting heavy rust scale of the hull plating and forward appendages. Much of the plating and structural members below the torpedo tubes is badly deteriorated and only a shipyard period can rectify this damage.

Ascertain scope of wastage to bow framing and hull scantlings at time of drydocking, repair as needed and install sacrificial anodes.

Properly sandblast hull to SSPC-10 Near White blast, prime and paint hull.

HULL INSPECTION EXTERIOR (cont.)

SUPERSTRUCTURE OR MAINDECK (cont.)

The superstructure deck forward and aft of the sail is in exceedingly poor condition. Much of the support foundation is rotted away with a crude attempt to strengthen the deck by the installation of wooden 4 x 4 and 2 x 4 planks.

This area is directly below maindeck and is a free-flooding space with limber holes cut into the exterior plating to facilitate drainage.. A forward anchor windlass and chain locker is fitted with an associated hawse pipe designed for a fluked anchor. Anchor and chain rode are aboard. Structural members support the maindeck and sail above. Also, there is associated piping and storage compartments for various operational gear (anchor windlass and warping capstans, etc.). Hinged steel deck plates allow limited access to this crawl space. At this time there are no structural issues outstanding, but structural members are rusted/scaled which demands attention.

There is significant corrosion occurring because of the following conditions:

1.) Pigeons have a major roost in this space with resultant damage to coating system due to acid related corrosion from standing guano.

2.) Standing water atop the pressure hull/ballast tankage due to blocked limber holes and standing dirt/debris.

Properly fence off all topside limber holes to prevent pigeon/wildlife from creating a home for themselves.

Utilizing a firehose, clean all standing dirt/debris from superstructure deck.

Free-up drainage limber holes to prevent standing water and develop schedule of regular flushing of space.

Properly sandblast superstructure deck to SSPC-10 Near-white blast, prime and paint.

Wasted mooring cleat foundation, typical of superstructure deck material condition.

HULL INSPECTION EXTERIOR (cont.)

SUPERSTRUCTURE OR MAINDECK (cont.)

Midship area of superstructure deck being crudely supported by 2 x 4 wood planks.

The deck between the public access paths, around the sail, and stern area is unsafe.

Properly template and replace all mooring cleat foundations as needed, immediately.

Properly template existing structure, fabricate and install new deck to historic standards.

UNDERWATER HULL

The hull bottom is freely eroding without benefit of an impressed cathodic system operational at time of survey; it is understood that Patriot's Point has engaged a contractor to design and install a new cathodic system.

The forward and aft torpedo tubes, being of bronze construction, are causing havoc galvanically with the surrounding steel structure. Much deterioration of forward and aft structure was observed at time of survey; this will require further inspection, fabrication and repair at time of drydocking. The area aft of the sail is suffering rust/scale on the exterior because of poor drainage on top of the fuel/ballast tanks.

HULL INSPECTION EXTERIOR (cont.)

UNDERWATER HULL (cont.)

Wasted structure around bronze torpedo tube.

Perform an ultrasonic inspection of the exterior fuel/ballast tankage at time of drydocking, crop out any plating with greater than 25% wastage and install new steel inserts.

Design, fabricate and install cover boxes over all ballast tank valve openings.

Design, fabricate and install cover boxes over all other through-hull openings from the pressure hull and fuel/ballast tankage.

Properly sandblast hull to SSPC-10 Near White blast, prime and paint hull.

Access hatches/escape scuttles both fore and aft (integral to the shell plating) have mildly wasted hinges and need new gaskets to be properly locked/secured.

Template, remove old wasted structure and renew with new scantlings the bow and stern fairing, foundations and shell plating around torpedo tubes.

TANK MANHOLES

The flat and flush type manholes are provided with 1/8” plant fiber gaskets except the fresh water tanks which have 1/8” sheet asbestos and the reduction gear oil tanks which have a 1/16” asbestos sheet gasket. The boiler-type manholes are provided with 7/8” x 11/16” rubber gaskets.

Bolted hatches and manholes on the ballast and fuel tanks have not been opened as part of this survey (although they may be opened to facilitate ventilation or periodically pumped with air to dewater tanks).

SOME standing oil and contaminated water have been pumped ashore. Tanks have not been inspected as this is strictly a drydock function where inspection is per 29 CFR for ‘safe entry’. Gas freeing is a necessary prerequisite before entering any of these tanks.

HULL PLATING

Inward compression of plates on her superstructure and ballast tanks is evident in many areas of the topside hull; sure evidence of the long operational life of the vessel. Condition of the hull from the sheer to the waterline is cosmetically rough, as expected after many years of service. Steel railings and ladders are in need of maintenance on the exterior of the superstructure; replace the pins and secure new chains where appropriate. All of the foredeck anchor handling gear and anchor chain is housed and secured.

A cast/forged hawse pipes are well anchored to the stem for housing the anchor; the anchor cannot be dropped or operated at this time; the amount of chain in the chain locker is unknown.

The chain locker is free-flooding; it is assumed that there is an inordinate amount of rust/scale/mud present; this should be explored at time of drydocking.

Properly secure anchor in hawse as weldment beads holding anchor are failing.

The vessel’s ballast tankage at the wind/waterline was ultrasonically tested at time of survey with the following results. Wind/waterline plating is 9# and 10# (7/32” & ¼”) mild steel plating throughout. Refer to ‘Shell Plate Expansion Plans’ for exact locations.

HULL WIND/WATERLINE, Starboard, Bow to Stern on 4’ Centers

.130 .191 .195 .176 .156 .148 .067 .089 .178 .098 .200 .115 .211 .222 .194 .156 .136 .057 .167 .189 .099
.155 .222 .200 .206 .221 .209 .154 .130 .167 .156 .143 .122 .200 .136 .147 .167 .178 .111 .190 .126 .145
.090 .130 .167 .157 .126 .072 .083 .138 .089 .200 .145 .210 .178 .154 .167 .111 .122 .194 .156 .136 .221
.207 .209 .219 .155 .122 .100 .156 .121 .189 .154 .130 .167

HULL WIND/WATERLINE, Port, Bow to Stern on 4’ Centers

.156 .143 .122 .200 .236 .147 .167 .178 .211 .149 .156 .234 .155 .132 .213 .141 .199 .188 .150 .145 .140
.146 .057 .144 .144 .150 .142 .063 .072 .069 .175 .054 .141 .137.083 .157 .152 .151 .157 .143 .051 .052
.063 .041 .150 .050 .130 .167 .156 .143 .122 .200 .236 .147 .167 .178 .111 .149 .156 .134 .155 .132 .213
.141 .199 .188 .150 .145 .155 .147 .159 .133 .120 .075 .062

Due to low shell plate readings, often exceeding the 25% threshold, it is recommended that the vessel’s waterline area in the splash zone be re-plated from bow to stern, port and starboard.

HULL INSPECTION EXTERIOR (cont.)

WATERTIGHT DOORS

The watertight doors are of built-up welded construction and tested originally to 200# per square inch hydraulic pressure on the 20” x 38” doors and 400# per square inch external pressure on the 30” D. doors. All doors are operated by a pair of crank handles located on each side of the door. The doors are further provided with an interlocking device which prevents the operation of the crank handles to lock the door until the door is closed, thereby insuring a portion of the locking dogs which will not interfere with the closing of the door at any time.

