Loss at sea of USS THRESHER

SUMMARY OF EVENTS

On 10 April 1963 Admiral USN, Commander in Chief, U. S. Atlantic Fleet, ordered a Court of Inquiry to inquire into the circumstances of the loss at sea of the USS THRESHER (SS(N)-593) on 10 April 1963. The Court included Vice Admiral USN, President and the additional members: Rear Admiral USN; Captain , USN; Captain , USN; and Captain USN. Captain , USN, was designated to serve as counsel for the Court.

The Court met for the first time at 8:25 p.m. on Thursday, 11 April 1963. Before the Court closed on 5 June 1963, it heard 179 separate appearances of witnesses and had occasion to recall 56 witnesses. The Court developed 1718 pages of testimony and received as exhibits in evidence 255 separate offers.

Among the witnesses who testified were Vice Admiral , USN, Bureau of Ships; Vice Admiral Chief of Naval Personnel; Vice Admiral Commander Submarine Force, U. S. Atlantic Fleet; Rear Admiral Deputy Commander, Submarine Force, U. S. Atlantic Fleet; Rear Admiral , Chief, Bureau of Ships; Rear Admiral , USN, Special Assistant to the Secretary of the Navy; Rear Admiral , Commander, Portsmouth Naval Shipyard; and Rear Admiral , Chief, Office of Industrial Relations. Commander USN, the former Commanding Officer of THRESHER, was questioned by the Court very early in its proceedings and provided valuable background information.

The Court considered many aspects of the circumstances surrounding THRESHER's loss in light of present day complexity of the modern submarine. Information was developed regarding THRESHER's construction, her post commissioning operations, and her post shakedown yard availability, in addition to the operations at sea which resulted in THRESHER's ultimate loss. The following detailed determinations by the Court of Inquiry provide significant information concerning the tragic loss of the Navy's first of a new class of nuclear powered attack submarines with her crew of 12 officers and 96 men and 21 additional passengers on official business, 17 of whom were highly qualified civilian employees.



all B-6

LOSS at SEA of the USS THRESHER

SUMMARY OF EVENTS

THRESHER Operations at Sea
9-10 April

THRESHER, under the command of Lieutenant Commander J. W. Harvey, USN departed Portsmouth Naval Shipyard on the morning of 9 April 1963, to conduct scheduled sea trials following a post shakedown availability which extended from 16 July 1962 to 11 April 1963.

THRESHER was a unit of Submarine Development Group TWO, and was operating under the orders of Commander Submarine Force, U.S. Atlantic Fleet (Administration), Portsmouth, for the sea trials.

USS SKYLARK (ASR 20), under command of Lieutenant Commander U. S. Navy, was designated to act as escort to THRESHER during sea trials, pursuant to orders of Commander Submarine Flotilla TWO. Commanding Officer, THRESHER, was Officer in Tactical Command of the two vessels.

At about 9:49 a.m. on 9 April 1963 in the vicinity of Latitude 42-56 North, Longitude 70-26 West, THRESHER affected a rendezvous with SKYLARK. After THRESHER completed a scheduled shallow dive, the two ships proceeded independently during the night to a second rendezvous in the vicinity of Latitude 41-46 North, Longitude 65-03 West. During transit, THRESHER proceeded surfaced and submerged and conducted various test evolutions, including full power propulsion.

add B-6

At 7:45 a.m., 10 April 1963, SKYLARK was in the vicinity of Latitude 41-46 North, Longitude 65-03 West, and THRESHER reported to her that SKYLARK bore 147 degrees true, 3400 yards from THRESHER. Shortly thereafter THRESHER began a deep dive which appeared to SKYLARK personnel to proceed satisfactorily until about 9:13 a.m., when THRESHER reported to SKYLARK to the effect, "Experiencing minor difficulties. Have positive up angle. Am attempting to blow. Will keep you informed." After this last clear message, SKYLARK received two further garbled communications.

At 9:00 a.m. on 10 April, the sea was calm, with a slight swell. Wind was from 015 degrees True at 7 knots. Depth of water in this area is about 8500 feet. Visibility was about 10 miles. No other ships are known to have been in the vicinity.

THRESHER was lost at sea with all on board at about 9:18 a.m. on 10 April 1963, in the vicinity of Latitude 41-45 North, Longitude 65-00 West. There was no evidence of sabotage or enemy action in connection with the loss of THRESHER.

