Distressed Submarine Ventilation and Decompression System

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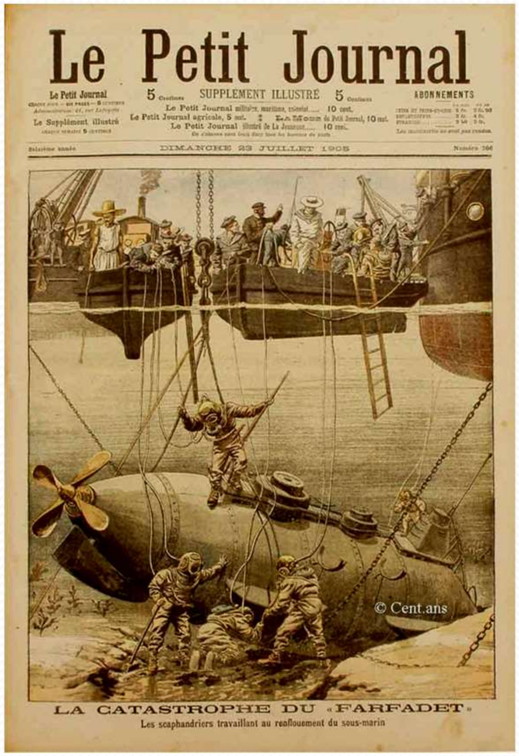
Agenda

- What Is DSVDS
- Why DSVDS
- DSVDS Exercises
- Questions

The Problem



Every scenario of distressed submarine is different, but critical parameters that may limit survivability of the crew are always the same:

- Pressure rise
- Toxic atmosphere
- Loss of life support capability
- **Time**

➔ How can these vital parameters can be managed?

The Ideal Case

In an ideal world, it should be possible to undertake:

- **Fast mobilization of rescue elements**
- **Fast localisation and environment assessment**
- **Safe & fast rescue intervention**
- **Immediate medical treatment for sub's crew**

***NATO NSRS** (or equiv.):*

- Transportable full rescue system
- TUP facilities
- On-board decompression chambers & medical experts

Rescue Systems

- A lot of rescue systems like NATO NSRS (or equiv.)are available.
- Most of these systems have the following functions :
- • Transportable full rescuesystem
- • TUP facilities
- • On-board decompression chambers & medical experts

Time Limit

- In some cases, SRS intervention may be difficult, or even impossible:
- • System not available (maintenance…)
- • Longer mobilization of system
- • Technical failure before or during operation
- • Bad sea conditions
- • Sub/SRS interface unreachable by SRS or damaged
- • Sub/SRS interface unreachable by sub's crew
- In such situations ADDITIONAL TIME is needed

The Challenge of Additional Time

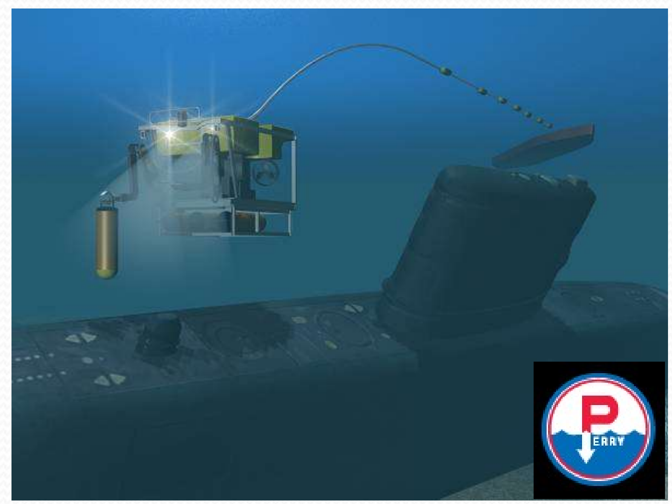
To increase significantly preparation and intervention time, the following problems must be addressed :

- **Avoid toxic atmosphere inside Sub by regeneration/ventilation**
- **Continuous monitoring and control of inside pressure**