The bulkhead doors are held open by spring loaded latches on the adjacent structure. The door for the forward escape trunk can be closed from inside the vessel by means of extension shafts through the pressure hull. A pin in the quadrant of the operating arm for this inboard closing device, is used to hold the door in the open position. The bulkhead doors may be held in the closed position without the operation of the locking mechanism by a single dog mounted in the door with an operating handle on each side. These doors are in excellent shape and are intact; they can be closed. Excellent gaskets.

PUBLIC ACCESS BROWS

Two doors have been cut into CLAMAGORE’s hull to facilitate public access to the forward and aft torpedo rooms; adequate railings and stairwells are fitted. Both utilize steel brows with adequate handrails with a small entry foyer that can be locked at each entrance/exit. Each access station has been cut through the exterior pressure hull with adequate non-skid intact, lighting installed and handrails provided. These public access brows are in good repair.

HULL INTERIOR

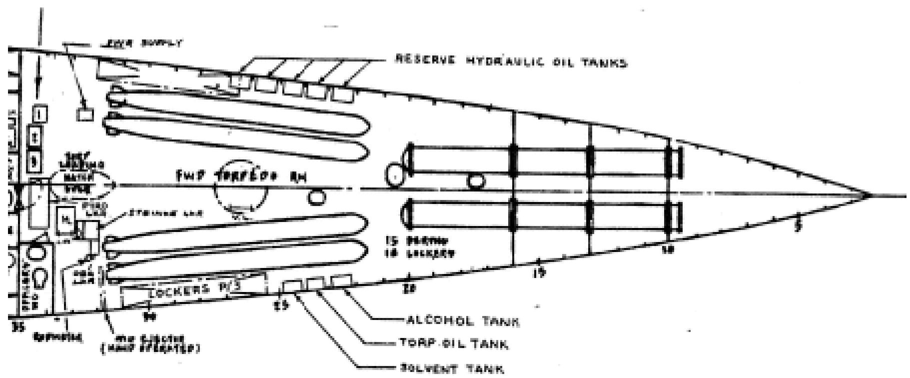
The interior of the vessel is divided into two main decks:

a.) The Platform Deck, which is the top deck.

b.) The Hold.

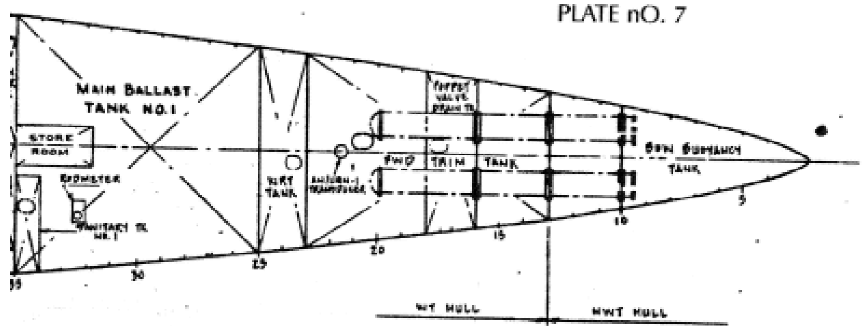
Only the 1974 INSURV report is extant and is not detailed as to the hull's structural condition. It is more concerned with equipment that could be of service to active fleet units. This report did state that the ship could not presently meet current operational needs because of outmoded communications and habitability conditions. Also, an expensive overhaul of her machinery would be necessary to correct deficiencies due to current safety operational guidelines. This report was instrumental in having the vessel stricken from the Naval Vessel Register in 1975.

FORWARD TORPEDO ROOM & HOLD SPACES



Forward Torpedo Room, Frames 0 – 35

PLATE nO. 7



Hold, Frames 0 – 35.

FORWARD TORPEDO ROOM (cont.)

Forward torpedo room, looking aft.

Forward torpedo tubes.

FORWARD TORPEDO ROOM (cont.)

Interior of Forward Trim Tank.

Floor under main cabin sole of Torpedo Room, showing debris and loose stowage.

The following observations are made as to the condition of this space:

1.) Heavily rusted and scaled under main floors over forward trim tank.
2.) No standing water.
3.) Forward torpedo tubes do not appear to be leaking.
4.) Well lighted.

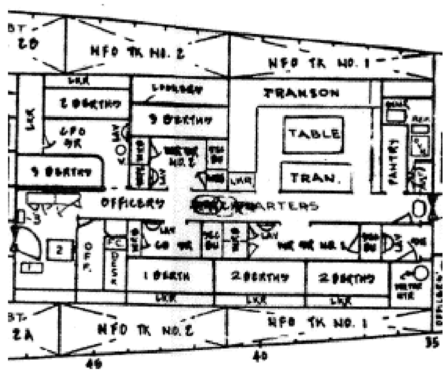
1.) Renew transverse floor panels, several are loose, deteriorated and are in need of replacement.
2.) Replace loose of missing floor tiles.

Pressure hull thickness gauge readings are as follows:

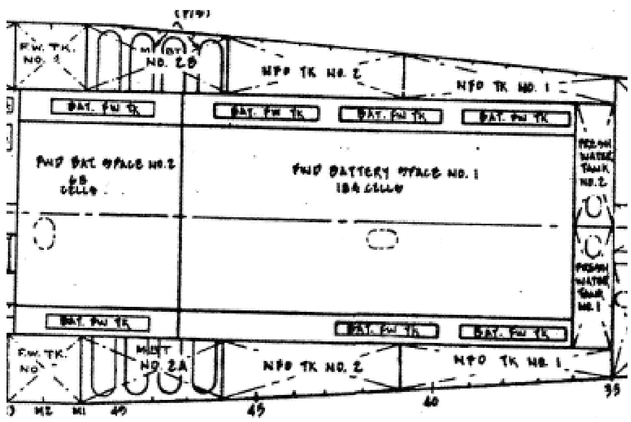
PORT	.675	.621	.590	.550	.622	.605
STBD	.623	.605	.678	.590	.555	.633

HULL INTERIOR (cont.)

OFFICER'S COUNTRY & FORWARD BATTERY ROOM



Platform Deck, Frames 35 – 48 ½.



Hold, Frames 35 – M3.

The following observations are made as to the condition of this space:

1.) All spaces in excellent material and cosmetic condition.
2.) Well lighted.
3.) No standing water.
4.) Battery room contains empty batteries in original condition, very interesting space.

Pressure hull thickness gauge readings are as follows:

PORT .643 .620 .655 .641 .590 .602
STBD .622 .600 .612 .620 .633 .645

OFFICER'S COUNTRY & FORWARD BATTERY ROOM (cont.)

Wardroom.

Watertight dogging door on interior passageway.

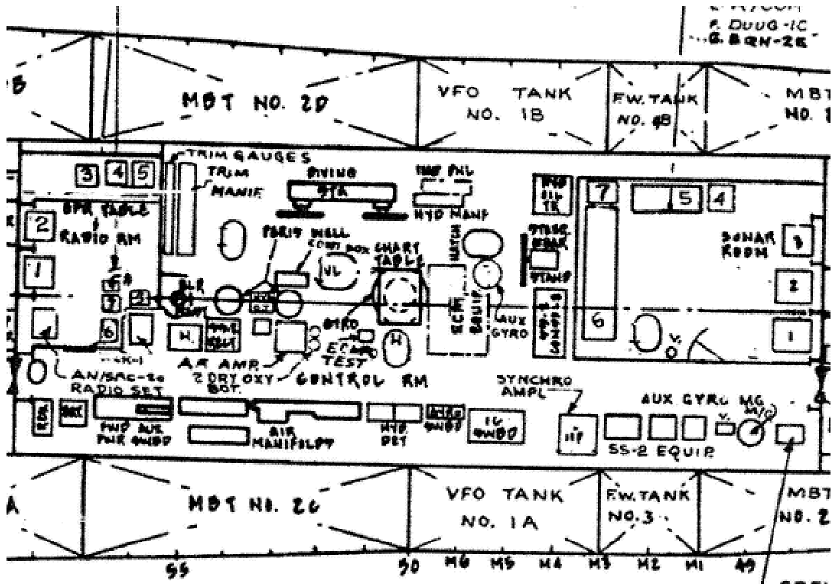
OFFICER'S COUNTRY & FORWARD BATTERY ROOM (cont.)

