UNDERSEAWARFARE
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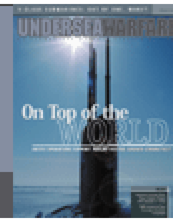
U.S. Submarines... Because Stealth Matters

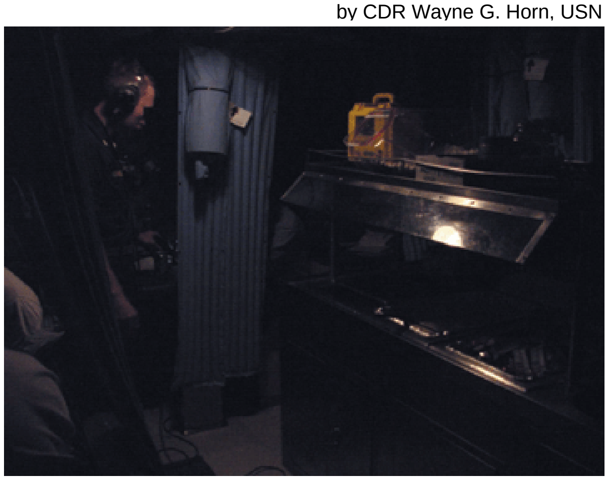


On 18 March 2003, the crew of USS Dallas *(SSN-700) completed the submarine survival exercise SURVIVEX 2003.* Dallas*, moored pier-side in Groton with 94 volunteers in the forward compartment, served as a simulated bottomed submarine. One of a number of major initiatives in the Submarine Force's escape and rescue program, the three-day exercise evaluated the ability of a submarine crew to maintain a survivable atmosphere and adequate living conditions while waiting for rescue.*

SURVIVEX 2003

Exercise Tests Disabled Submarine Survival

by CDR Wayne G. Horn, USN



The darkened mess decks are seen with Battelle curtains hanging from the overhead and yellow portable gas analyzers on the counter.

Few U.S. Navy submarines have sunk since World War II, and none since the loss of USS *Scorpion* (SSN-589) in 1968. Since then, Navy submarines have achieved an unparalleled record of safe operation. Nonetheless, with submarines operating increasingly in shallow waters where submerged rescues are possible, the constant risk of collision and other accidents demands that we be prepared for emergencies.

Survivors trapped in a sunken submarine face life-threatening conditions and need to make life-critical decisions. Once the initial situation in a disabled submarine (DISSUB) has stabilized, the crew must decide whether to attempt escape or to await rescue. Using procedures in the *Senior Survivor Guidance Guardbook* or Chapter 13 of the *Atmosphere Control Manual*, survivors can calculate estimates of survival time and time to escape, based on the number of crew in a compartment, conditions in the boat, and available life-support supplies.

Escape? Or Await Rescue?

Warfare

Commander, Naval Submarine Forces

Commander, Submarine Force Pacific Fleet

Navy News Stand

In most situations, awaiting rescue is preferred over attempting to escape, since a successful rescue effort delivers the survivors directly to a safe environment and medical care. Even after a successful escape, a life-threatening delay can still occur if search and rescue forces have not yet arrived to recover the escapees.

The time needed to reach a DISSUB and perform rescue operations depends on the period required to mobilize and transport rescue vessels to the scene.This may take several days in U.S. waters or longer if a submarine is deployed overseas. For this reason, navies operating submarines, including ours, maintain agreements for international sharing of assets in submarine disaster situations. For a successful rescue to occur, a DISSUB's crewmembers must be able to survive in difficult environmental conditions until rescue forces arrive. To ensure a reasonable probability for successful rescue, the Navy has established a goal for maintaining survival capability in a DISSUB for seven days.

Submarine Disaster Survival Factors

Planners assume that a sunken submarine will be without electrical power and unable to run carbon dioxide (CO_2) scrubbers and other equipment necessary to maintain normal atmosphere control. As a result, in nearly every potential scenario, the greatest threat to survival is the buildup of respiratory CO_2 as crewmembers wait for rescue. Other likely survival risks include depletion of oxygen, hypothermia, heat stress, toxic gases, or pressure buildup in the boat.

