STATEMENT OF REAR ADMIRAL PAUL E. SULLIVAN, U.S. NAVY
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BEFORE THE HOUSE SCIENCE COMMITTEE ON THE SUBSAFE PROGRAM
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Good Morning Chairman Boehlert, Ranking Member Hall and members of the committee.

Thank you for the opportunity to testify before this committee about the Submarine Safety Program, which the Navy calls SUBSAFE, and how it operates.

My name is RADM Paul Sullivan, USN. I serve as the Naval Sea System Command's Deputy Commander for Ship Design, Integration and Engineering, which is the authority for the technical requirements of the SUBSAFE Program.

To establish perspective, I will provide a brief history of the SUBSAFE Program and its development. I will then give you a description of how the program operates and the organizational relationships that support it. I am also prepared to discuss our NASA/Navy benchmarking activities that have occurred over the past year.

SUBSAFE PROGRAM HISTORY

On April 10, 1963, while engaged in a deep test dive, approximately 200 miles off the northeastern coast of the United States, the USS THRESHER (SSN-593) was lost at sea with all persons aboard - 112 naval personnel and 17 civilians. Launched in 1960 and the first ship of her class, the THRESHER was the leading edge of US submarine technology, combining nuclear power with a modern hull design. She was fast, quiet and deep diving. The loss of HRESHER and her crew was a devastating event for the submarine community, the Navy and the nation.

The Navy immediately restricted all submarines in depth until an understanding of the circumstances surrounding the loss of the THRESHER could be gained.

A Judge Advocate General (JAG) Court of Inquiry was conducted, a THRESHER Design Appraisal Board was established, and the Navy testified before the Joint Committee on Atomic Energy of the 88th Congress.

The JAG Court of Inquiry Report contained 166 Findings of Fact, 55 Opinions, and 19 Recommendations. The recommendations were technically evaluated and incorporated into the Navy's SUBSAFE, design and operational requirements.

The THRESHER Design Appraisal Board reviewed the THRESHER's design and provided a number of recommendations for improvements.

Navy testimony before the Joint Committee on Atomic Energy occurred on June 26, 27, July 23, 1963 and July 1, 1964 and is a part of the Congressional Record.

While the exact cause of the THRESHER loss is not known, from the facts gathered during the investigations, we do know that there were deficient specifications, deficient shipbuilding practices, deficient maintenance

practices, and deficient operational procedures. Here's what we think happened:

* THRESHER had about 3000 silver-brazed piping joints exposed to full submergence pressure. During her last shipyard maintenance period 145 of these joints were inspected on a not-to-delay vessel basis using a new technique called Ultrasonic Testing. Fourteen percent of the joints tested showed sub-standard joint integrity. Extrapolating these test results to the entire population of 3000 silver-brazed joints indicates that possibly more than 400 joints on THRESHER could have been sub-standard. One or more of these joints is believed to have failed, resulting in flooding in the engine room.

* The crew was unable to access vital equipment to stop the flooding.

* Saltwater spray on electrical components caused short circuits, reactor shutdown, and loss of propulsion power.

* The main ballast tank blow system failed to operate properly at test depth. We believe that various restrictions in the air system coupled with excessive moisture in the system led to ice formation in the blow system piping. The resulting blockage caused an inadequate blow rate. Consequently, the submarine was unable to overcome the increasing weight of water rushing into the engine room.

The loss of THRESHER was the genesis of the SUBSAFE Program. In June 1963, not quite two months after THRESHER sank, the SUBSAFE Program was created. The SUBSAFE Certification Criterion was issued by BUSHIPS letter Ser 525-0462 of 20 December 1963, formally implementing the Program.

The Submarine Safety Certification Criterion provided the basic foundation and structure of the program that is still in place today. The program established:

* Submarine design requirements

* Initial SUBSAFE certification requirements with a supporting process, and

* Certification continuity requirements with a supporting process.