➔ ***Ventilation and Depressurization System (DSVDS)***

- **Ensure life support for the sub's crew**

➔ ***ELSS Pod posting***



DSVDS Main Requirements

DSVDS main functions :

- **Assessment of inside air composition and pressure**
- **Ventilation of Sub with a suitable fresh air flow**
- **Simultaneous fine control of inside pressure**
- **Continuous monitoring and adjustment of vital parameters**

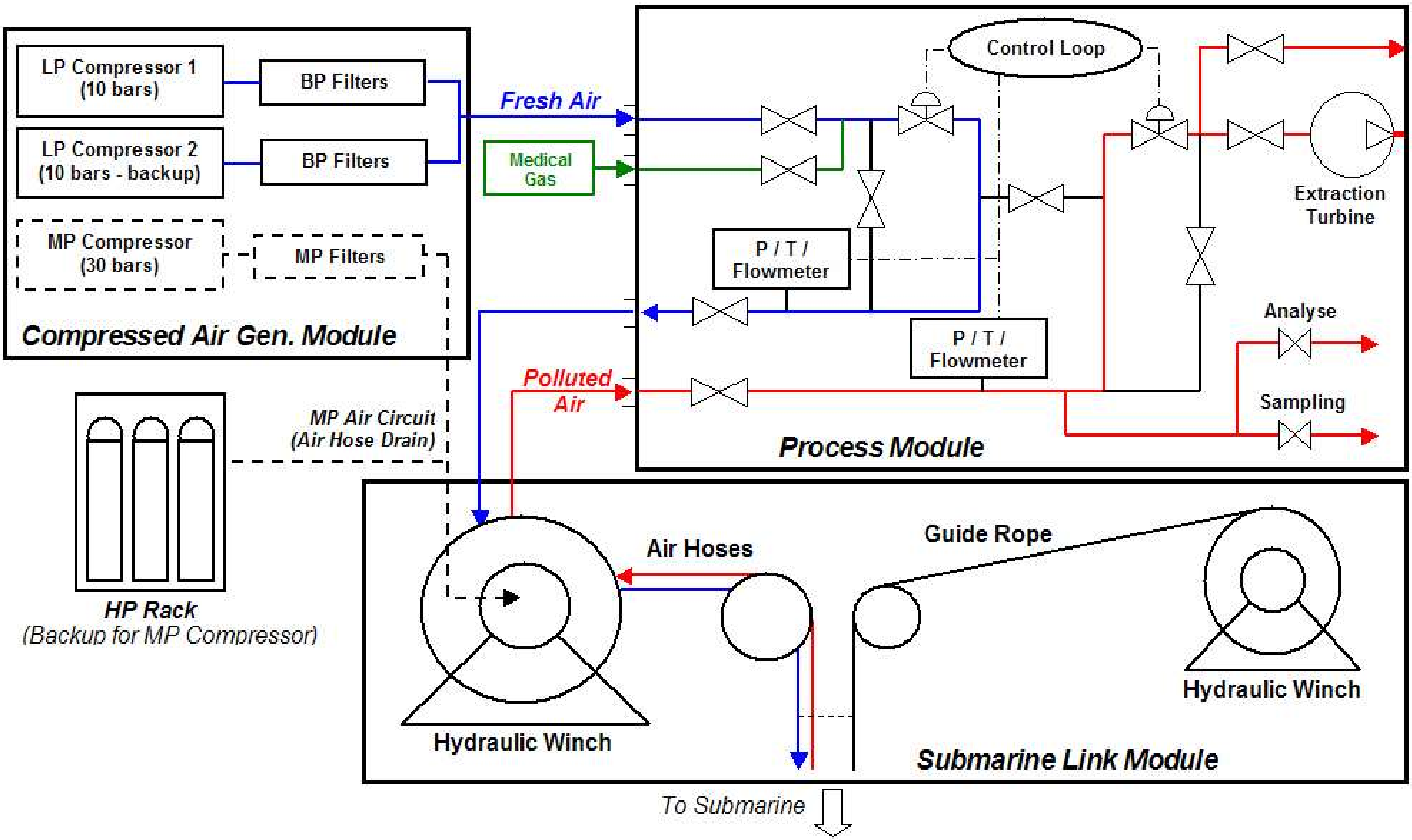
DSVDS main operational requirements :

