

# SDO-SuRS Deployable Assets Program

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**Abstract.** ITA Navy has started a new program for the acquisition of a Naval Vessel called SDO-SuRS (Special and Diving Operation – Submarine Rescue Ship). In order to fulfill operational requirements, IT Navy has recently procured the so-called “SDO-SuRS Deployable Assets”.

A temporary business grouping (RTI) between SAIPEM Spa (leader in robotics and offshore) and DRASS Srl (national excellence in the hyperbaric sector and rescue) is the enterprise selected for the scope. This grouping represents a national excellence and a technological reference point for IT Navy in the Submarine Escape and Rescue.

The new SDO-SuRS Deployable assets will have specific peculiarities such as: modularity, deployability, interoperability and complementarity. Modular assets will be either installable on board the national mother ship SDO-SuRS or rapidly deployable in scalable configurations (from rapid intervention to deep rescue) on a vessel of opportunity, military or commercial, for far-from-home operations.

In order to establish a framework on damaged submarines rescue’s topic between Countries within ISMERLO (International Submarine Escape and Rescue Liaison Office) and NATO organizations, Italy offers the opportunity of providing any type of technical-administrative support in design, procurement, Life Management System or training of SAIPEM - DRASS systems, useful to a potential cooperation in the Submarine Escape and Rescue.

On the whole the above mentioned Submarine Rescue packages consist of a several assets as follow:

- Submarine Rescue Vehicle (SRV) tethered type composed by a Rescue Chamber and a WROV (Working Class Remote Operated Vehicle) which will be managed both aboard the SDO-SuRS ship (Mother Ship) and aboard the Vessel of Opportunity. The system has to be designed/realized to perform the search and rescue of DISSUB as well as the transfer of crew inside the Diving Decompression Chamber.
- Portable Launch and Recovery System (PLARS) to permit the Launch/Recovery of SRV/SRC and WROV;
- Diving Decompression Chambers (DDC) with TUP (Transit Under Pressure) to face a specific sanitary treatment which could involve the submarine’s crew;
- Ventilation System (VS) by means of which will be possible the change of dirty air inside of the distressed submarine as well as the air insufflation to main ballast tanks;
- Submarine Rescue Chamber (SRC);
- Working Class Remote Operated Vehicle (WROV) able to perform underwater work and completely redundant with the WROV associated to SRV.

**Keywords.** Submarine, rescue, modularity, deployability, optimization, national excellence, Italian Navy.

## 1. Introduction

The submarine is a mean able to operate in a three-dimensional space, equipped with high-tech systems that guarantee high reliability and the capability to face any kind of failures as well as damaging events that are particularly critical to the safety of personnel. Nonetheless, the autonomous capability to return to the surface could be compromised as a consequence of particular emergency situations, forcing the submarine to stuck in the seabed.

Following the accident of the Russian submarine Kursk, the continuous improving of Search and Rescue (SAR) procedures of Distressed Submarine (DISSUB) has been perceived as particularly important by the whole international community. As a direct

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consequence of that tragic event, in 2003, the International Submarine Escape and Rescue Liaison Office (ISMERLO) was set up within NATO. ISMERLO's core business is to ensure the coordination actions necessary for the search and rescue DISSUB operations, regardless of which nation the submarine belongs to (NATO or non-NATO).

In order to face possible DISSUB conditions, submarines are equipped with devices/materials that guarantee an average crew survival for up to 7 days as well as systems/arrangements that both allow the escape from the submarine (collective or single escape) and facilitate rescue from the outside by means of rescue vehicles. Consequently, the speed of intervention, intended as the rapidity and capability to locate and rescue the DISSUB, is the factor that determines the chances of saving the submarine's crew. For the above mentioned, the SAR operations require:

- The implementation of well-defined search and rescue procedures;
- Establishing a well-structured rescue chain capable of rapidly deploying in the incident area;
- ensuring the availability of rescue equipment that is quickly deployable and adaptable to the ARS (Auxiliary Rescue Ship or Mother Ship - MOSHIP) or VoO (Vessel of Opportunity) in the area.

## **2. The IT Navy's Industrial Choices**

The IT Navy, keenly attentive to the technological evolution of systems and assets, wants to maintain an active role as a technological driver in this field with focus on its role as guarantor of economic and geopolitical balances above and below the sea surface.