Forward Battery Room, looking forward to port. Largely original.

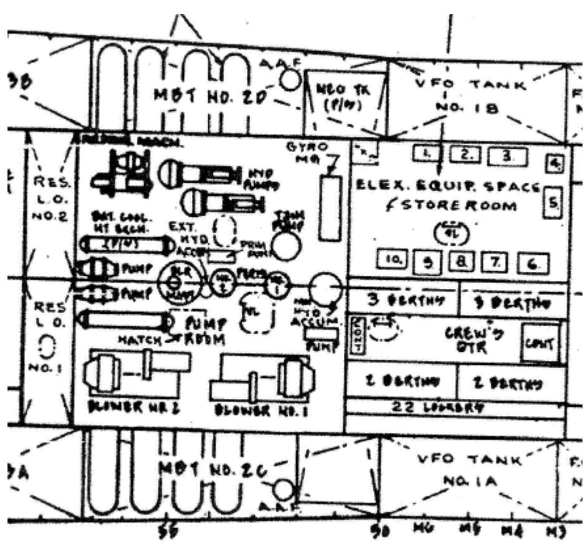
Forward Battery Room, looking aft to port.

HULL INTERIOR (cont.)

CONTROL ROOM, SONAR ROOM, PUMPROOM, BERTHING/STOREROOM



Platform Deck, Frames 47 – 58 ½.



Hold, Frames M3 – to Frame 58 ½.

The following observations are made as to the condition of this space:

1.) Well lighted in control room, not well lighted in sonar room and storeroom.
2.) Control room in good material and cosmetic condition.
3.) Sonar room and storeroom are dirty, rust/scale evident, possible PCB/oil contamination.
4.) Some standing water/oil in bilges (4-8”) with heavily corroded bases of bulkheads. Standing water from leaks from periscope tube in conning tower.

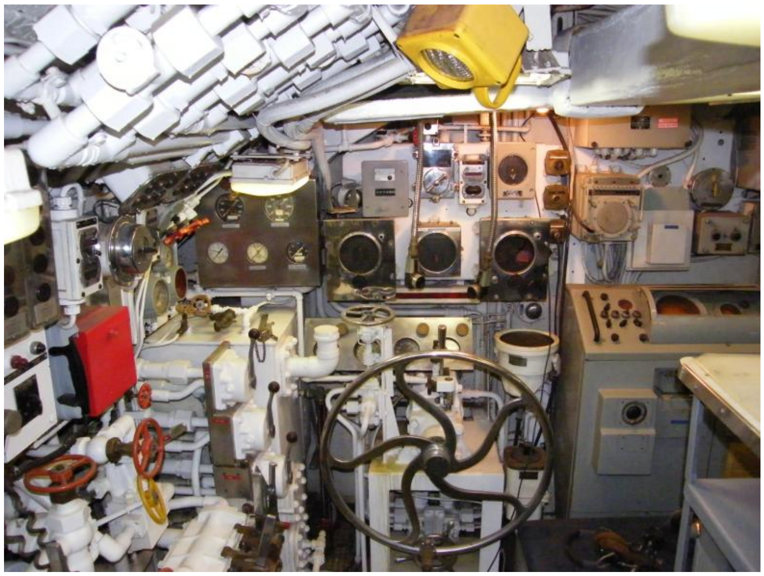
HULL INTERIOR (cont.)

CONTROL ROOM, SONAR ROOM, STOREROOM (cont.)

Pressure hull thickness gauge readings are as follows:

PORT .602 .540 .625 .607 .670 .612
STBD .634 .600 .631 .560 .593 .545

1.) Properly seal periscopes from rainwater entry above.
2.) **Remove and properly dispose of all standing hydraulic and lubrication oil in piping and sumps.**



Control Room, helm station.

Sonar Room.

HULL INTERIOR (cont.)

CONTROL ROOM, SONAR ROOM, STOREROOM (cont.)

Standing oil in Pumproom.

HULL INTERIOR (cont.)

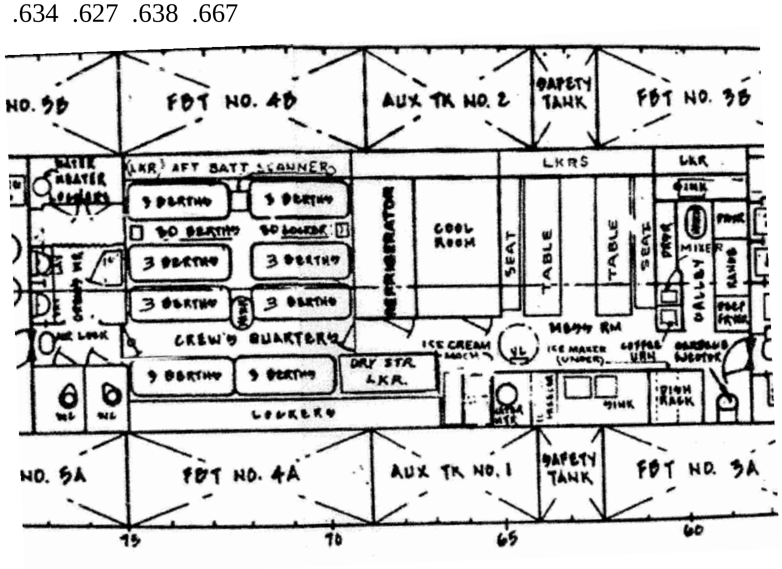
CREW’S GALLEY/MESSDECKS, STOREROOM & AFT BATTERY ROOM

The following observations are made as to the condition of this space:

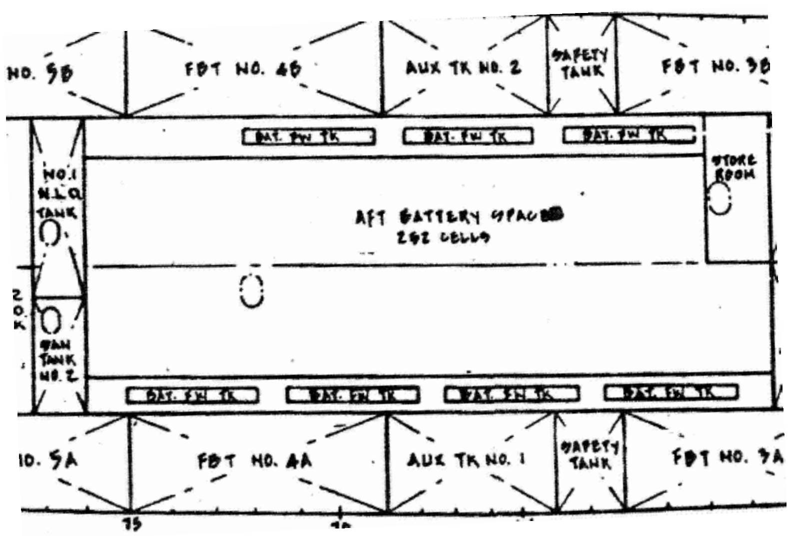
1.) Well lighted in galley and mess spaces, not well lighted in battery/store room.
2.) All spaces in good material and cosmetic condition.
3.) Storeroom is dirty with rust/scale evident.

