Submarine Ventilation Systems

OceanWorks International
IN THE EVENT OF A DISSUB INCIDENT THE CRITICAL FACTORS THAT LIMIT SURVIVAL ARE:

• COMPARTMENT INTEGRITY AND FLOODING
• COMPARTMENT PRESSURE INCREASE
• INEFFECTIVE OR DAMAGED LIFE SUPPORT
• LIMITED REMAINING LIFE SUPPORT DURATION
• CONTAMINATED ATMOSPHERE

IT IS CRITICAL TO PROVIDE SURVIVORS WITH AS MUCH TIME AS POSSIBLE TO AWAIT RESCUE ASSET ARRIVAL ON SCENE.

THE OCEANWORKS SEVDS IS DESIGNED FOR RAPID MOBILIZATION AND TO EXTEND THE LIFE OF SURVIVORS BY VENTILATION OF COMPARTMENTS WITH CLEAN AIR AND BY INITIATING CONTROLLED DECOMPRESSION TO REDUCE THE PHYSIOLOGICAL EFFECTS OF PROLONGED HYPERBARIC EXPOSURE.
THE PRINCIPAL **FEATURES** OF THE *OceanWorks* SEVDS ARE:

- OPERATIONAL DEPTH CAPABILITY OPTIONS OF 300 AND 600 METERS
- MODULAR FOR RAPID MOBILIZATION AND INSTALLATION ON SHIP
- RAPID CONNECTION BY DIVERS, ADS AND ROV USING *OceanWorks* EXCLUSIVE SRF AND SAU NATO STANAG 1450 COMPATIBLE TECHNOLOGY
- CONNECTION AND SEVDS CONTROL FULLY INDEPENDENT OF DISSUB CREW
- AUTOMATIC MASS FLOW BASED VENTILATION AND DECOMPRESSION CONTROL WITH MANUAL BACK UP
- MULTI-GAS ANALYSIS AND RECORDING OF DISSUB ATMOSPHERE AND CONDITIONS
- VACUUM PUMP BASED EXHAUST BOOST
- FULLY REDUNDANT SUPPLY, EXHAUST AND CONTROL SYSTEMS
- INTEGRATED SUPPLY AND RETURN UMBILICAL WITH EXTRUDED THERMOPLASTIC OVERJACKET AND STRENGTH MEMBER
- OPERATED BY 2 PERSON CREW ON EACH 12 HOUR SHIFT
THE PRINCIPAL **ADVANTAGES** OF THE **OceanWorks** SEVDS ARE:

- **UMBILICAL HOSE TECHNOLOGY** combined with a vacuum pump exhaust boost allows operational depth options up to 600 meters.

- **OceanWorks** exclusive SRF and SAU technology means that connection time is effectively the same for divers, ADS and ROV (other systems connection time varies from 2 to 6 or more hours between divers and ROV).

- **AUTOMATIC MASS FLOW BASED VENTILATION AND DECOMPRESSION CONTROL** is very precise and easy to operate.

- **VACUUM PUMP BASED EXHAUST BOOST** allows decompression of survivors following accepted decompression table profiles due to variable flow settings referenced to dropping compartment pressure and hose length.

- **INTEGRATED UMBILICAL CONFIGURATION** simplifies LARS design and winch spooling and speeds overall hose handling.
THE PRINCIPAL BENEFITS OF THESE FEATURES ARE:

• THE TIME TO INITIATION OF ASSESSMENT AND VENTILATION, INCLUDING THE TIME TO DEPLOY THE HOSES AND MAKE THE CONNECTION TO THE DISSUB, IS REDUCED BY THE MODULAR CONSTRUCTION OF THE OceanWorks SEVDS DECK SYSTEMS AND THE EXCLUSIVE SRF/SAU TECHNOLOGY

• THE NAVY HAS THE OPTION OF USING SUBSEA INTERVENTION ASSETS FROM ITS OWN CAPABILITY OR COMMERCIAL SOURCES SINCE THE SYSTEM CAN BE CONNECTED EQUALLY EFFECTIVELY BY DIVERS, ADS OR ROV BY USING THE OceanWorks SRF AND SAU TECHNOLOGY

• IF USED WITH THE OceanWorks ELSS POD DEPLOYMENT AND ADS SYSTEMS, THE PROBABILITY OF SUCCESSFULLY EXTENDING SURVIVAL UNTIL RESCUE ASSETS ARRIVE ON SCENE IS GREATLY INCREASED.

• OceanWorks CAN OFFER THE NAVY A COMPLETELY INTEGRATED LIFE EXTENSION PACKAGE INCLUDING SUBMARINE INTERFACE ENGINEERING, SRF AND SAU TECHNOLOGY, SEVDS SURFACE SYSTEMS, ELSS POD DEPLOYMENT AND ADS SYSTEMS
GUIDE WIRE ON CONSTANT TENSION WINCH

UMBILICAL ATTACHED TO GUIDE WIRE USING RUNNING SHACKLES

HARDSUIT ADS OR ROV MAKES CONNECTION TO DISSUB

SEVDS AND ADS ON INTERVENTION SHIP
SEVDS DEPLOYMENT SEQUENCE

• Complete function, flow and pressure tests of hose and SAU prior to deployment
• Deploy ADS/ROV and attach downhaul wire to DISSUB (or use clump weight)
• ADS/ROV remove knockout plate protecting SRF
• Deploy umbilical and SAU on downhaul wire
• ADS or ROV connect SAU to SRF and lock in position
• Pressure test hose connection
• ADS or ROV open submarine internal hull stop valves and begin ventilation with full control and monitoring at the surface
TYPICAL VENTILATED AREA IN SUBMARINE

Additional connections to additional compartments

High pressure inlet hose

Low pressure outlet hoses

Connection Points

Ventilated area

SRF CAN BE FITTED AT SEVERAL LOCATIONS ON MULTI-COMPARTMENT SUBMARINES
IDENTIFICATION OF DESIGN FACTORS

- **SEVDS Operational Objective**
  - Primary - extract CO2 generated by survivors and provide controlled decompression
  - Secondary - provide fresh breathing air

- Effectiveness of the system performance is governed by the volume of gas that can be made to flow through the exhaust hoses and fittings.