In particular, in the context of the institutional task of rescue of distressed submarines, the IT Navy has defined an acquisition program for SDO-SuRS Deployable Assets that will form part of the largest acquisition program of the SDO-SuRS (Special and Diving Operation - Submarine Rescue Ship) Unit dedicated to deep-sea diving operations and supporting the Special Forces in the maritime domain.

The SDO-SURS PROGRAM, ambitiously, aims to create an operational center at sea in favor of the divers and special forces of the IT Navy, both internationally recognized like operational excellences.

Concerning the Submarine Rescue Assets, in respect of strategic national constrains and following a careful analysis of the market and subsequent technical evaluations, the Naval Directorate of Armaments has identified the Association of Enterprise (RTI) formed by companies DRASS and SAIPEM, as the 'industrial reality' capable of designing and meeting the operational requirements of the Navy. With an ideal combination of technological competence and industrial capacity, these companies are references in their specialized areas of expertise, having a proven track record in production, supply and contractual management of projects, deep-sea diving and rescue equipment and systems at national and international level. They are certainly also world benchmarks in the design and implementation of remote-controlled underwater processing/inspection systems. In particular, DRASS, the Design Authority of the SRV 300 mini-submarine currently used by ITN Anteo, holds a vast specialist heritage in the diving and hyperbaric sectors, and is firmly focused on the consolidation of its advanced dual technologies. SAIPEM, on the other hand, is known as an absolute global excellence in the oil sector, in the construction of oil and gas pipelines, and in the capacity of inspection and surveillance at sea. Furthermore, the program also involves the Italian Naval register RINA in its design and certification, adding value and expertise to the whole enterprise.

### 3. The New Rescue Assets

The main system of SDO-SuRS Deployable Assets Program will be a new generation mini-submarine: tethered, modular and, as already said, based on national technology. This innovative and versatile system, of which the prototype has already been successfully tested in restricted waters of the Adriatic Sea, will be suitable for high depth operations by specialist staff of the Underwater Operations Group (GOS), both by SDO-SuRS and, potentially, on Vessel of Opportunity. The scope of this choice is not only to close the capacitive gap that will arise in this area when the obsolete Anteo Ship leaves service, but also to increase the deployment flexibility of rescue vehicles in international scenarios. Other assets are Portable Launch And Recovery System (PLARS), Diving Decompression Chambers (DDC) with Transfer Under Pressure (TUP), Ventilation System (VS), Submarine Rescue Chamber (SRC), and Working Class Remote Operated Vehicle (WROV).

The benefits and key aspects of the chosen solution are the following:

- Underwater systems are fully unmanned and piloted from dedicated control vans on the surface
- Ergonomics and optimization of spaces and occupancy has been stretched to the limits
- Tethered solutions allow continuous operations
- Modularity allows to identified multiple operation combinations of the assets
- Multiple payloads allowed to be operated by the Submarine Rescue Vehicle power and navigation part
- Standardization between multiple assets/payloads interfaces and connections
- Standardization of pilots and maintainers training programs.

Following we'll illustrate each asset performing a real operation.

#### VS (Ventilation System)

Once the Alerting Authority/SUBOPAETH receives indicators or doubts about a submarine's involvement in an accident, the alarm is raised and the Submarine Search and Rescue Authority (SSRA) starts coordinating the search activities in order to locate the DISSUB and/or any shipwrecked personnel. Simultaneously with the search phase, the SSRA will deploy/coordinate the nation's and worldwide community's "Rescue Forces."

To arrange the whole rescue activity can take different days moving the mothership or deploying all the assets in the DISSUB's area. Gaining time is essential and this means providing fresh air to the crew in order to prolong the survival on board, waiting to be evacuated. It's clear that the first asset to be moved is the Ventilation System, an arrangement for the regeneration of the internal atmosphere of a distressed submarine, needed to operate a first INTERVENTION.

The concept of Drass' VS system is based on the use of an underwater ventilation capsule, containing a compressor that is positioned close to the DISSUB; the compressor works in suction mode from the DISSUB while fresh air is sent to the submarine, produced by compressors located on the MoShip. Thanks to its compact size and to the short extension of the intake line (DISSUB venting outline), the compressor can meet the renewal requirements of the DISSUB atmosphere, preventing accumulation or build-up of pressure inside, thus operating at atmospheric pressure and dumping the exhausted air directly at depth.