Increasing atmospheric pressure in a DISSUB is highly probable and can result from flooding, rupture of compressed gas banks, air leaks, or prolonged use of emergency breathing apparatus (EABs). This increased pressure in the boat causes gas to dissolve in human tissues just as if the survivors were scuba diving. Like divers, survivors breathing a pressurized atmosphere corresponding to 23 feet of seawater or more for longer than a day will be at risk for decompression sickness, or the "bends," after reaching the surface. For this reason, today's guidance calls for survivors at risk of the bends to await rescue – after which decompression chambers will be available – instead of performing escape to the surface before rescue forces and chambers have arrived.

Also, as internal pressure rises, the increased partial pressure of oxygen in the boat can cause respiratory and nervous system effects, such as respiratory failure and seizures. The risk of these conditions increases rapidly when atmospheric pressure in the boat exceeds five atmospheres.

Biomedical engineer Celeste Trapani of NSMRL positions external temperature sensors on the hull.

Escape and Rescue Capabilities

Nonetheless, significant improvements in U.S. submarine escape systems are imminent. The Navy is rapidly replacing the Steinke Hood rescue device with the new Submarine Escape Immersion Equipment (SEIE), a combined whole-body suit and one-man life raft that provides protection against hypothermia in freezing water. Using this suit, survivors can escape a DISSUB at depths down to 600 feet, at a rate of eight or more men per hour.

In San Diego, the Deep Submergence Unit maintains the Navy's submarine rescue vessels and equipment. Rescue assets include the mini-submarine DSRV *Mystic* and the submarine rescue chamber (SRC). Both assets and their accompanying rescue gear can be flown anywhere in the world from Naval Air Station North Island. *Mystic* can perform rescues at depths down to 2,000 feet, carrying up to 24 passengers either to a mother submarine or the surface. The SRC can be lowered from a vessel of opportunity down to 850 feet and can carry six survivors at a time to the surface. The Navy used an SRC to rescue survivors successfully from USS *Squalus* (SS-192) in 1939, recounted in a recent best-selling book by Peter Maas, *The Terrible Hours*. [Ed. Note: *The Terrible Hours was reviewed in the Winter 1999 issue of UNDERSEA WARFARE*.]

SURVIVEX 2003 Results

SURVIVEX 2003 began as a research initiative by the Naval Submarine Medical Research Laboratory (NSMRL), Groton, Connecticut, to verify conditions and equipment performance in an actual *Los Angeles* (SSN-688)-class SSN simulating a DISSUB. Initial planning for modification of *Dallas* into a trial platform began at COMSUBDEVRON-5 and required major support from COMSUBLANT, COMSUBGRU-2, COMSUBRON-2, and COMNAVSEASYSCOM. *Dallas*, commanded by CDR Dale Sykora, enthusiastically took on the project, which involved virtually every member of the crew.

Objectives of the exercise included determining the atmospheric conditions that would develop in the absence of normal ventilation and CO2 scrubbing; testing newly-developed polypropylene curtains for emergency, unpowered CO2 scrubbing; determining the adequacy of current DISSUB survival guidance and equipment; and measuring temperature changes in an unpowered submarine.

The SURVIVEX commenced when the boat's forward compartment hatches and doors were shut and ventilation secured. The *Dallas* volunteers and observers then began acclimatizing themselves to the dark and quiet conditions in the boat. For the duration of the exercise, all electrical power in the forward compartment was secured, except for the Central Air Monitoring System (CAMS), one motor generator, and emergency DC lighting. A special pier-side and engineering-room watch was maintained. Eleven observers, from COMSUBDEVRON-5, COMSUBLANT, NSMRL, Naval Submarine School, Naval Undersea Med-ical Institute, and Naval Ambulatory Clinic Groton, monitored the health and safety of the crew.

