Deep Dive into the World of Submarines

By: Caio Mussolini, ITN former Submarine Officer

The recent accident of the Indonesian submarine Nanggala-402 brought the attention to the intrinsic sailing risks of submarines and, notwithstanding the Hollywood movies, still remain a quite unknown reality for the majority of the people. Even visiting a submarine is more complex and difficult than visiting a ship, so let's explore the submarine world further.

As anticipated in a previous article, it is more appropriate to consider a submarine like an airplane, instead of a ship, with all the risks deriving from moving in a three-dimension environment and associated dangers. This peculiarity is one of the reasons why the submarines' crews are usually trained more than other navy crews, before and during the period on board mainly focusing on safety and emergency that is considered paramount.

Navigation and Emergency Submarine Trainer, Ph. Marina Militare Maricosom

Technical Skills

Contrary to ships, the entire submarine's crew (enlisted, petty-officer and officers) is made of volunteer. Before joining the submarine training process usually, they must pass medical and psychological selection tests, in addition to assessments and oral examinations.

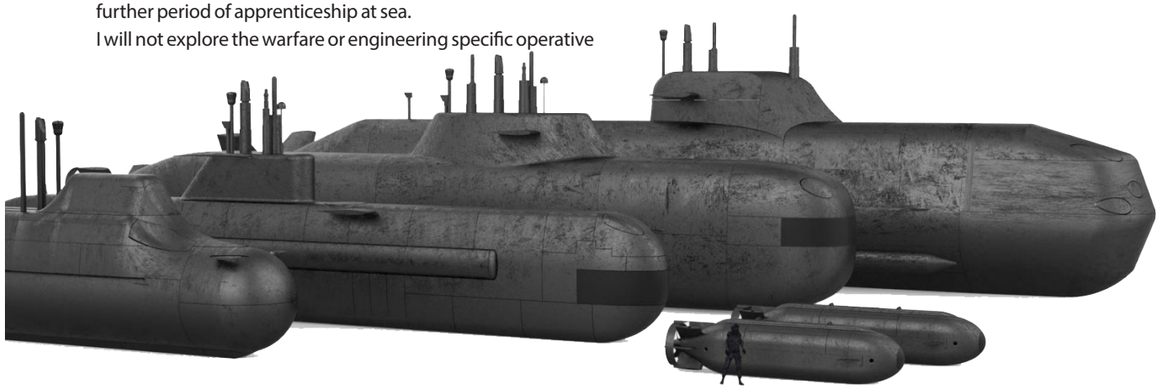
Being a submariner is highly demanding from a technical point of view, and each member of the crew must have a deep knowledge of the submarine and all the systems and circuits existing onboard. The training programme for new submariners is usually divided in two parts: a basic course on-ground premises (where the engineering and submarine fundamentals are taught) that last from three up to six months, and a further period of apprenticeship at sea.

I will not explore the warfare or engineering specific operative training courses, instead I'll focus on emergency training, which gives to the crewmates all the skills to respond to any dangerous event in a correct way or to leave a distressed submarine. Skills are the result of drills and procedures – improved after any event or experience – that should increase the probability of success after any event that can jeopardise the submarines or crew safety.

Instinctive Damage Control

The whole submarine's crew is trained to fight any casualty in an "instinctive" way developing, through continuous drills during the sailing, all the skills required to contrast any emergency situation.

The most common areas of training are firefighting, water leakage, blackout and lack of power, emergency rise, rudder problems, emergency torpedo launch, gas or smoke presence onboard.



The SEIE MK-10 on the surface after escape

Drills are periodically executed taking advantages of the training centres onshore also, where it is possible to simulate a real emergency situation, like fire onboard or water leakages from pipes or valves.

Most of the Navies have dedicated training centres, where all the submariners follow the individual or team training courses in operative and safety topics.

The most developed have premises with hydraulic simulators of the submarine's control room, that replicates the equipment and consoles of a real submarine and managed by a software that can simulate any operative situation to the limit, and analyse at a later time the crew's reactions, decisions and response to simulated emergencies.

Escape Training

In case of submarine distress, depending on the depths, there are some methods and procedures that can be used to leave the submarine. There is the individual escape, and the groups escape.

The individual escape consists in leaving the submarine from the hatch, with a special designed suit (e.g., the series Submarine Escape Immersion Equipment, SEIE) designed to allow a free ascent from a distressed submarine, providing protection against the cold and due the bright colour easy to localise when reaching the surface waiting to be rescued.

This escape's system can be employed usually up to 150, maximum 180 metres depth, at a rate of 7/8 persons per each exit trunk. Consider that possible health consequences or diseases increase with the escape depth, so a quick surface support for the escapers is needed.

Training on this escape technique is carried out periodically in dedicated "escape trunk" ground facilities, where it is possible to simulate all the procedure to leave the submarine.

In the escape trunk, the lower hatch is opened to allow the access of the trainer and then shut. It is filled with water and brought to the same outside pressure with HP air. This allows the opening of the outside hatch, leaving the trainer free to rise up to the surface thanks to the expansion of the air in the hood, that provides buoyancy and a bubble of air to breathe.

Submarine Rescue Bell

This is a mechanic rescue system derived from the Mc Cann Bell and needs the support of a ship.

Modern Submarine Rescue bell are designed for the rescue of up to nine DISSUB (DIStressed SUBmarine) personnel, throughout the escape hatch and crewed by two operators. The cylinder capsule is composed of three independent subsystems: the upper lock, the lower trunk and the ballast water tanks. The maximum allowable internal pressure is 5 bar / 6ATA and the maximum depth rating of a SR is 300 msw.