Pressure hull thickness gauge readings are as follows:

PORT	.573	.580	.625	.641	.670	.668
STBD	.642	.615	.634	.627	.638	.667



Platform & Hold, Frames 58 ½ to 77 ½.



HULL INTERIOR (cont.)

CREW'S GALLEY/MESSDECKS, STOREROOM & AFT BATTERY ROOM

Crew Messdeck.

Crew Galley.

<u>HULL INTERIOR (cont.)</u>

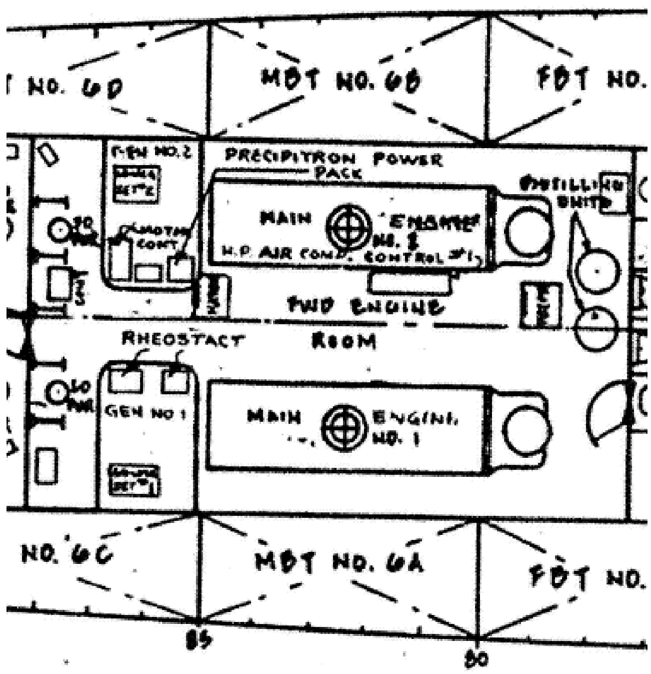
CREW'S GALLEY/MESSDECKS, STOREROOM & AFT BATTERY ROOM

After Battery Room, looking forward to port.

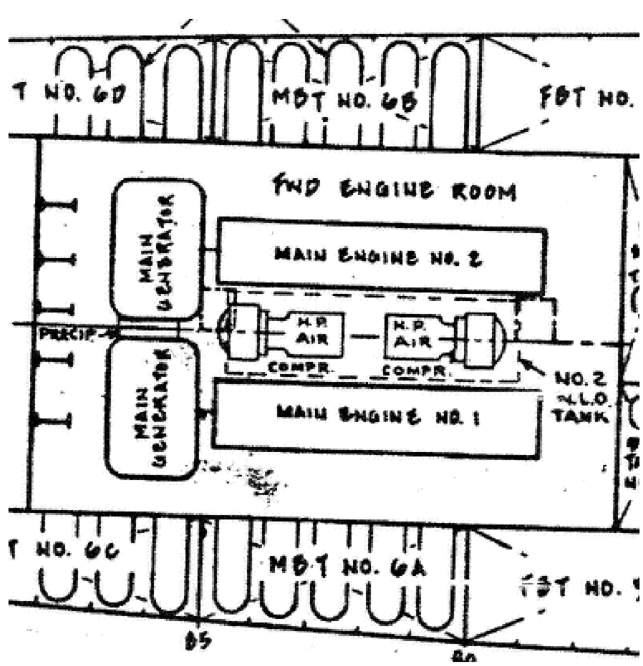
After Battery Room, looking aft.

HULL INTERIOR (cont.)

FORWARD ENGINEROOM



Platform, Forward Engineroom, Frames 77 ½ to 88.



Hold, Forward Engineroom, Frames 77 ½ to 88.

HULL INTERIOR (cont.)

FORWARD ENGINEROOM (cont.)

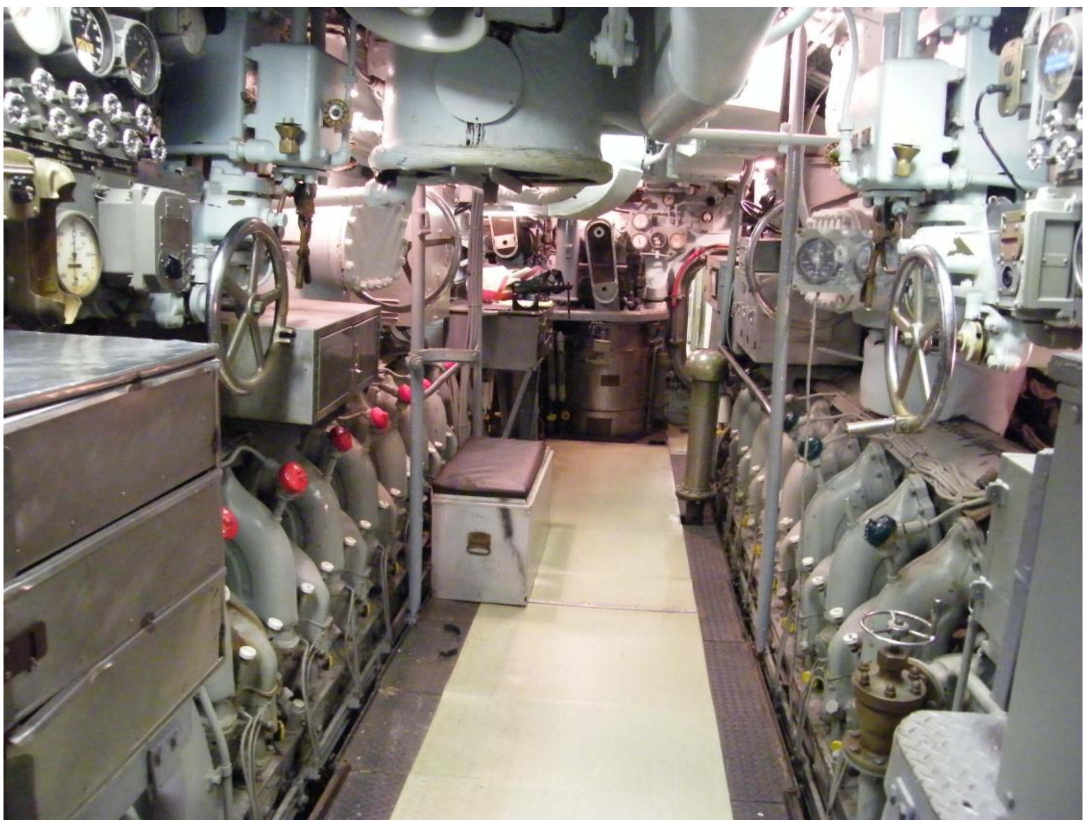
The following observations are made as to the condition of this space:

1.) Well lighted in upper engineroom, not well lighted below.
2.) Upper engineroom in good material and cosmetic condition.
3.) Lower engineroom is dirty, heavy rust/scale evident, possible PCB/oil contamination.
4.) Some standing water/oil in bilges (3 to 4").
5.) Hatches to lower room needs locking devices.