## SKYLARK'S ACTIONS DURING OPERATIONS WITH THRESHER

Upon receipt of THRESHER's 9:13 a.m. communication ("Experiencing minor difficulties. . . ." etc.) SKYLARK initiated certain actions. She advised THRESHER of SKYLARK's course and that the area was clear, and she requested range and bearing from THRESHER. At about 9:15 a.m. SKYLARK, in an attempt to establish communication not only by sonar and radio but

also by underwater telephone, asked and repeated this query, "Are you in control?" SKYLARK established its LORAN position (logged at 9:21 a.m. as 41-45 N 64-59 W), and at 10:40 a.m. commenced dropping a series of hand grenades indicating to THRESHER that she should surface.

At about 10:45 a.m. the Commanding Officer, SKYLARK directed the Operations Officer to initiate a message reporting the loss of contact with THRESHER. Difficulty was encountered with transmission of the message to NBL (Radio New London), notwithstanding the fact that SKYLARK had conducted radio communication checks earlier that morning.

At 12:45 p.m. New London receipted for SKYLARK's message which stated, "UNABLE TO COMMUNICATE WITH THRESHER SINCE 0917R. HAVE BEEN CALLING BY UQC VOICE AND CW QHB CW EVERY MINUTE EXPLOSIVE SIGNALS EVERY 10 MINS WITH NO SUCCESS. LAST TRANSMISSION RECD WAS GARBLED. INDICATED THRESHER WAS APPROACHING TEST DEPTH. MY PRESENT POSITION 41-43 N 64-57 W CONDUCTING EXPANDING SEARCH."

Therefore, SKYLARK's message did not convey to Operational Commanders t full extent of the information then available, nor did any of SKYLARK's subsequent reports include such additional information. Moreover, THRESHER last messages were not disclosed to higher authority until 12 April, when LTJG [redacted], navigator of SKYLARK, boarded the USS BLANDY with the underwater telephone log which was examined by Deputy Commander Submarine Force, U. S. Atlantic Fleet. However, the Court of Inquiry formed the

opinion that SKYLARK's Commanding Officer's failure to promptly notify higher authority of all the information available to him pertinent to the circumstances attending the last transmission received by SKYLARK from THRESHER on 10 April, as it was his duty to do, did not contribute in any way to the loss of THRESHER and was not materially connected therewith.

## THE SEARCH FOR THRESHER

Deputy Commander Submarine Force, U. S. Atlantic Fleet (Rear Admiral (b)(6) USN) was in route to New London, Connecticut from Key West, Florida and arrived at Trumbull Airport, Groton, Connecticut, at about 6:30 p.m. Upon notification of THRESHER's status, he proceeded by helicopter to Newport, Rhode Island, and embarked in the USS BLANDY to proceed to the scene of the search.

Command of the search force passed from Commanding Officer, SKYLARK, to Commander Submarine Development Group TWO at about 5:30 a.m. on 11 April 1963 and was subsequently exercised, for varying and consecutive periods, by Deputy Commander Submarine Force, U. S. Atlantic Fleet, Commander Submarine Development Group TWO, and Commander Submarine Squadron EIGHT.

Shortly after 9:17 a.m., 10 April, when efforts to communicate with THRESHER had been unsuccessful, SKYLARK commenced an expanding search pattern Sonar was the principle means of underwater detection available to SKYLARK

Patrol aircraft and the USS RECOVERY (ARS 43) joined SKYLARK in the search area during the afternoon.

At about 5:30 p.m. RECOVERY sighted an oil slick about seven miles to the southeast of SKYLARK's 9:17 a.m. position. Samples were collected and articles of debris were recovered. These items and debris subsequently recovered were examined by laboratory personnel of the Portsmouth Naval Shipyard and were determined to be materials which could have come from THRESHER.

Radiation measurements were taken in the search area by surface ships and submerged submarines, and the water samples and recovered debris, examined by laboratory personnel, were found to contain no radioactivity beyond normal background level.

As the search for THRESHER continues naval units and personnel are being assisted by civilian scientists and research ships.

## CONSTRUCTION OF THRESHER

The construction of THRESHER commenced at the Portsmouth Naval Shipyard in 1958, and she was commissioned and delivered on 3 August 1961. THRESHER had been designed by the Bureau of Ships, assisted by the Portsmouth Naval Shipyard in the contract design phase (1957-1958); working plans were developed by the Portsmouth Naval Shipyard. The THRESHER Class underwent several design reviews during the building period, including a review in March, 1959, by the Chief of Naval Operations.