- **Easy mobilization/Operation with limited personnel**
  ➔ ***DSVDS must be deployed as fast as possible***
- **« Independance » from sub: DSVDS must not rely on crew nor on sub's onboard systems to be operated**
- **Adapted for harsh conditions**
- **Safety**

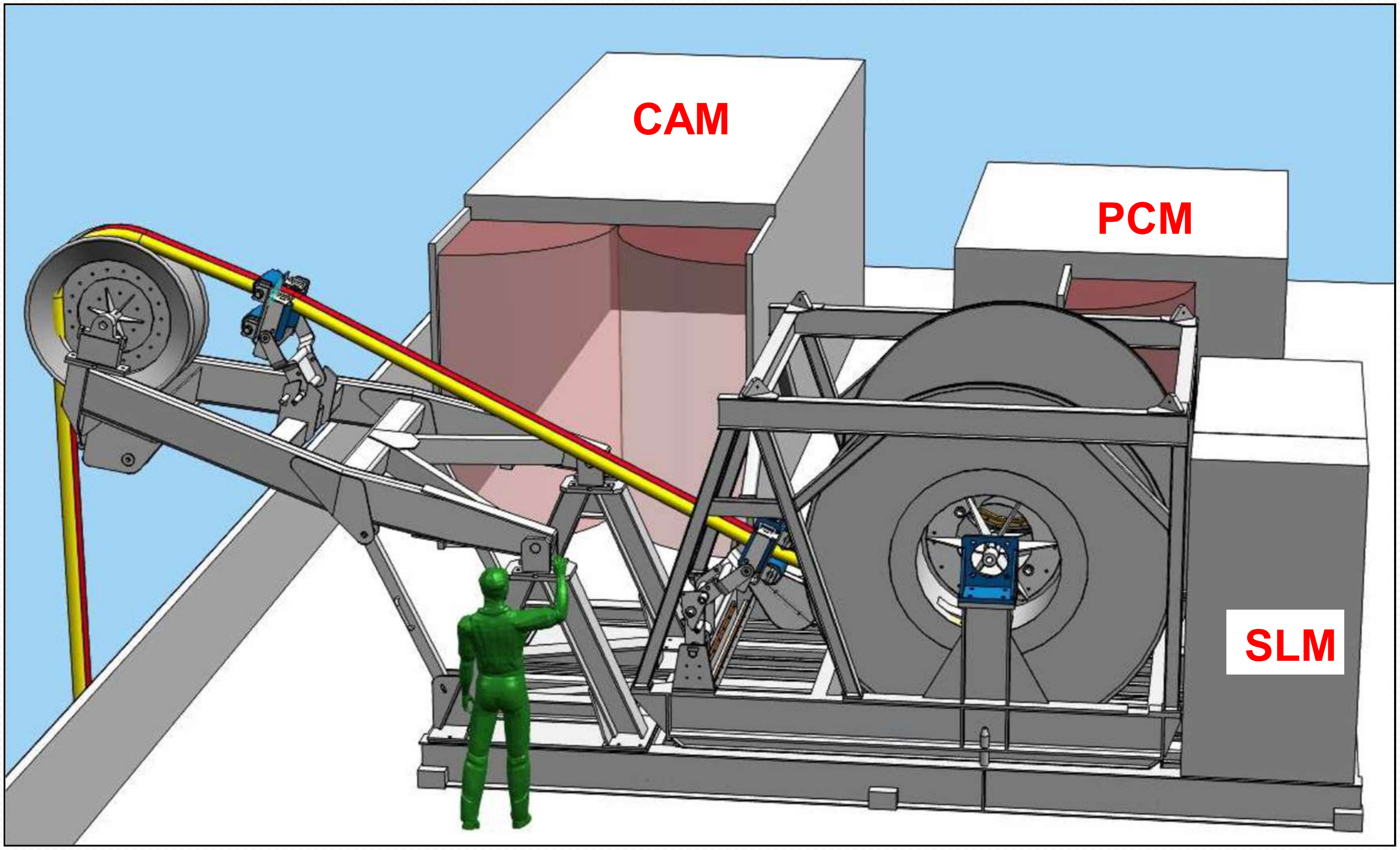
Background

- A DSDVS provides the means of remotely depressurising and / or ventilating a DISSUB compartment that is subject to elevated internal pressure, or has an atmospheric specification beyond breathable limits.
- A DSDVS therefore has two purposes; firstly to control pressure /de-pressurise, and secondly to ventilate.
- The former would either be able to maintain pressure within survivable limits(against for example a rising pressure gradient) or to lower the pressure to reduce the surface decompression obligation.
- The latter would supply air and remove waste gases.

Synoptic Diagram



Hi-Level System Description



Dissub Internal Pressure

- Of all the factors influencing the system capabilities, the target pressure (and airflow) in the DISSUB is arguably the most critical. It is from this point that the rest of the system must be matched and sized
- When looking at a system that supplies breathing air, too high a DISSUB internal pressure demands a high flow to provide sufficient refreshing of the atmosphere to accommodate the submariner's life support consumption rates – whilst the higher internal pressure aids recovery of the exhaust gasses, the size of the recovery hose this may entail on the recovery side could hamper system mobilisation.