Pressure hull thickness gauge readings are as follows:

PORT .597 .589 .634 .666 .675 .588
STBD .624 .653 .634 .634 .647 .650

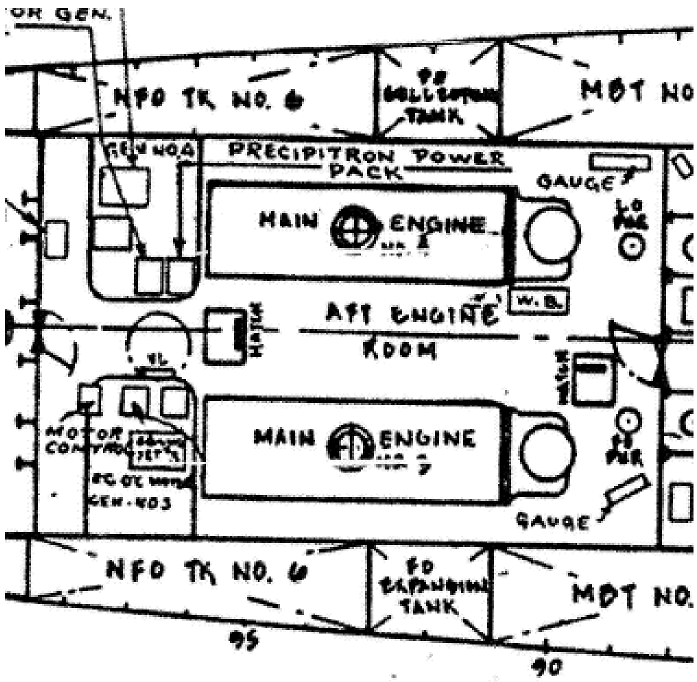
1.) Properly dispose of all standing oil from bilges and sumps.
2.) Consider cleaning, sanding and painting lower bilge space.
3.) Install proper lighting for bilge space.



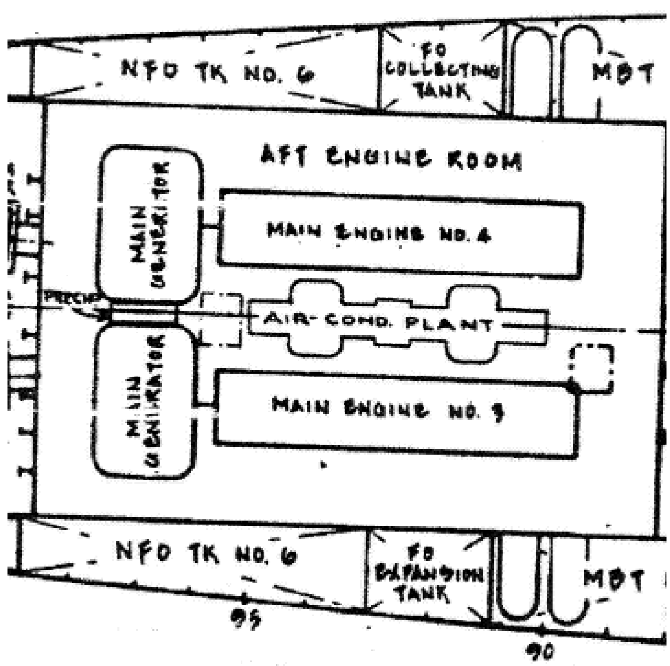
Forward Engineroom, looking aft..

HULL INTERIOR (cont.)

AFTER ENGINEROOM



Platform Deck, After Engineroom, Frames 87 ½ to 98.



Hold, After Engineroom, Frames 87 ½ to 98.

HULL INTERIOR (cont.)

AFTER ENGINEROOM

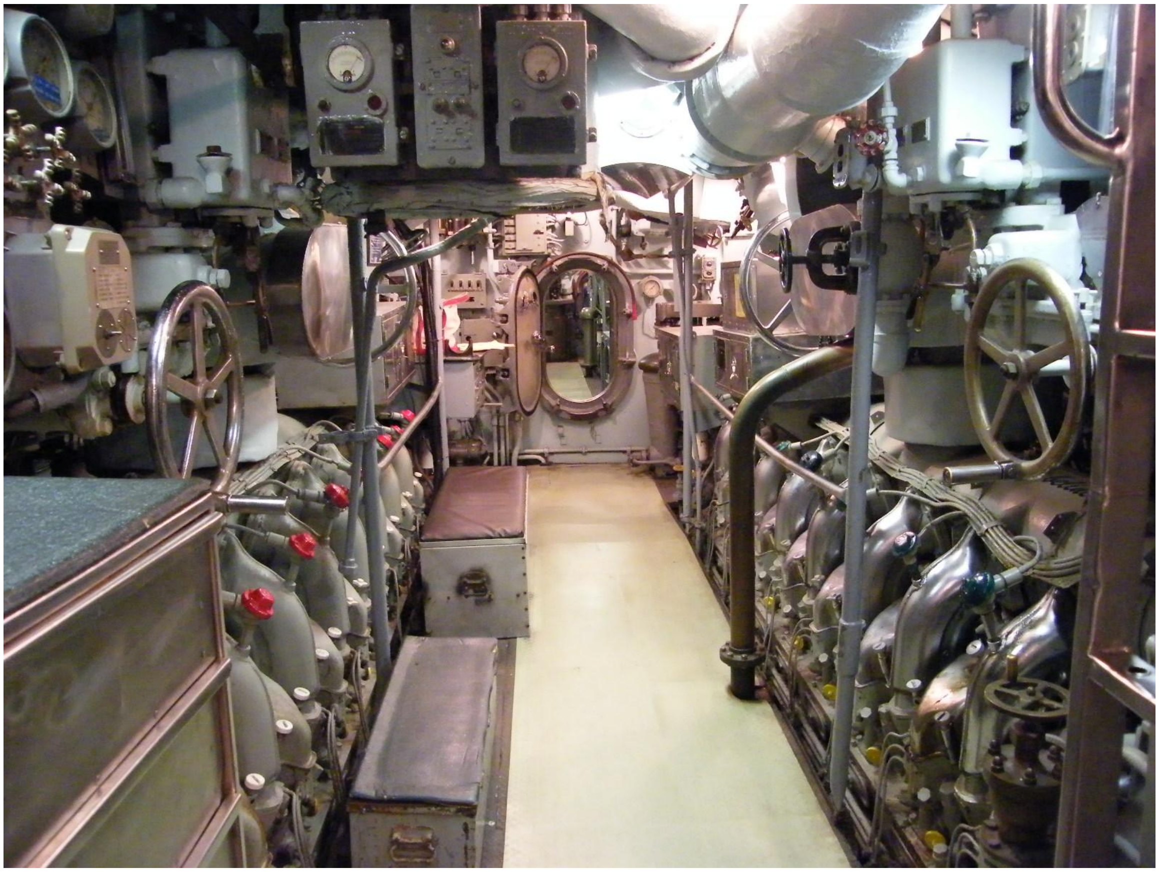
The following observations are made as to the condition of this space:

1.) Well lighted in upper engineroom, not well lighted below.
2.) Upper engineroom in good material and cosmetic condition.
3.) Lower engineroom is dirty, heavy rust/scale evident, possible PCB/oil contamination.
4.) Some standing oil in bilges.
5.) Hatches to lower room needs locking devices.