Over the next 11 years the submarine safety criterion underwent 37 changes. In 1974, these requirements and changes were codified in the Submarine Safety Requirements Manual (NAVSEA 0924-062-0010). This manual continues to be the set of formal base requirements for our program today. Over the years, it has been successfully applied to many classes of nuclear submarines and has been implemented for the construction of our newest VIRGINIA Class submarine.

The SUBSAFE Program has been very successful. Between 1915 and 1963, sixteen submarines were lost due to non-combat causes, an average of one every three years. Since the inception of the SUBSAFE Program in 1963, only one submarine has been lost. USS SCORPION (SSN 589) was lost in May 1968 with 99 officers and men aboard. She was not a SUBSAFE certified submarine and the evidence indicates that she was lost for reasons that would not have been mitigated by the SUBSAFE Program. We have never lost a SUBSAFE certified submarine.

However, SUBSAFE has not been without problems. We must constantly remind ourselves that it only takes a moment to fail. In 1984 NAVSEA directed that a thorough evaluation be conducted of the entire SUBSAFE Program to ensure that the mandatory discipline and attention to detail had been maintained. In September 1985 the Submarine Safety and Quality Assurance Office was established as an independent organization within the NAVSEA Undersea Warfare Directorate (NAVSEA 07) in a move to strengthen the review of and compliance with SUBSAFE requirements. Audits conducted by the Submarine Safety and Quality Assurance Office pointed out discrepancies within the SUBSAFE boundaries. Additionally, a number of incidents and breakdowns occurred in SUBSAFE components that raised concerns with the quality of SUBSAFE work. In response to these trends, the Chief Engineer of the Navy chartered a senior review group with experience in submarine research, design, fabrication, construction, testing and maintenance to assess the SUBSAFE program's implementation. In conjunction with functional audits performed by the Submarine Safety and Quality Assurance Office, the senior review group conducted an in-depth review of the SUBSAFE Program at submarine facilities. The loss of the CHALLENGER in January 1986 added impetus to this effort. The results showed clearly that there was an unacceptable level of complacency fostered by past success; standards were beginning to be seen as goals vice hard requirements; and there was a generally lax attitude toward aspects of submarine configuration.

The lessons learned from those reviews include:

* Disciplined compliance with standards and requirements is mandatory.

* An engineering review system must be capable of highlighting and thoroughly resolving technical problems and issues.

* Well-structured and managed safety and quality programs are required to ensure all elements of system safety, quality and readiness are adequate to support operation.

* Safety and quality organizations must have sufficient authority and organizational freedom without external pressure.

The Navy continues to evaluate its SUBSAFE Program to adapt to the ever-changing construction and maintenance environments as well as new and evolving technologies being used in our submarines. Since its creation in 1974 the SUBSAFE Manual has undergone several changes. For example, the SUBSAFE boundary has been redefined based on improvements in submarine recovery capability and establishment of a disciplined material identification and control process. An example of changing technology is the utilization of fly-by-wire ship control technology on SEAWOLF and VIRGINIA class submarines. Paramount in this adaptation process is the premise that the requirements, which keep the SUBSAFE Program successful, will not be compromised. It is a daily and difficult task; but our program and the personnel who function within it are committed to it.

PURPOSE AND FOCUS

The purpose of the SUBSAFE Program is to provide maximum reasonable assurance of watertight integrity and recovery capability. It is important to recognize that the SUBSAFE Program does not spread or dilute its focus beyond this purpose.

Mission assurance is not a concern of the SUBSAFE Program, it is simply a side benefit of the program. Other safety programs and organizations regulate such things as fire safety, weapons systems safety, and nuclear reactor systems safety.

Maximum reasonable assurance is achieved by certifying that each submarine meets submarine safety requirements upon delivery to the Navy and by maintaining that certification throughout the life of the submarine.

We apply SUBSAFE requirements to what we call the SUBSAFE Certification Boundary - those structures, systems, and components critical to the watertight integrity and recovery capability of the submarine. The SUBSAFE boundary is defined in the SUBSAFE Manual and depicted diagrammatically in what we call SUBSAFE Certification Boundary Books.