DISSUB Internal Pressure

- The consequent increase in supporting equipment quickly adds to the overall size of the rescue spread.
- Too low a target pressure reduces the differential available to exhaust spoiled air at the surface.

Flow Rate Limitations

- The flow rates required to maintain the atmosphere within habitable bounds are a function of:
- - the consumption rates of the submariners
- - the pressure of the chamber
- - the size of the chamber
- - any contaminated air to be removed and production sources of contamination
- - the smallest restriction in the line

Flow Rate Limitations

- It is also worth noting that the flow rates may produce problems at entry to the DISSUB –there is a physical limit to the velocity with which air may enter and exhaust through a salvage point. A restriction at this point, should be investigated with respect of orifice size and internal layout. This will then have an impact on the system. Although it is possible to increase mass flow rate with pressure, the velocity shall remain constant, the point at which this occurs on a submarine requires understanding ahead of purchasing a system as it may affect internal pressures
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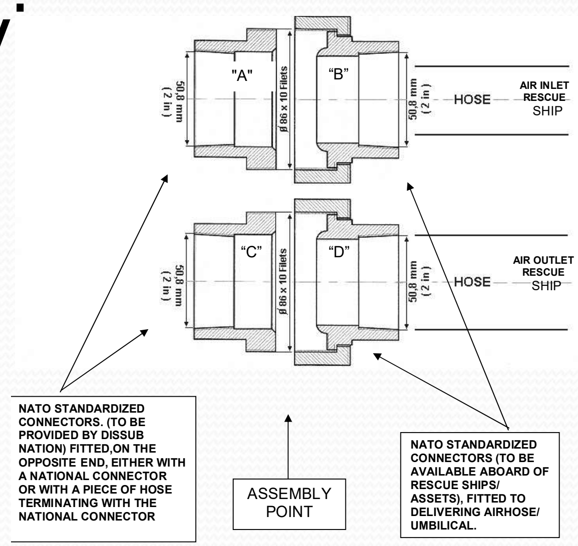
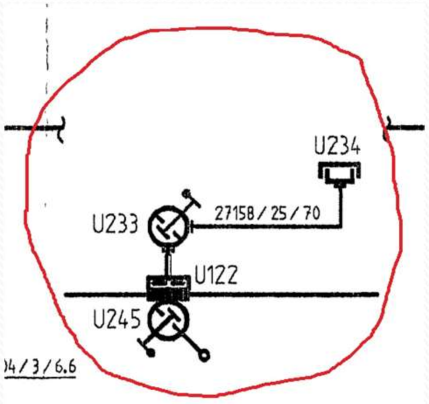
DISSUB Ventilation