By keeping the submersible pressure at near-atmospheric levels (or the one found in the DISSUB at the beginning of the operations), up to the depth of 300msw, the DISSUB can be evacuated with a simpler, safer and faster procedure, avoiding crew

pressurization and subsequent decompression. Moreover, the Company is studying an upgrade of the system to operate it up to 600 msw (in this case the connection with the DISSUB should be performed by a ROV).

During the operation, inside the capsule, the system performs a local and independent analysis of the atmosphere in DISSUB checking the air extracted from inside. Reporting the data to the MoShip through a light umbilical cable let us monitor all the parameters and adjust the flow of fresh air.

#### SRV SYSTEM (Submarine Rescue Vehicle and Working remotely operated vehicle)

In the meanwhile the DISSUB is located and INTERVENTION is operated, providing fresh air to the crew on board, the SSRA must arrange the rescue from the DISSUB to the MOSHIP/VoO by means of a Submarine Rescue Vehicle SRV.

The SRV, a Drass-Saipem collaboration, is the main element of the Submarine Rescue System (SRS). It is a modular system composed of a Work Class Remotely Operated Vehicle (WROV) engineered by Saipem, connected to the Drass Capsule for Intervention and Rescue Operations.

It is a reliable, modular, expandable solution that allows:

- at operational depth: transfer of submariners from DISSUB to the rescue capsule, using the dedicated mating skirt and transfer materials from the capsule to the DISSUB on demand;
- on surface: pressure transfer of rescue personnel (TUP capacity) from the vehicle to the hyperbaric chambers on the surface using a connecting trunk.

The vehicle is connected to the surface via the umbilical cable and is piloted by the control container on board the MoShip / VoO. It is a pressure-resistant capsule suitable to accommodate up to 16 rescue personnel and 3 operators, designed to operate continuously with all the functions and systems necessary for the duration of a rescue operation such as navigation, life support and communication, equipped with a set of additional thrusters which increase navigation precision in the phase of matching the Submarine.

The navigation and power are assured by a WROV connected with the capsule. The WROV Saipem Innovator 2.0 is capable of dynamic positioning and station-keeping, control and maneuverability even in strong currents while carrying heavy loads. It is equipped with an extra platform forming the so called JVB-X (Joint Vehicle Baseline with eXtra platform).

The WROV system is supplied with its own LARS, a winch with 2200 m of umbilical and a TMS capacity of 1100 m of tether. It is equipped with a 7F-manipulator and a 5F-grabber, three cameras (Color zoom camera, low-light camera and miniature camera), two sonars, three emergency devices (a flasher, a radio beacon and a locator beacon) and other accessories.

The modularity of the vehicle allows the SRV WROV to be exchanged at the surface with a back-up WROV in the event of any failure. This feature makes it possible to continue with the rescue mission even when the first WROV is under maintenance.

The functions of the SRV vehicle are:

- Navigation and control even in the event of strong currents (up to 3 knots of current on each direction)
- Location of a DISSUB (Distressed Submarine), or other underwater assets. Localization is understood as the possibility to identify and reach the underwater asset by means of on-board instrumentation, mainly chambers and sonar, in the ranges of operation and maneuverability of the vehicle;

- Connection to DISSUB by mating skirt up to 600msw, even in the presence of DISSUB inclination up to 40° (pitch and roll), at a maximum DISSUB internal pressure of 6 ata;
- Presence of access hatches of which at least one can be used, only in emergency, with a floating vehicle on the surface;
- Transfer additional supplies to the DISSUB after mating skirt-pairing and door-opening;
- Connecting in TUP mode to surface hyperbaric chambers (once connection to the DISSUB has been made and rescue personnel recovered, the system is brought to the surface where the submariners can be transferred to the hyperbaric chambers).

Thanks to the modularity of the SRV, the capsule can be replaced with payloads of dimensional and weight characteristics compatible with the JVB-X module interfaces thus allowing the dual-use functionality of the vehicle. Below are some examples of possible uses:

- Laying of hydrophone arrays for protection of strategic areas;
- Mine-removal. WROV can also be used for transport of a sacrificial vehicle for mine-detonation;
- Core drilling or underwater sampling of sediment for the analysis of seabed composition for geological and environmental protection purposes using specific modules;
- Detection, containment and remediation of radioactive and/or toxic sites using specific modules;
- Inspection/protection and control of underwater national strategic assets, such as underwater pipelines or subsea cables;
- Transport of a system for the underwater deployment and recharging of a fleet of autonomous underwater vehicles (AUVs); the system can launch and recover a series of AUV capable of scanning a large underwater area around the launch area.
- Any other underwater operation deemed compatible with the use of the system in accordance with the needs of the system user and implementable with a payload compatible with the JVB-X module.