SUBSAFE CULTURE

Safety is central to the culture of our entire Navy submarine community, including designers, builders, maintainers, and operators. The SUBSAFE Program infuses the submarine Navy with safety requirements uniformity, clarity, focus, and
accountability.

The Navy's safety culture is embedded in the military, Civil Service, and contractor community through:

* Clear, concise, non-negotiable requirements,

* Multiple, structured audits that hold personnel at all levels accountable for safety, and

* Annual training with strong, emotional lessons learned from past failures.

Together, these processes serve as powerful motivators that maintain the Navy's safety culture at all levels. In the submarine Navy, many individuals understand safety on a first-hand and personal basis. The Navy has had over one hundred thousand individuals that have been to sea in submarines. In fact, many of the submarine designers and senior managers at both the contractors and NAVSEA routinely are onboard each submarine during its sea trials. In addition, the submarine Navy conducts annual training, revisiting major mishaps and lessons learned, including THRESHER and CHALLENGER.

NAVSEA uses the THRESHER loss as the basis for annual mandatory training. During training, personnel watch a video on the THRESHER, listen to a two-minute long audiotape of a submarine's hull collapsing, and are reminded that people were dying as this occurred. These vivid reminders, posters, and other observances throughout the submarine community help maintain the safety focus, and it continually renews our safety culture. The Navy has a traditional military discipline and culture. The NAVSEA organization that deals with submarine technology also is oriented to compliance with institutional policy requirements. In the submarine Navy there is a uniformity of training, qualification requirements, education, etc., which reflects a single mission or product line, i.e., building and operating nuclear powered submarines.

SUBSAFE CERTIFICATION PROCESS

SUBSAFE certification is a process, not just a final step. It is a disciplined process that brings structure to our new construction and maintenance programs and leads to formal authorization for unrestricted operations. SUBSAFE certification is applied in four areas:

* Design,
* Material,
* Fabrication, and
* Testing.

Certification in these areas applies both to new construction and to maintenance throughout the life of the submarine.

The heart of the SUBSAFE Program and its certification processes is a combination of Work Discipline, Material Control, and Documentation:

* Work discipline demands knowledge of the requirements and compliance with those requirements, for everyone who performs any kind of work associated with submarines. Individuals have a responsibility to know if SUBSAFE impacts their work.

* Material Control is everything involved in ensuring that correct material is installed correctly, beginning with contracts that purchase material, all the way through receipt inspection, storage, handling, and finally installation in the submarine.

* Documentation important to SUBSAFE certification falls into two categories:

o Selected Record Drawings and Data: Specific design products are created when the submarine is designed. These products consist of documents such as system diagrams, SUBSAFE Mapping Drawings, Ship Systems Manuals, SUBSAFE certification Boundary Books, etc. They must be maintained current throughout the life of the submarine to enable us to maintain SUBSAFE certification.

o Objective Quality Evidence (OQE): Specific work records are created when work is performed and consist of documents such as weld forms, Non-Destructive Testing forms, mechanical assembly records, hydrostatic and operational test forms, technical work documents in which data is recorded, waivers and deviations, etc. These records document the work performed and the worker's signature certifying it was done per the requirements. It is important to understand that SUBSAFE certification is based on objective quality evidence. Without objective quality evidence there is no basis for certification, no matter who did the work or how well it was done. Objective quality evidence provides proof that deliberate steps were taken to comply with requirements.

The basic outline of the SUBSAFE certification process is as follows:

* SUBSAFE requirements are invoked in the design and construction contracts for new submarines, in the work package for submarines undergoing depot maintenance periods, and in the Joint Fleet Maintenance Manual for operating submarines.

* Material procurement and fabrication, overhaul and repair, installation and testing generate objective quality evidence for these efforts. This objective quality evidence is formally and independently reviewed and approved to assure compliance with SUBSAFE requirements. The objective quality evidence is then retained for the life of the submarine.