Pressure hull thickness gauge readings are as follows:

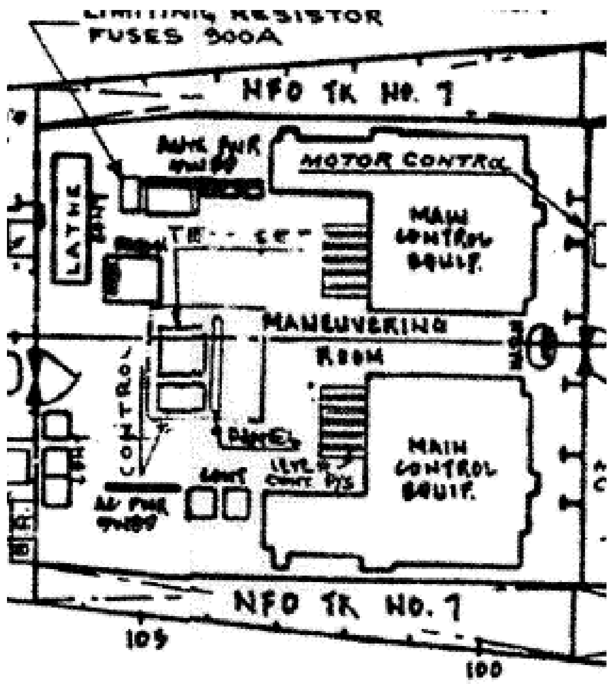
PORT	.602	.592	.644	.635	.655	.608
STBD	.600	.689	.695	.699	.723	.753

1.) Properly dispose of all standing oil from bilges and sumps.
2.) Consider cleaning, sanding and painting lower bilge space.
3.) Install proper lighting for bilge space.

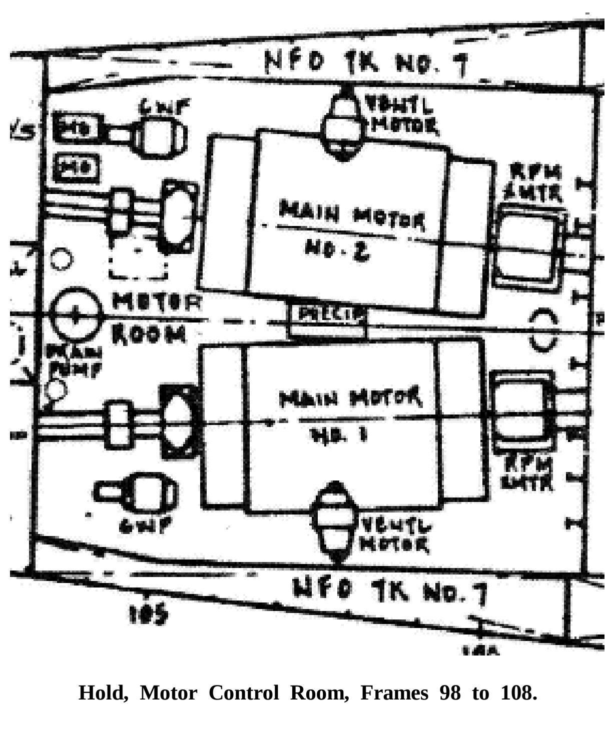


Aft Engineroom, looking aft.

MAIN PROPULSION & MOTOR CONTROL ROOM



Platform Deck, Motor Control Room, Frames 98 to 108.



Hold, Motor Control Room, Frames 98 to 108.

MAIN PROPULSION & MOTOR CONTROL ROOM (cont.)

The following observations are made as to the condition of this space:

1.) Well lighted in upper room, no lighting below.
2.) Upper control room in good material and cosmetic condition.
3.) Lower motor room is dirty, heavy rust/scale evident, possible PCB/oil contamination.
4.) Much standing water in bilges (12 to 18") with heavily corroded bases of bulkheads and foundations.
5.) Hatches to lower room needs locking device.
6.) Both shaft packing glands seeping water.

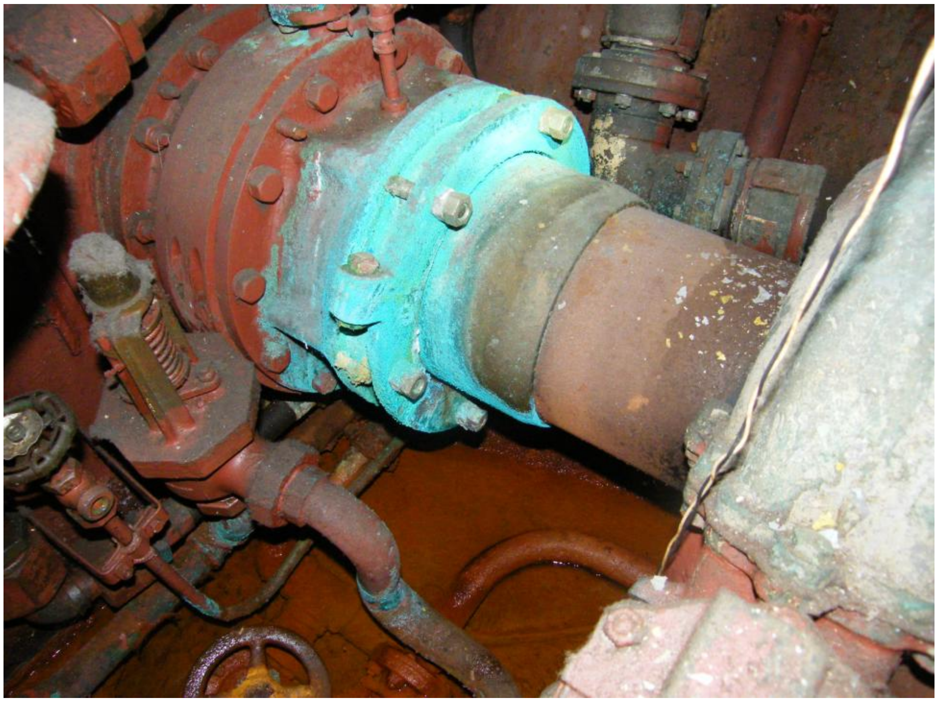
Pressure hull thickness gauge readings are as follows:

PORT	.623	.619	.645	.654	.556	.543
STBD	.567	.544	.573	.639	.612	.601

1.) Consider installation of exterior blanking seals while vessel is in water.
2.) At time of drydocking re-pack both shaft packing glands.
3.) Lower motor room is dirty, heavy rust/scale evident, possible PCB/oil contamination.
4.) Properly de-scale, repair foundations as needed, sand, prime and paint lower space.
5.) Install proper lighting.

Platform Deck, Motor Control Room. Notice throttles and main panel.

MAIN PROPULSION & MOTOR CONTROL ROOM (cont.)