The condition of the ship when delivered was defined by the certificates of condition furnished by the Commander, Portsmouth Naval Shipyard, and the report of the Board of Inspection and Survey. In general, the ship was built in accordance with specifications and was in generally good material condition.

As part of the general construction of THRESHER, silver braze joints and flexible hose connections were extensively used in vital piping systems throughout the ship in accordance with usual submarine building practice and THRESHER's specifications. Subsequent to the investigation of a casualty involving a submarine of an earlier class, silver braze joints in THRESHER's vital systems were subjected to visual examinations, mallet tests, chemical material re-identification tests, hydrostatic tests and hydraulic pressure cycling tests, but there was no extensive retrofit of silver braze joints in THRESHER.

Quality assurance procedures employed at Portsmouth Naval Shipyard during THRESHER's construction period, consisted in general of mechanic and line supervision, with some system tests being conducted by inspectors. Xray techniques were used extensively for non-destructive testing of welds, forgings and castings. Some ultrasonic testing was used to detect internal flaws in steel plates. To supplement these techniques and wherever possible, hydrostatic pressures were applied to pressure vessels and piping systems. These test pressures were, in general, one hundred and fifty per cent of the designed working pressures. In the case of those piping systems exposed to

sea pressure, this test pressure was also equal to that sea pressure expected to cause collapse of the hull. Hydrostatic pressure testing is a standard engineering technique and was the best non-destructive method of testing silver braze piping joints available at the time of THRESHER construction.

Hull production processes during THRESHER's building period did not include the use of all the techniques and safeguards for hull surveillance which now exist, nor was the ultrasonic method of testing silver braze joints available.

## POST-COMMISSIONING OPERATIONS AND YARD AVAILABILITY OF THRESHER

Following commissioning, THRESHER conducted operations in the eastern Atlantic area, for the purposes of shakedown, training and evaluation. A much longer operating period was provided than is normal before a post shakedown availability due to the need to test the many new developments and equipments incorporated into THRESHER.

From 16 April 1962 to 21 May 1962 THRESHER received instrumentation and shock hardening at the Electric Boat Division of General Dynamics Corporati Groton, Connecticut, in preparation for scheduled shock tests.

During a visit to Cape Canaveral in early June, THRESHER was struck by a tug and suffered damage to the exterior plating of one of the main ballas tanks. Upon return to the Electric Boat Division all damage was repaired,

and a thorough inspection revealed no damage to the pressure hull nor any damage which affected the safety of the ship.

On 11 July 1962 THRESHER arrived at Portsmouth, New Hampshire, for post shakedown availability after conducting full power trials enroute. Post shakedown availability commenced on 16 July 1962 with an estimate of approximately 35,000 man-days and a scheduled duration of six months; however, because of work added and the underestimation of the effects of new and old work, 11 April 1963 became the final completion date. The total of man-days expended was over 100,000.

During THRESHER's availability flexible hoses were replaced in accordance with process instructions existing in the Shipyard. These instructions did not fully define specifications for allowable twist, and some flexible hoses were twisted in initial installation but were corrected. Although no formal training program existed for installing flexible hoses, an inspection program for flexible hose installations did exist and was carried out. Also, a comprehensive flexible hose listing which was used for quality assurance planning and inspection was prepared for THRESHER.

Some valves in THRESHER's hydraulic, auxiliary sea water system, and other systems were installed backwards during the post shakedown availability to permit testing of systems, some due to inadvertence and one due to an error in the ship's plans; however, all were corrected and properly installed prior to departure of the ship for sea trials.

The Ship Information Book and working plans for THRESHER's auxiliary sea water system called for cross-connection of the system as the normal operating mode. However, installation of new check valves in the constant vent portion of this system during the post shakedown availability made possible the complete separation of the auxiliary sea water system into two loops.

Difficulties were experienced in operating the high pressure air system, and in leakage from the reducing valves. These difficulties, which began early in the life of the ship and existed throughout the post shakedown availability appeared to stem from the presence of minute particles in the system. High pressure air and hydraulic systems require a high order of small particulate matter rejection during fabrication, installation and repair. However, the difficulties with the high pressure air valves, particularly leakage and venting, were reported as having been corrected prior to sea trials.