* Formal statements of compliance are provided by the organizations performing the work and by the government supervising authority responsible for the oversight of these organizations. All organizations performing SUBSAFE work must be evaluated, qualified and authorized in accordance with NAVSEA requirements to perform this work. A Naval Supervising Authority, assigned to each contractor organization, is responsible to monitor and evaluate contractor performance.

* Audits are conducted to examine material, inspect installations and review objective quality evidence for compliance with SUBSAFE requirements.

* For new construction submarines and submarines in major depot maintenance periods, the assigned NAVSEA Program Manager uses a formal checklist to collect specific documentation and information required for NAVSEA Headquarters certification.

When all documentation has been collected, reviewed and approved by the Technical Authority and the SUBSAFE Office, the Program Manager formally presents the package to the Certifying Official for review and certification for sea trials. For new construction submarines, the formal presentation of the certification package is made to the Program Executive Officer for Submarines, and for in-service submarines completing a major depot maintenance period the certification package is formally presented to the Deputy Commander for Undersea Warfare.

Approval by the Certifying Official includes verification of full concurrence, as well as discussion and resolution of dissenting opinions or concerns. After successful sea trials, a second review is performed prior to authorizing unrestricted operations for the submarine.

SUBSAFE CERTIFICATION MAINTENANCE

Once a submarine is certified for unrestricted operation, there are two elements, in addition to audits, that we use to maintain the submarine in a certified condition. They are the Re-Entry Control Process and the Unrestricted Operation/Maintenance Requirement Card (URO/MRC) Program.

Re-entry Control is used to control work within the SUBSAFE Certification Boundary. It is the backbone of certification maintenance and continuity. It provides an identifiable, accountable and auditable record of work performed within the SUBSAFE boundary. The purpose is to provide positive assurance that all SUBSAFE systems and components are restored to a fully certified condition. Re-entry control procedures help us maintain work discipline by identifying the work to be performed and the standards to be met. Re-entry control establishes personal accountability because the personnel authorizing, performing and certifying the work and testing must sign their names on the re-entry control documentation. It is the process we use to collect the OQE that supports certification.

The Unrestricted Operation/Maintenance Requirement Card (URO/MRC) Program facilitates planned periodic inspections and tests of critical equipment,

systems, and structure to ensure that they have not degraded to an unacceptable level due to use, age, or environment. The URO/MRC Program provides the technical basis for authorizing continued unrestricted operations of Navy submarines. The responsibility to complete URO/MRC inspections is divided among multiple organizations. Some inspections can only be completed by a shipyard during a maintenance period.

Other inspections are the responsibility of an Intermediate Maintenance Activity or Ships Force. NAVSEA manages the program by tracking performance to ensure that periodicity requirements are not violated, inspections are not missed, and results meet invoked technical requirements.

AUDITS

A key element of certification and certification maintenance is the audit program. The audit program was established in 1963. During testimony before Congress Admiral Curtze stated: "To ensure the adequacy of the application of the quality assurance programs in shipyards a system of audits has been established...." This system of audits is still in place today. There are two primary types of audits: Certification Audits and Functional Audits.

In a SUBSAFE CERTIFICATION Audit we look at the Objective Quality Evidence associated with an individual submarine to ensure that the material condition of that submarine is satisfactory for sea trials and unrestricted operations. These audits are performed at the completion of new construction and at the end of major depot maintenance periods. They cover a planned sample of specific aspects of all SUBSAFE work performed, including inspection of a sample of installed equipment. The results and resolution of deficiencies identified during such audits become one element of final NAVSEA approval for sea trials and subsequent unrestricted operations.

In a SUBSAFE FUNCTIONAL Audit we periodically review the policies, procedures, and practices used by each organization, including contractors, that performs SUBSAFE work, to ensure that those policies, procedures and practices comply with SUBSAFE requirements, are healthy, and are capable of producing certifiable hardware or design products. This audit also includes surveillance of actual work in progress. Organizations audited include public and private shipyards, engineering offices, the Fleet, and NAVSEA headquarters.