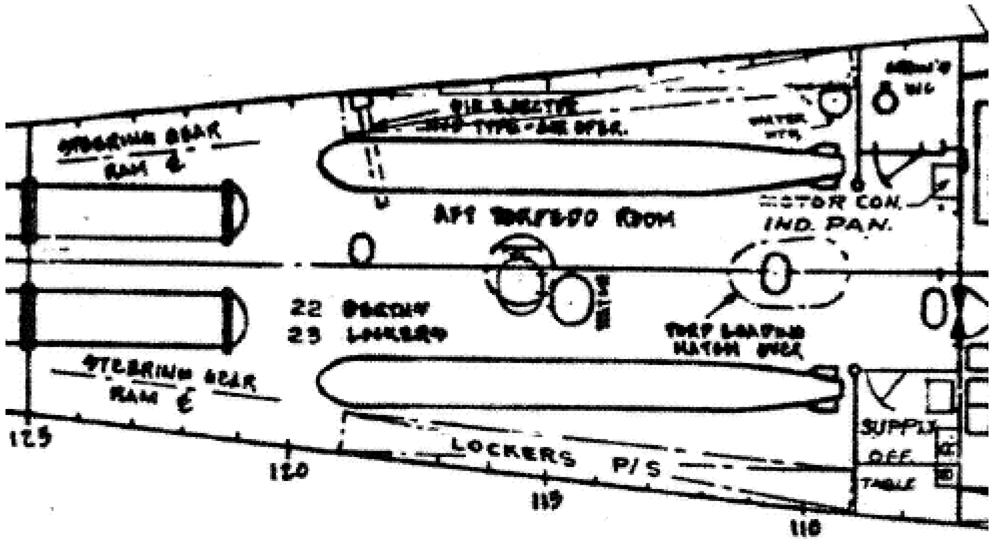


Port shaft packing gland in lower aft motor room. Showing weeping packing gland and standing water in bilges.

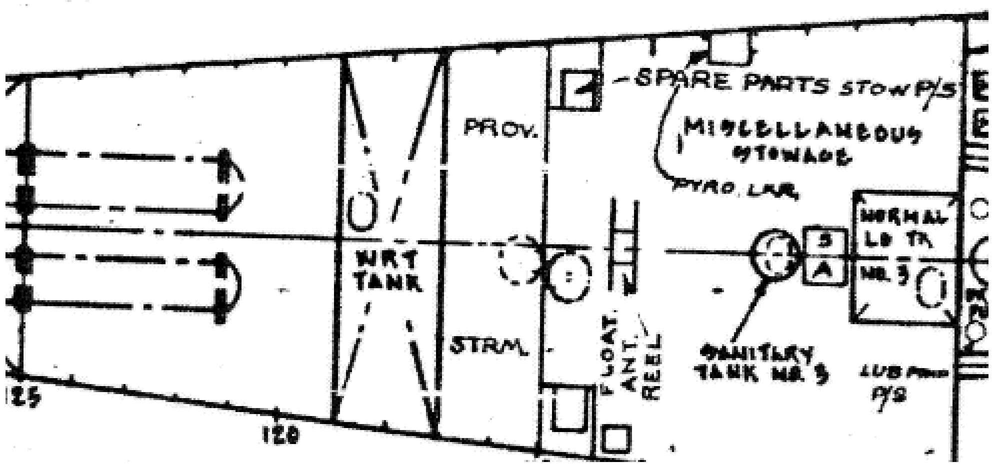
Standing water on centerline bilge of lower motor room.

HULL INTERIOR (cont.)

AFT TORPEDO ROOM



Aft Torpedo Room, Platform Deck, Frames 107 - 125.



Aft Torpedo Room, Hold, Frames 107 - 125

The following observations are made as to the condition of this space:

1.) Heavily rusted and scaled under main floors over after trim tank.
2.) After torpedo tubes do not appear to be leaking.
3.) Well lighted.
4.) Deck plates need proper securing to alleviate possible trip/fall condition.

Pressure hull thickness gauge readings are as follows:

PORT	.612	.634	.675	.650	.643	.621
STBD	.657	.656	.670	.630	.655	.635

HULL INTERIOR (cont.)

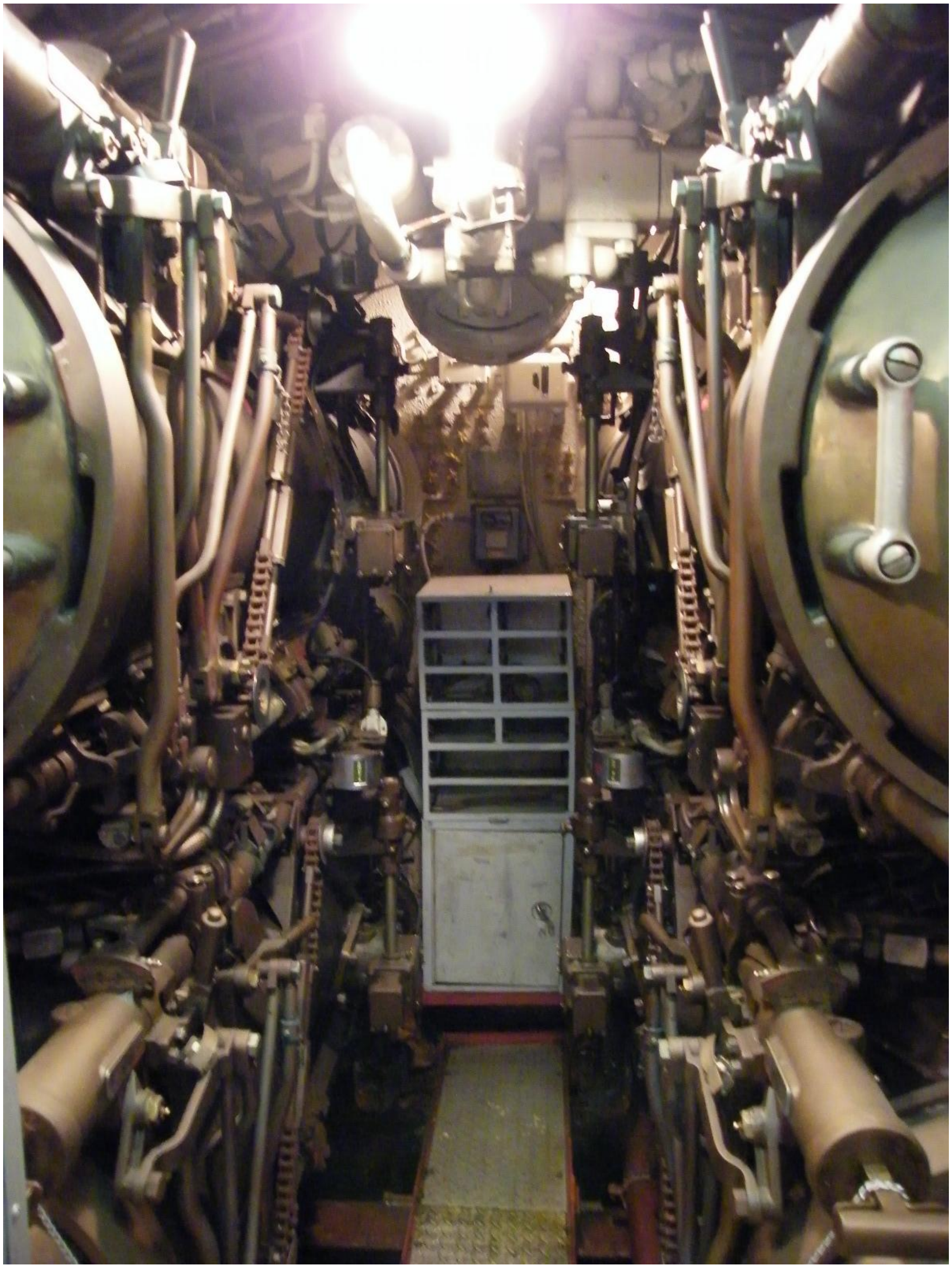
AFT TORPEDO ROOM (cont.)