To maintain CO2 levels as low as possible, crewmembers not on watch stayed in their bunks or at rest. No unusual physical activity or exercise was permitted during the trial.

March was selected for the trial, since average March air and water temperatures in Groton approximate seawater temperatures in most submarine operating areas. During the three days of the exercise the average air temperature was 41º F, and the average water temperature was 37º F. Despite the cold New England conditions, the temperature in the submarine rose from 70º F to nearly 80º F. This contrasts with the experience of the 33 *Squalus* survivors, who complained mostly of cold. During SURVIVEX, hull insulation, body heat from the volunteers, heat generated by CO2 scrubbing, and some smaller amounts of heat from equipment contributed to the rise in temperature.

> "Significant improvements in U.S. submarine escape systems are imminent. The Navy is rapidly replacing the Steinke Hood rescue device with the new Submarine Escape Immersion Equipment (SEIE), a combined whole-body suit and one-man life raft that provides protection against hypothermia in freezing water."

Longstanding guidance for emergency control of high CO2 levels called for opening lithium hydroxide canisters and spreading the granules on horizontal surfaces. However, testing at NSMRL showed that this method absorbs CO2 too slowly and creates high levels of caustic dust that can cause eye and skin burns, as well as coughing and respiratory irritation. To solve this problem, workers at NSMRL evaluated several methods and found that a mesh curtain container used by the French Navy scrubbed CO2 fairly well. This design was modified by the Battelle Corporation into a 6-foot long, polypropylene-fabric, curtain-shaped device that crewmembers can load with a canister of lithium hydroxide granules without spreading large amounts of dust. Each curtain, when hung from the overhead, passively absorbs the CO2 production of one man at rest over two days. The new passive CO2 scrubbing curtains performed well in the simulated DISSUB conditions. At the start of the simulated casualty, the *Dallas* crew quickly filled and hung 98 curtains, which maintained CO2 levels below the upper limit goal of three percent over three days. These curtains are now being implemented in the fleet.

As the crew breathed the atmosphere in the boat, the oxygen level fell to 17 percent after 33 hours. Oxygen was then bled from banks and effectively distributed to several spaces using Tygon® tubing. Diffusion occurred readily, and no fire risk developed due to localized pocketing of oxygen.

The mess specialists on *Dallas* readily met the challenge of feeding the make-believe survivors. With no ability to provide hot meals, the cooks prepared sandwiches and other food items normally on board, providing twice-a-day meals supplemented by snacks.

Several new equipment items proved both useful and effective during the trial. Portable atmosphere-monitoring equipment provided gas level readouts much more quickly and accurately than the Dräger tubes now used in the fleet. Chemical light sticks provided effective illumination where emergency DC lighting was unavailable. A single six-inch light stick provided enough illumination to make log entries, read manuals, or move about in a space or passageway. Many crewmembers preferred battery-powered LED lights, which provided bright, long-lasting illumination. Lessons learned in the trial included the importance of portable light sources when electrical power is lost and the need to rapidly identify and control small air leaks, which over time can raise pressure in the boat to hazardous levels. The slight hiss of air leaks was readily heard in the quiet conditions of the unpowered boat.

With success in great part due to the enthusiastic effort by the *Dallas* crew, SURVIVEX 2003 provided many lessons learned and demonstrated that new survival equipment and supplies perform well in disaster conditions. As *Dallas* volunteer ET3(SS) Clifford Copeland said, "It was strange with the power out and definitely uncomfortable, but this was valuable because it will help us know the effects and plan for the future in case of a disabled submarine." This highly successful exercise demonstrated that submariners can survive many "terrible hours" on the bottom.

CDR Horn is the head of the NSMRL Submarine Medicine and Survival Systems Department, and has authored or co-authored a number of publications regarding submarine medicine and disaster survivability. Dr. Horn is a qualified Submarine, Diving and Saturation Diving Medical Officer, with previous tours at Submarine Development Squadron 5, Submarine Group 10, and Naval Submarine Base Medical Clinic, Kings Bay, Georgia.

return to top