In addition to the audits performed by NAVSEA, our shipyards, field organizations and the Fleet are required to conduct internal (or self) audits of their policies, procedures, and practices and of the work they perform.

SUBSAFE ORGANIZATIONAL RELATIONSHIPS

The SUBSAFE Program maintains a formal organizational structure with clear delineation of responsibilities in the SUBSAFE Requirements Manual. Ultimately, the purpose of the SUBSAFE Organization is to support the Fleet. We strongly believe that our sailors must be able to go to sea with full confidence in the safety of their submarine. Only then will they be able to focus fully on their task of operating the submarine and carrying out assigned operations successfully.

There are three key elements in our Headquarters organization: Technical Authority, Program Management and Submarine Safety and Quality Assurance.

Each of these elements is organizationally independent and has specifically defined roles in the SUBSAFE Program.

NAVSEA Technical Authority provides technical direction and assistance to Program Managers and the Fleet. In our terms, Technical Authority is the authority, responsibility and accountability to establish, monitor and approve technical products and policy in conformance to higher tier policy and requirements. Technical authorities are warranted (formally given authority) within NAVSEA and our field organizations. Technical warrant holders are subject matter experts. Within the defined technical area warranted, they are responsible for establishing technical standards, entrusted and empowered to make authoritative decisions, and held accountable for the technical decisions made. Where technical products are not in conformance with technical policy, standards and requirements, warrant holders are responsible to identify associated risks and approve non-conformances (waivers or deviations) in a manner that ensures risks are acceptable. NAVSEA is accustomed to evaluating risk; however, non-conformances are treated as an exception vice the norm. Full discussion of technical issues is required before making decisions. Discussions and decisions are coordinated with the Program Management and Submarine Safety and Quality Assurance Offices. However, NAVSEA 05, Ship Design, Integration and Engineering, is the final authority for the technical requirements of the SUBSAFE Program.

* Within the Undersea Warfare Directorate (NAVSEA 07) the Director, Submarine Hull, Mechanical and Electrical Engineering Management Division (NAVSEA 07T) is the warranted technical authority and provides system engineering and support for submarine technical SUBSAFE issues.

Submarine Program Managers manage all aspects of assigned submarine programs in construction, maintenance and modernization, including oversight of cost, schedule, performance and direction of life cycle management. They are responsible and accountable to ensure compliance with the requirements of the SUBSAFE Program and with technical policy and standards established by the technical authority.

The Submarine Safety and Quality Assurance Office (NAVSEA 07Q) manages the SUBSAFE program and audits organizations performing SUBSAFE work to ensure compliance with SUBSAFE requirements. NAVSEA 07Q is the primary point of contact within NAVSEA Headquarters in all matters relating to SUBSAFE Program policy and requirements.

In addition, several groups and committees have been formally constituted to provide oversight of and guidance to the SUBSAFE Program and to provide a forum to evaluate and make changes to the program:

* The SUBSAFE Oversight Committee (SSOC) provides independent command level oversight to ensure objectives of the SUBSAFE Program are met. Members are of Flag rank and represent NAVSEA Directorates (SEA 09, PEO-SUB, SEA 05, SEA 04, SEA 07) and the Navy Inventory Control Point.

* The SUBSAFE Steering Task Group (SSSTG) was established based on results of the THRESHER investigation to ensure adequate provision of safety features in current and future submarine construction, conversion, and major depot availability programs. The SSSTG defines the scope of the SUBSAFE Program, reviews program progress and approves or disapproves proposed policy changes. Members include Admirals, Senior Executive Service members and other senior

civilian managers with direct SUBSAFE and technical responsibilities, as well as the Submarine Program Managers.

* The SUBSAFE Working Group (SSWG) consists of SUBSAFE Program Directors from Headquarters, shipyards, field organizations, and the Fleet. The Working Group meets formally twice a year to provide a forum to discuss and evaluate SUBSAFE Program progress, implementation and proposals for improvement. SUBSAFE Program Directors are the focal point for SUBSAFE matters and are responsible and accountable for implementation and proper execution of the SUBSAFE Program within their respective organizations. They maintain close liaison with NAVSEA 07Q to present or obtain information relative to SUBSAFE issues.