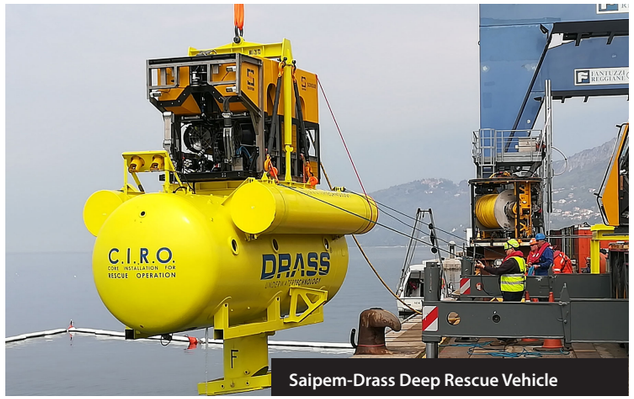
Escape drills are carried out and necessary with the participation of a support ship, and a submarine bottoming at a safe depth (e.g., 60/80 metres). The system suffers due to strong underwater current and submarine pitch/roll on the seabed. However, the reduced acquisition costs and easiness of management (and maintenance) make the new updated version of this system a very good solution for small Navies.

The Submarine Escape Immersion Equipment suit (SEIE)

SRV to the Rescue

The most modern Submarine Rescue Vehicle (SRV) is an underwater remotely operated system, launched from a moon pool (it offers the highest reliability and safety standards even in extreme sea conditions thanks to the rail guides and protection of a passive cursor) or from fixed/portable Launch and Recovery System (LARS) A-Frame type.

The "Ciro" (Core Installation for Rescue Operations) model, recently selected by the Italian Navy as a SRV for the new SDO-SuRS (Special & Diving Operations – Submarine Rescue



Saipem-Drass Deep Rescue Vehicle

Ship, the new vessel for the rescue of submarines), is equipped with a new variable inclination skirt to mate with the DISSUB if pitched and/or rolled, and allowing faster adjustment to better pair on the DISSUB. This system can transport up to 19 people (with the possibility to increase the capacity up to 25 in emergency conditions) per trip and can operate with significant wave up to sea state 6.

The use of a standard Working Remotely Operated Vehicle (WROV), not integrated with the rescue capsule, allows an easy plug and play connection. In addition, there is the possibility to use the WROV as a stand-alone unit for other purposes thanks to the dual use capacity of the system especially for the first subsea intervention phases in a DISSUB Scenario.

As the WROV is an industrial and well proven technology, there is the possibility to train also the end-user personnel on industrial simulators and on Industrial and Offshore applications, without the need to operate in real submarine rescue scenarios. This allows keeping the WROV pilots trained and updated at all times, with unlimited possibility for personal growth and reducing associated costs at the same time. In addition, there are many subsea activities that could be performed by a WROV keeping the operators trained in real scenarios, sharing costs between different Government Branches for various activities not only SMER (SubMarine Escape & Rescue) if any.

Regarding the endurance, the use of the umbilical cable gives unlimited mission duration; the mission will reportedly never end due to limits of the battery. In addition, the use of an "umbilical" guarantee power to use more powerful thrusters to effectively contrast underwater current. Furthermore, the possibility to connect many different payloads to the docking plate of the WROV makes the SRV a real dual-use system, allowing alternative payloads not only for defence applications but also industrial and offshore ones, with major benefits for the final user's country.

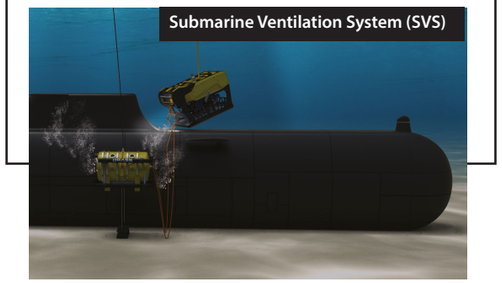
SVS – A Key Priority

One of the first actions to do after locating a DISSUB (identification of the DATUM) is to provide fresh air and heat to the survivors. A state-of-the-art SVS system is designed to provide sufficient ventilation to a DISSUB even in the most challenging and distressed emergency situations.

Compared to onboard traditional systems, a modern SVS is based on the utilisation of an underwater ventilation capsule, containing a suction compressor, which is, therefore, positioned immediately adjacent to the DISSUB (around 15 metres). A ROV extracts the suction and supply hoses from the dedicated pods installed in the capsule, and these cables are connected to the air ventilation and signal ports on the external surface of the DISSUB.

Thanks to the minimal size and length of the suction line, the compressor can satisfy the requirement of air recirculation without any pressure build-up inside the DISSUB, thereby operating at atmospheric pressure. By maintaining the atmospheric pressure in the submarine, the evacuation of the DISSUB is achieved with a simpler, safer and faster procedure at every depth, avoiding complex and long decompression procedures or transfer under pressure to a hyperbaric chamber after the rescue from the submarine.

In the event of distressed submarine, it is of utmost importance to put in place all the actions to guarantee the highest level of success in the search and rescue operation. The submarine's crew, the support ship's crew and the DISSUB Support Team must be trained and have access to the most modern, efficient equipment available on the market. It is an investment that cannot be waived and must be a priority for all the Navies with a Submarines Fleet in service.


Submarine Ventilation System (SVS)