#### PLARS (Portable Launch and Recovery System)

The PLARS is the launching and recovery system of the SRV. With a beam size of 10m, the PLARS system has a smaller width than that of the NSRS 14m x 40m system and is therefore compatible with installation on a vessel of opportunity.

The PLARS system allows the transfer of the SRV, when placed on the reception cradle, in TUP mode directly to the deck decompression chambers intended for it.

The system can operate with all its functions for the full duration of the mission, considering the simultaneous use of assets that make up the rescue system, according to the expected operating methods.

It is an A-frame installed at the stern of the vessel, equipped with hooking and anti-pitching systems, consisting of a depressor and a snubber, that enable the safe launch and recovery of the SRV, in a controlled manner, without the need for operators in the water.

The depressor is a fundamental element to accompany the vehicle up to an attenuation depth of the influence of wave motion and then release it (no higher release/hooking altitude 50 msw) allowing therefore real driverless operation.

The system is hydraulically powered with a dedicated and redundant control unit. The hydraulic circuit feeds the winches located on the legs of the A-frame and the opening and closing cylinders of the A-frame.

The umbilical winch for SRV with 1200 m of coiled umbilical cable

The launch and recovery system of the rescue vehicle is adapted for dual use:

- To launch and recover the rescue vehicle to operate submersible rescue missions;
- To launch and recover vehicles alternative to the rescue vehicle, but still compatible with the mechanical interface and load capacity characteristics, with a view to dual use.

#### SRC (Submarine Rescue Chamber)

Another way to rescue the crew is adopting the SRC that is a rescue system based on the McCann bell principle. This system, if the operating range allows the employment of the SRC can be used to perform a “dry” material transfer to and from the DISSUB too.

The rescue bell allows immersion and mating on DISSUBs up to an operating depth of 300 msw. The coupling of the bell with the DISSUB mating flange takes place mechanically, through appropriate turnbuckles and/or hydrostatically by means of the suction effect.

The rescue bell then allows the evacuation of 8 rescued people and the recovery of the same on the surface, employing 2 operators maximizing the occupancy for each run of this kind of rescue asset all over the world but still maintaining the flexibility of deployment and use.

The bell is divided into two compartments. The upper one:

- provides ergonomic space for all seated occupants (catering also for the possibility of recovery of personnel laying on a stretcher) and displacement volume to ensure a normally positive trim, with empty ballast tanks and flooded lower compartment;
- allows occupants to enter and exit when the bell is floating through a hatch on the top ceiling and connection to the DISSUB after hydrostatic/mechanical coupling with the damaged submarine, by means of a hatch placed on the lower section;
- Houses command and control systems for the bell and downhaul winch; life support equipment (analyzers, O2 injection and scrubbers); lighting systems, video surveillance and communication systems with the surface and DISSUB.

The lower compartment acts as a link between the upper compartment and the deck, is normally flooded during the descent/ascent phases of the bell and, when the bell is connected to the DISSUB, can be exhausted. The lower part of the compartment has an interface compatible with NATO interoperability standards (ANEP 85 Ed. A Ver.2 - Material interoperability requirements for submarine escape and rescue). The downhaul winch is housed in the lower compartment.

The ballast tank is positioned in the lower part the hull, and partially surrounds the lower compartment, forming a volume horseshoe shaped that can be inspected via hatches. It has the function of receiving the water transferred from the lower compartment during the coupling phase with the submarine. This transfer makes it possible to weigh down the bell and thus improve the landing capability especially in shallow water.

#### DDC (Deck Decompression Chamber)

The sheltering of survivors and/or the medical treatment of recovered persons is the last activity to be performed in the rescue operations. It requires the availability of resources and skills (manpower and means) capable of prioritizing the medical treatment of recovered personnel on-site.