The hull repairs, access hatches and hull stiffening work were completed in accordance with existing Bureau of Ships Instructions and were checked by non-destructive tests means as being satisfactory, and the hull surveillance inspection scheduled during the post shakedown availability was completed.

The first dockside simulated cruise for purpose of crew training (fast cruise) was held 23-26 March 1963 and was terminated because of the large number of deficiencies noted. The second and last "fast cruise"

was begun on 31 March and satisfactorily completed on 1 April 1963. In the second "fast cruise", during one of the drills involving a flooding casualty in the after auxiliary sea water system, twenty minutes were required to isolate a leak. This was one of the early drills and changes had been made in the system involved during the post shakedown availability.

THRESHER was at the Sound Pier for sound trials during the period 1-4 April, and in drydock from 4 April to 8 April 1963, to make repairs to torpedo door shutters and a main circulating water valve. During this period liberty was granted to the crew.

Testing of systems was in accordance with Portsmouth Naval Shipyard and other applicable instructions. A comprehensive test program was conducted. All work undertaken by the Shipyard during THRESHER's post shakedown availability was reported as having been completed satisfactorily, and the Commanding Officer expressed his concurrence that the work was completed.

Portsmouth Naval Shipyard has had an extensive training program over the past two years, expending about $1,300,000.00 in the Shipyard, of which the Pipe Shop (56) portion was about $400,000.00. The number of people in the quality assurance program in the Portsmouth Naval Shipyard has increased from 152 to 243, and the direct expenditures for the program from approximately $1,200,000.00 to approximately $2,800,000.00 in the past two years. During THRESHER's post shakedown availability, the total work effect performed at Portsmouth Naval Shipyard also included construction of five submarines.

Other minor ship repair work and some manufacturing work also was accomplished.

Portsmouth Naval Shipyard has authority to deviate from building specifications in certain areas, and is using the specifications as goals rather than requirements in certain cases.

## COMPLEXITY OF MODERN SUBMARINES AND REQUIREMENTS FOR SPECIALIZED MANPOWER

The complexity of modern submarines has increased at a rapid rate. The advent of nuclear propulsion, ballistic missiles, and greatly increased speeds and operating depths has made it essential that all information affecting their safe operation be analyzed and promptly disseminated. While there is at present no organization at any level within the Navy with the sole responsibility for submarine safety, Commander Submarine Force, U. S. Atlantic Fleet, has a system of disseminating information which affects submarine operational safety.

During the past four years, while the Navy's annual ship building program has increased from approximately $2,500,000,000 to $4,500,000,000, the civilian personnel ceiling of the Bureau of Ships in Washington, D. C. has been reduced from 3800 to 3100, and the number of naval officers designated for Engineering Duties (ED) has declined from 1057 to about 840. More significant the number of naval officers serving as Technical and Management Officers in the Portsmouth Naval Shipyard has been reduced over the past few

years. This is particularly serious in the Design Division where, in 1956, five Assistant Design Superintendents were assigned -- none is so assigned today; and in the Ship Building Division, where the loss of ten qualified officers (mainly ED) in 1961 and 1962 has reduced capabilities.

During recent years, the advent of the nuclear submarine has resulted in a major increase in the complexity and difficulty of submarine design, construction and maintenance. The increase in complexity of nuclear submarines has resulted in an appreciable increase in the responsibilities imposed upon their commanding officers during the construction and post shakedown availability periods.

During THRESHER's post shakedown availability there was a change of THRESHER's Assistant Ship Superintendent in November, 1962, and a change of THRESHER's Ship Superintendent in December, 1962. Also, there were changes of THRESHER's Commanding Officer and Executive Officer in January, 1963.

## OPINIONS OF COURT OF INQUIRY

There is a danger that, in melding together fact and conjecture, conjectu may be stretched too far and may be accepted as fact, thus narrowing the fiel of search for possible causes of the casualty. The Court's singling out of certain questions for study should not deter others, particularly members of the crew of similar ships, from continuing to study the many questions raised by the THRESHER's loss.

The Court concluded that a flooding casualty in the engine room is the most probable cause of the sinking of THRESHER and that it is most likely that a piping system failure had occurred in one of the THRESHER salt water systems, probably in the engine room. It was also concluded that in all probability water affected electrical circuits and caused a loss of power.

The Court stated the opinion that the basic design of THRESHER class submarines is good, and its implementation resulted in the development of a high performance submarine. However, there are certain improvements desirable, as set forth in the recommendations, to increase the safety margin.