SUBSAFE CERTIFICATION RELATIONSHIPS

As described earlier in this testimony, each NAVSEA organization is assigned separate responsibility and authority for SUBSAFE Program requirements and compliance. Our technical authority managers are empowered and accountable to make disciplined technical decisions. They are formally given the authority, responsibility and accountability to establish, monitor and approve technical products and policy. The Submarine Program Managers are responsible for executing the SUBSAFE Program for assigned submarines in new construction and major depot availabilities. They have the authority, responsibility and accountability to ensure compliance with technical policy and standards established by cognizant technical authority. NAVSEA 07Q, Submarine Safety and Quality Assurance Office, is responsible and accountable for implementation and management of the SUBSAFE Program and for ensuring compliance with SUBSAFE Program requirements.

The ultimate certification authority is the Program Executive Officer for Submarines (PEO SUB) for new construction and the Deputy Commander for Undersea Warfare (NAVSEA 07) for major depot availabilities. The Program manager, with the concurrence of and in the presence of the technical authority representative (NAVSEA 07T) and the SUBSAFE office (NAVSEA 07Q), presents the certification package with which he attests that the SUBSAFE material condition of the submarine is satisfactory for sea trials or for unrestricted operation. Each of the participants has the authority to stop the certification process until an identified issue is satisfactorily resolved.

NAVSEA PERSONNEL

Our nuclear submarines are among the most complex weapon systems ever built. They require a highly competent and experienced technical workforce to accomplish their design, construction, maintenance and operation. In order for NAVSEA to continue to provide the best technical support to all aspects of our submarine programs, we are challenged to recruit and maintain a technically qualified workforce. In 1998, faced with downsizing and an aging workforce, NAVSEA initiated several actions to ensure we could meet current and future challenges. We refocused on our core competencies, defined new engineering categories and career paths, and obtained approval to infuse our engineering skill sets with young engineers to provide for a systematic transition of our workforce. We hired over 1000 engineers with a net gain of 300. This approach allowed our experienced engineers to train and mentor young engineers and help NAVSEA sustain our core competencies. Despite this limited success, mandated downsizing has continued to challenge us. I remain concerned about our ability, in the near future, to provide adequate

technical support to, and quality overview of our submarine construction and maintenance programs.

NASA/NAVY BENCHMARKING EXCHANGE (NNBE)

The NASA/NAVY Benchmarking Exchange effort began activities in August 2002 and is ongoing. The NNBE was undertaken to identify practices and procedures and to share lessons learned in the Navy's submarine and NASA's human space flight programs. The focus is on safety and mission assurance policies, processes, accountability, and control measures. To date, nearly all of this effort has involved the Navy describing our organization, processes and practices to NASA. The NNBE Interim report was completed December 20, 2002. Phase-2 was delayed due to the COLUMBIA accident. It is planned that when Phase-2 resumes, the NASA team will complete its assessment activity by participating as observers during a certification audit of a submarine. Follow-on steps include continued collaboration of NAVSEA subject matter experts with NASA counterparts. Several memoranda of agreement are being developed to formalize this collaboration effort. Phase-2 will then conclude with NASA describing their processes and practices to Navy participants.

In conclusion, let me reiterate that since the inception of the SUBSAFE Program in 1963, the Navy has had a disciplined process that provides MAXIMUM reasonable assurance that our submarines are safe from flooding and can recover from a flooding incident. In 1988, at a ceremony commemorating the 25th anniversary of the loss of THRESHER, the Navy's ranking submarine officer, Admiral Bruce Demars, said: "The loss of THRESHER initiated fundamental changes in the way we do business, changes in design, construction, inspections, safety checks, tests and more. We have not forgotten the lesson learned. It's a much safer submarine force today."

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