The DDC surface decompression chamber system has as its main function the capability to accommodate rescued people. Through the Transit Under Pressure (TUP) the crew can be transferred from the SRV to the chambers to begin the depressurization activities.

The interior layout of the chambers and the level of automation applied ensure that the hyperbaric complex, during the operational phase, does not require technical staff inside, but only operators for DISSUB rescues.

There are 3 chambers in total, each with two hyperbaric locks, all positioned inside its dedicated shelter (dimensions 40' x 8' x 8'). The complete system has other 2 support containers, containing installation material, walkways and support structures, interconnecting trunks and mating trunk, equipment for alignment and fixing of the system.

The chamber complex can be installed on a dedicated submarine rescue ship or on a VoO.

In the standard operational configuration, the 3 40-foot containers will be assembled on top of other 20-feet containers that are part of other systems. The three chambers are arranged side by side and are interconnected with their respective flexible trunks; the mating trunk connects to the central TUP chamber, facing the PLARS and SRV system.



Figure 1. General layout of the system (for reference only)

The configuration shown in figure 1 above requires a transversal footprint on the ship deck of around 10 meters.

The entire DDC decompression chamber complex can accommodate up to 66 persons in continuous mode and 6 additional operators in temporary mode at an operational pressure of 5 bar (6 ATA). It is possible to install the DDC system in partialized configurations. Considering the number of rescuees and in order to speed up the deployment and installation phases, it is possible to assemble two chambers, or only one, instead of the standard three available.

#### IZ (External blowing system for main ballast tanks)

This system, that can be used as redundancy to the VS, allows the water discharge of the DISSUB ballast tanks via an air supply line or to recharge its air bundles in the case in which the DISSUB has lost his capabilities and the crew is a cooperating one.

The operations on the Intervention MoShip will be carried out at an appropriate distance from the vehicle to avoid possible collisions, in compliance with the expected emergency cone. The system requires diving and underwater operation capabilities with

ROV or divers to connect the flexible hoses and can operate up to 300 msw, at a recharge pressure of 200 bar with a load of 1000 m<sup>3</sup>/h of air.

#### FASD (Fast Auxiliary System Deploy)

One of the innovations of this system is the capability of being transferred, totally or in part, to a VoO even with very poor auxiliary systems because all the plants needed to operate are provided by the so called Fast Auxiliary System deploy that allow the entire assets to be considered independent from the VoO that accommodate them.

Complementary to the Systems above mentioned it provides diesel electric power stations, breathable air and mix gas, operation monitoring Central Unit, water distribution, mechanical interfaces, spare parts, all installed in transportable ISO Containers and part of the VoO spread configuration but still remaining in the generic overall dimensions of the NSRS system allowing the complete spread to be installed and operated by the same VoO.

The system has been thought to let the Rescue Assets completely independent when moved to another Vessel of Opportunity but it has been structured in order to be flexible, moving only the containers strictly needed to supply the specific asset in accordance with the needs of the ongoing SMER scenario.

#### **4. CONCLUSIONS**

SDO-SuRS Deployable Assets Program is organic to the underwater technological trajectory in which Italy, as already mentioned, plays a fundamental role at the level of major industrialized countries and which look to the sector for both civilian and military purposes. The UW Italian cluster includes valuable skills, both industrial and academic, vital for the development of a large-scale economy of the underwater world that looks at multi-disciplinarity with a special emphasis on 'unmanned'.

Looking at worldwide scenario, this Program highlights significant technological advances with respect to the operating systems and thanks to its innovative design will be extremely versatile as it will be able to carry out high-precision interventions by means of technologically advanced payloads, possess high endurance by means of tethered power and will allow modularity for fast repositioning by air, sea, rail and road, in every part of the globe. The uniqueness of the technological choices inherent in the new project will allow a huge amount of data to be accessed more effectively (e.g. greater angles of engagement on DISSUB), and by means of the broadband provided by the cable, a huge amount of data will be managed. Moreover, there will be a level of safety for operators and awareness for the decision-makers, something that is notably unfeasible with the current solely manned systems in operation. The sum of these characteristics make the SDO-SuRS ship and its assets the ideal tool for any type of subsea intervention, rendering it a functional tool for the strategic interests of the country and opens up as an effective alternative to the rescue systems operated by the US Navy and the North European Consortium NSRS (NATO Submarine Rescue System). A strategic perspective for a country of great political, military and economic importance.