1.) Consider properly sealing inboard door for surface buoy tube.
2.) Consider properly cleaning all bilge spaces in Storeroom, properly sand, prime and paint lower bilge spaces.
3.) Install proper lighting for lower bilge spaces.

Aft Torpedo Room, looking aft.

Hold, Storeroom, formerly tank #7.

AFT TORPEDO ROOM (cont.)



After bank of four torpedo tubes.

ELECTRONICS

The vessel has 440 Volt, 3 Phase, service capability at this time as most of the lighting circuits for the entire vessel are operable. The main control panels for these circuits are within each main machinery/engineroom and in the main control room. All main power and load centers are well labeled and tagged and several ship's electricians have been going over all ship's service wiring and trunks prior to activation/inactivation of any additional circuitry. A shore power AC breaker box is mounted with appropriate shore cable rigged to the vessel.

Many of the boat's wiring harness to specialized equipment onboard has been severed as part of the "mothball" process.

All of the vessel's batteries are intact aboard.

Ship's wiring harness appears to be in good order and well preserved; although, much labeling has been removed during the decommissioning process.

VENTILATION

Currently, this system aboard is inoperable and ventilation is supplied by opening hatches and supplementary fans and natural ventilation.

The existing duct system is intact and in good repair; inspection will need to determine if there are PCB gasket issues.

The entire ventilation duct and filtration system will require cleaning.

Additional ventilation is needed for Hold spaces.

VESSEL HULL PRESERVATION/MANAGEMENT PLAN

No formal hull preservation/maintenance plan was presented during the inspection of this vessel. A hull maintenance program should be developed as a benchmark for scheduling ongoing repairs by utilizing ship's volunteer force (such as may exist) or contractors.

This a also a primary insurance underwriting concern. A well researched and complete maintenance program also provides successive management/personnel turn-overs with a superb research tool as to past work accomplished. The 'Standards for Historic Vessel Preservation Projects' issued by the Secretary of the Interior and the National Maritime Initiative may be of use in formulating such a plan.

FIREFIGHTING/SAFETY

The vessel, as previously mentioned, has adequate interior fire extinguishers. It is not known how familiar local fire department personnel are with the interior layout of this boat.

The Museum has stationed size I & II dry chemical extinguishers (all properly tagged) along all platforms within the passageways with one extinguisher being stationed between each pair of watertight doors. Emergency lighting is fitted throughout the vessel and is operable.

Ambulance and police service is not far away.

SUPPLEMENTAL RECOMMENDATIONS

The following additional recommendations are made:

1.) Remove old FREON and other gas cylinders throughout vessel.

2.) Shore Power System & Cables

This system has the following problems:

a.) The shore cable box and cord should be fitted with protective lagging, fencing, or warning signs to ensure personnel and public are adequately protected,

b.) Associated cable supports at railing topside need to be properly welded and secured to deck.

3.) Emergency Lighting

Emergency lighting is inoperable or has weak batteries in various areas of the below deck tour spaces.

4.) Insulation

Piping insulation in public access spaces will need attention as it has been disturbed/opened by past inspections and not put back to original shape.

5.) Safety Climbs

Climber safety rails need to be installed on any ladders leading out of lower storerooms and machinery spaces.

6.) Public Access/Watertight Hatches (Maindeck)

Both fore and aft hatches need to be refitted with proper gaskets installed.

7.) CO-2 Fire Bottles

Some of the vessel's fire extinguishers (particularly in lower engineroom spaces) are in need of recent inspection and tagging.

8.) Decking

Decking in areas of maindeck open to the public is slick and needs non-skid on centerline sections.

9.) Lifelines, Stanchions

Some of the lifeline stanchions need to be secured on maindeck.

10.) Switchboards

Proper shielding from public access all main switchboards is needed

Switchboard bus bars facing closest to the rear of the units are not labeled 'DANGER 440 VOLTS' ; applicable voltage should be entered with red letters not less than 3/4" high.

11.) Lighting

Lenses, protective guards, and face plates were missing from many fluorescent and incandescent fixtures exposing naked bulbs or exposed, energized terminals. Repair/replace as needed.

12.) Electric Cables

Dead ended cables were not properly identified and isolated; properly identify and isolate these units throughout the ship. In general, the cabling on the weatherdecks and auxiliary engineering space has deteriorated. Cable jackets are deteriorated in many locations. Continue to identify and isolate/repair.

13.) Power Panels

The power panel in the main control room was missing components and has exposed component leads. Replace/repair.

14.) Asbestos Hazards

There are suspected asbestos hazards in all lower compartments identified throughout the ship. Confirmation/control measures are needed where suspect. Asbestos is present and the integrity of the covering is degraded. Develop working asbestos plan and use 29 CFR 1910, 1915 & 1926 as guides.

15.) Grab Rods

Grab rods need to be fitted where they would aid persons using ladders.

16.) Slip Resistant Treads

Slip resistant treads are degraded or missing at many areas throughout the vessel. Repair/replace as necessary

17.) Remove standing water and oil from all interior spaces. Inspect and clean electrics prior to lighting off any panels. Dispose of any waste oil and water according to Clean Water Act and Oil Pollution Act of 1990.

SUPPLEMENTAL RECOMMENDATIONS (cont.)

18.) Develop 'Safe Working Practices Plan' for lead, asbestos, confined spaces, air contaminants and safety standards for shipboard and shipyard employment. Designate 'Competent Person' and ensure this person is thoroughly versed/trained in these categories. Establish training program for volunteers and staff using OSHA guidelines. Much free assistance is provided by this government agency as regards methodology for training and compliance.

19.) Develop hull maintenance program.

20.) Develop 'Safe Working Practices Program' for safety and lifesaving.

21.) Establish an inspection program as required by 29 CFR 1915 and 1917.

22.) Install proper float alarms and instruct park personnel about emergency procedures with regard to a flooding event.

SUMMARY

CLAMAGORE has been in existence for 63 years and despite that is in fair material and structural condition. The topsides require cosmetic and structural attention, but these are the usual issues that all museum ships face. Her hull is the major question mark as her ballast tank system must be sorted out prior to her move to drydock.

An experienced crew with ability to fabricate gaskets, perform tap/die functions and be informed about the ballast tank system arrangement should be in place before any fuel/ballast tank hatches are removed. Removal of contaminated water/oil from her fuel/ballast tank system is paramount before an incident occurs.

The above will have to be sorted out prior to removal of mud around vessel as CLAMAGORE will be afloat at all stages of the tide after dredging.

Selective audio-gauging of her maindeck, bulkheads, platforms, and some side plating shows excessive plate wastage at the waterline; readings on the ballast tank skin plating and main pressure hull show only a greater than 60% loss throughout the vessel. There is minor compression of surface plating on the outer fuel/ballast tank skin at time of survey. The pressure hull is sound.

Care of her hull deserves immediate attention. Her topside paint system has failed and needs immediate remediation. Likewise, her superstructure deck is in trouble and immediate attention is needed there to prevent further degradation.

Drydocking and repair of the vessel is needed and should be a priority.

All interior ballast and fuel tank spaces were not inspected.

The Museum should develop a hull maintenance and repair program, and establish a proper training program for staff for flooding events, hazardous materials, air contaminants, confined space entry, lead, PCB and asbestos issues. This plan will provide the planning required for downstream restoration work.

The bottom line is that U.S.S. CLAMAGORE is an exceptional museum icon that many have come to see as incorporating some of the best in American material culture. She is the last of her breed.

A great boat.

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Joseph Lombardi
Principal Surveyor