The basic auxiliary sea water loop system concept and design for the THRESHER class is good, and is an improvement over the single header "Christmas tree" systems installed in other nuclear submarines. The dummy valves used as spacers and valves installed backwards for tests should be so marked (tagged) and should be designated in the ship's system status or "rip out" procedure.

The quality of work performed by Shop 56 (Pipe Shop) at Portsmouth Naval Shipyard has improved since the construction of earlier class submarine particularly in the sil-braze area and in material identification and control workmanship and quality assurance. In view of the many potential sources of casualties and their serious consequences in high performance submarines,

such as THRESHER, there is a need to re-emphasize and improve, where indicated, the quality assurance program in shipbuilding and repair yards. The Court formed the opinion that the quality assurance program of the Portsmouth Naval Shipyard would be improved by appropriate consideration of the following

1. Quality Assurance Division should report directly to the Shipyard Commander.
2. Quality assurance should be engineered and planned, utilizing the statistical approach and should de-emphasize the "inspector" approach.
3. Quality assurance audits should be forwarded to management on a regular basis.
4. Quality assurance should record all defects, not just remaining defects (for example, brazers and inspectors reject joints and do not report defects found which are readily correctible)
5. Quality assurance ultrasonic test and welding radiographic test requirements should not depend on initiation of inspection requests by pipe fitters and welders, but should be separately initiated by the job order preparing authority to facilitate cross-checking.
6. A quality assurance program should be developed for flexible hose installation and check out.
7. The Quality Assurance Division does not currently have power to disqualify workers observed to be violating procedures, process controls and normal operating instructions, but must so recommend

to the shop supervision involved. It might be desirable to permit quality assurance personnel to temporarily remove qualifications (brazers' cards, etc.) under such circumstances to insure that defective work is not built into submarines during the normal administrative handling time for disqualification action.

8. Welding quality is under the Welding Engineer and is not completely integrated with the quality assurance program in the same manner as other procedures are. It is believed desirable to integrate this effort.

9. Condition sheets (for defects discovered) should be reviewed, analyzed and summarized by the Quality Assurance Division for presentation to management to insure that process deficiencies are brought to management's attention.

Since high performance submarines require full quality assurance and a high degree of uniformity, the Bureau of Ships should require adherence to specifications.

There were many reasons for the Bureau of Ships and Portsmouth Naval Shipyard continuing the use of sil-braze joints in piping systems of submarines. These included: years of ship building practice and service, extensive tests, improvement in processes and non-destructive test techniques the lack of weldable fittings and the high welded-joint rejection in all shipyards.

The substantially contemporaneous transfer of THRESHER's Commanding Officer, Executive Officer, Ship's Superintendent and Assistant Ship's Superintendent in the final portion of her post shakedown availability was not conducive to optimum completion of the work undertaken.

The evidence does not establish that the deaths of those embarked in THRESHER were caused by the intent, fault, negligence or inefficiency of any person or persons in the naval service or connected therewith.

The lessons learned from inquiry into the loss of THRESHER are of such moment as to require wide dissemination within the Navy.

Certain actions have already been taken. For example, the Navy's Bureau of Ships is applying a newly developed inspection technique to assure the integrity of high pressure piping systems on all naval ships. Based upon ultrasonic principles, the new method is being employed initiall on nuclear submarines. Personnel training and ultrasonic inspection equipment familiarization are necessary and some rescheduling of submarine construction dates and overhaul intervals will be required.

## RECOMMENDATIONS OF THE COURT OF INQUIRY

The bulk of the Court's recommendations stated the need for careful review of the design, construction and inspection of vital submarine syste such as sea water and air systems, and a review of operating procedures tc improve damage control capability under casualty conditions such as flood

The Court recommended that the quality assurance program at Portsmouth Naval Shipyard be further emphasized and improved in scope along the lines indicated in the Court's opinions.

Further, the Bureau of Ships should require submarine ship building activities to adhere to specifications, and to obtain from it approval for all waivers where this is not practicable. The Bureau of Ships should increase its audit activity to insure adherence to specifications for submarine building, overhaul and repair.

Early consideration should be given to the establishment of an organization similar to that employed in Naval Aviation, in the interest of safe submarine operating procedures. Such an organization should be responsible for the analysis of events and developments which pertain to submarine safety and the timely dissemination of such information.