

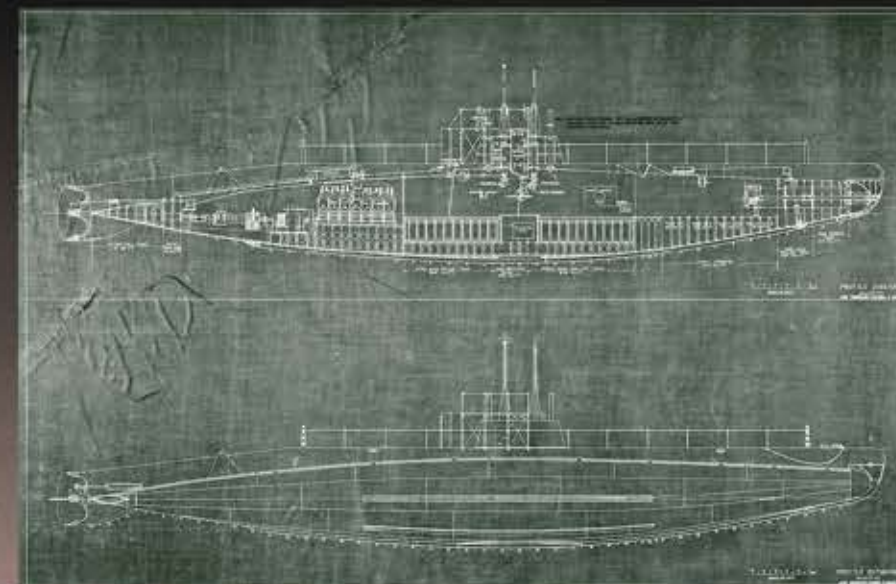
# LOST... AND FOUND

TRAGIC RAMMING AND SINKING OF THE F-1 SUBMARINE AND HOW  
MODERN TECHNOLOGY HAS BEEN ABLE TO EXPLORE THE VIRTUALLY INTACT VESSEL

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PHOTOGRAPHY COURTESY WOODS HOLE

This oil on canvas painting by Peter Bull illustrates the moment that F-3 rammed her class mate F-1 off La Jolla, California, on 17 December 1917.



Profile views of the F-class submarine.



**D**uring late February 2025, the Woods Hole Oceanographic Institution (WHOI) and the Naval History and Heritage Command (NHHHC), aboard the Office of Naval Research-owned (ONR) research vessel R/V *Atlantis*, visited and documented the final resting places of two US Navy sunken military craft off San Diego, California, with the human-occupied vehicle (HOV) *Alvin*.

*Alvin*, carrying a science observer from both NHHHC and ONR, was piloted by WHOI to explore the World War One-era submarine USS *F-1* (SS-20), which serves as the final resting

place for 19 sailors, and a post-World War Two Grumman TBM-3E Avenger, BuNo 53404.

The F-class submarines were a group of four submersibles designed for the United States Navy by Electric Boat in 1909. *F-1* and *F-2* were built by Union Iron Works in San Francisco while *F-3* and *F-4* were built by the Moran Company in Seattle.

The F-class was generally similar to the C-class and D-class submarines built by Electric Boat but were larger at 400 tons submerged compared to the D-class's 337 tons. They were single-hulled boats with circular sections laid

along the longitudinal axis. Overall length was 142 feet 6 inches and the beam was 15 feet 5 inches. The E-class and F-class were the first American subs to have bow planes. Like the E-class, their early-model diesels had problems and were replaced during 1915.

The hull contained three compartments separated by partial strength watertight bulkheads:

- Torpedo room with four 18-inch torpedo tubes.
- Control room/battery rooms with the ballast control valves, hydroplane controls, and periscope. Two battery

wells with 60 cells each were located under the deck in the forward and aft ends of the compartment.

- Engine room with two NEOSECO diesel engines and two Electro Dynamic electric motors with two shafts.

The two diesel engines were clutched to shafts that turned electric motors that could also be used as generators for charging the batteries. The shafts also turned the screws. For submerged operation, the diesels were de-clutched and shut down with the battery providing all of the submarine's power.

The battery was an array of 120 cells in rubber-lined, open-topped steel jars — this system obviously had a built-in danger points.

The F-class had a small conning tower that initially eliminated any sort of bridge structure for surface cruising because of its size. For extended surface runs, the crew would have to erect a temporary and rather flimsy pipe and canvas structure that would give the topside watchstanders a modicum of protection from the elements. To erect or dismantle this structure took time and this meant that it would be impossible to crash-dive the F-class

so the Navy realized it had to come up with something better. During 1917/1918, a permanent metal "chariot-style" bridge structure was designed and built but because the F-class was serving in the more placid Pacific, the modification was not installed.

To eliminate underwater drag, the torpedo system was designed to have a streamlined rotating torpedo tube muzzle cap and when it was in the stowed position, the F-class appeared to have no torpedo tubes as the muzzle openings in the cap were covered by the bow stem. With the exception of the L-class and the one-off *M-1*, this feature