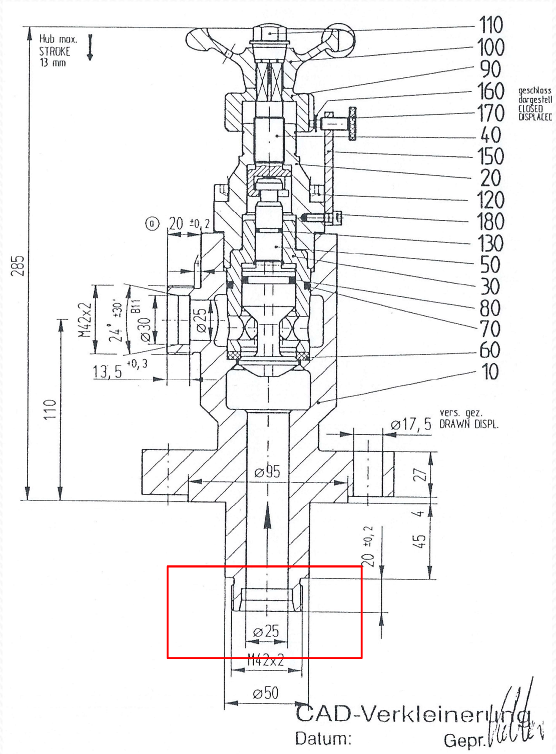
- ANEP-85 couplings & hoses: ø50mm
- ATP 57.1 outlet hose dia. ≥ 50mm
- ATP 57.1 minimum flow rate: 30 liters/min/surv



DISSUB Ventilation

- SM valves for PH blow-off not designed for ventilation
- valves & pipes are ø25





DISSUB Ventilation

- conversion study underway for U214

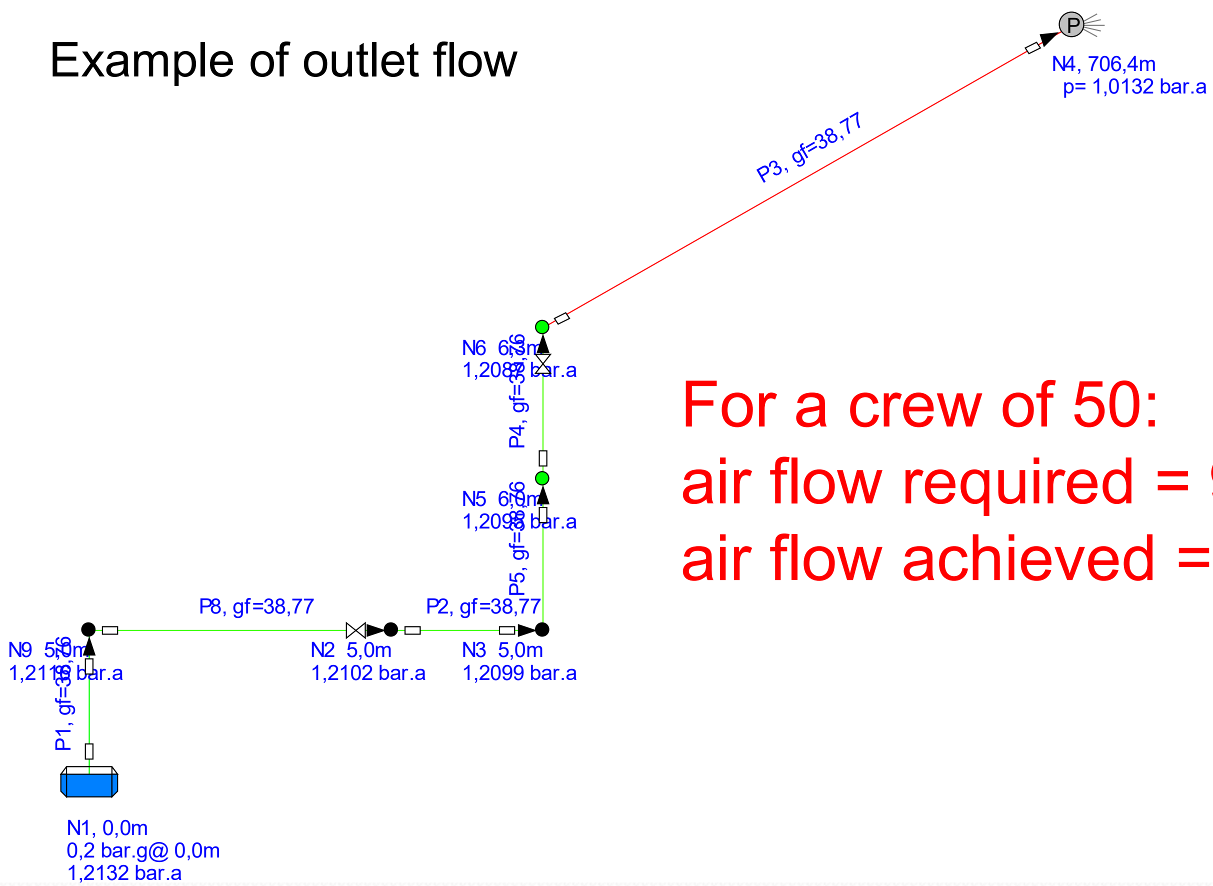
- early findings from compressed-air flow model:

1. air outlet without vacuum suction may prove insufficient, even with full diameter fittings and hoses

2. pressure drop sensitive to DISSUB depth (at deep depths pressure loss due to friction comparable to static head loss)

DISSUB Ventilation

Example of outlet flow



For a crew of 50:
air flow required = **90** m^3/hour
air flow achieved = **38.77** m^3/ho

Transportation

- The system has to be air transportable, and the items specified comply with JADTEU guidelines.
- It is worth noting however that standard 20ft ISO specified size of shipping container disqualifies use of certain common 747 transport planes. These planes have historically been the most readily available means of air mobilisation and form the basis of many designs.
- If a specific set of air transport guidelines or the details of the most readily available air transporter were available, the design may be specifically tailored to this.

Medical Air / Oxygen

- A system capable of introducing oxygen, coupled with ELSS pod posting of LIOH Curtains or similar would offer additional system flexibility at extremes of operation.
- Integration of such facility is a relatively small cost when considering the purchase of a system but adds an additional layer of capability and the ability to extend the habitable environment in certain scenarios.
- A system capable of supplying oxygen must be designed with this in mind at the outset and material and safety considerations applied throughout as standard

Umbilical System Deployment

- The means of deploying the umbilical, requires thoroughly integrated and must be considered as the system develops. Historically this is one of the most challenging aspects when providing a rescue ready DSDVS.
- Regard for factors such as deck handling, splash zone transition, submarine interface, ROV and diver interface and surface ship stability are critical. Whilst a large diameter umbilical facilitates the flow rates, were it also load rated, its stiffness would demand a winch of such dimensions that it would severely limit deployment and mobilisation

Umbilical System Deployment

- Similar systems are deployed utilising a clump weight arrangement. The clump weight is deployed from a dedicated winch using a dedicated line – thereby eliminating the umbilical from the deployment loads. The design of the deployment method and the winch will require careful consideration to isolate elements from the load path. That said, the design of winch system would lend itself to neat integration with a weight deployment winch.
- Over boarding of the umbilical, flying leads and any clump weight can be simplified using dedicated lifting equipment. LARS's used by similar air mobile rescue assets routinely incorporate deployable cranes. This gives the system autonomy and independence from MOSHIP facilities and increases the number of VOOs available for mobilisation

DSVDS Exercises

- Although their are several systems in use with different Navies, knowledge of the working of the systems is minimal
- Every exercise a succesfull coupling of the hoses is performed and when air is flowing the exercise stops
- All these exercises take place at limitted depths while the real challeng is to do it deep
- Also not much thought is given how to deal with partial pressure of oxygen / CO_2 and what mixture to supply to the submarine

New Solutions

- An Italian Company , Drass, is busy with a new and revolutionary idea.
- They will bring a pressure tight container to the dissub
- In that container they install two compressors who will take the foul air out of the submarine.
- This way a return hose to the surface is not necessarry
- The system is at the moment being develloped.

Questions ?????