- **OceanWorks will custom configure the submarine interface to match submarine details per the following slides**
IDENTIFICATION OF DESIGN FACTORS

• Umbilical / hose configuration and size is customized based on:
  – Number of personnel
  – Number of compartments
  – Volume of compartments

• Submarine Receiving Fittings (SRF) configuration detail is customized based on:
  – Existing or new hull penetration configuration in submarine
  – Fairing and deck configurations

• Submarine Adapter Unit (SAU) configuration detail is customized to match method of connection:
  – Diver – basic SAU
  – HARDSUIT ADS – modified diver SAU
  – ROV – full SAU per this presentation

• OceanWorks will custom configure the submarine interface hardware and umbilical hose configuration to match submarine requirements
IDENTIFICATION OF DESIGN FACTORS

- **Size / type / location of the submarine salvage fittings / piping**
  - Determines attachment configuration
  - Determines SAU supply & exhaust hose configuration re losses
  - Affects available flow rates
- **Exhaust hose number and size is driven by**
  - Number of personnel
  - Volume of compartments
  - Decompression rate desired
  - Maximum and minimum submarine internal pressure (e.g.: 5 to 1 bar)
  - Maximum CO₂ level allowed (0.06 pp CO₂)
- **Supply hose size is standard for all systems**
- **Depth of operation is limited by exhaust hose size and technology related to flow. Hose requirements are impacted by:**
  - Depth of operation
  - Total length of the hoses (always 20 to 30% greater than depth)
  - Friction losses due to flow
  - Hose collapse under external pressure
SUBMARINE INTERFACE CONNECTION

OceanWorks has developed the following systems for connection of SEVDS to typical submarines:

- **Submarine Receiving Fittings** (SRF) – permanent fittings on submarine to connect SDVS supply and exhaust hoses to Hi and Lo salvage points in each compartment
- **Submarine Adapter Units** (SAU) – portable fittings connecting submarine to surface systems

OceanWorks systems are:

- Compliant with **NATO STANAG 1450** (Draft) – Common Interfaces to be used for Ventilating a Distressed Submarine – 5 March 2005
- SRF and SAU systems are compatible with deployment by Divers, ROV or ADS
To facilitate optimization of the exhaust flow and ventilation and decompression process, OceanWorks developed a simple questionnaire to gather the fundamental data to allow us to tailor the SEVDS design to a specific need.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>INFORMATION REQUIRED</th>
<th>INFORMATION PROVIDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Does the submarine have existing inlet and outlet piping that can be used for ventilation connection? If yes provide details.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Maximum external depth of operation required</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Number of crew</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Number of compartments:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volume of compartment 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volume of compartment 2</td>
<td></td>
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<tr>
<td></td>
<td>Volume of compartment 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volume of compartment 4</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Location of inlet and outlet fittings if fitted (Provide drawing or photo if available).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compartment 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compartment 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compartment 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compartment 4</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Internal diameter of inlet and outlet fittings if fitted.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compartment 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compartment 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compartment 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compartment 4</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Type of end fitting on inlet/outlet if fitted (provide drawing if available).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diver</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Atmospheric Diving System</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remotely Operated Vehicle (must have manipulators 1 x 5 function; 1 x 7 function)</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Diving asset to be used for connection (indicate one or more)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diver</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Atmospheric Diving System</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remotely Operated Vehicle (must have manipulators 1 x 5 function; 1 x 7 function)</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Information on deck bailing if fitted.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide drawing if available</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Does inlet/outlet piping have internal hull stop that can be operated from outside the pressure hull? If yes provide detail of existing actuation system.</td>
<td></td>
</tr>
</tbody>
</table>
OCEANWORKS SEVDS HARDWARE OVERVIEW

A-FRAME (FOLDED FOR TRANSPORT)

CONTROL VAN

MACHINERY VAN

CLUMP WEIGHT

HPU

DOWN WIRE WINCH

UMBILICAL SKID - REEL 1 – REEL 2

SAU

SRF
# OCEANWORKS SEVDS HARDWARE OVERVIEW

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>LENGTH mm</th>
<th>WIDTH mm</th>
<th>HEIGHT mm</th>
<th>WEIGHT kg</th>
<th>POWER INPUT kVa</th>
<th>Phase</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A-frame Skid Assembly</td>
<td>6094</td>
<td>2591</td>
<td>2591</td>
<td>16,000</td>
<td>150</td>
<td>3</td>
<td>Includes HPU, constant tension winch and wire, clump weight, A-frame and controls</td>
</tr>
<tr>
<td>2</td>
<td>Umbilical Reel Skid Assembly - 600 m depth rating</td>
<td>6094</td>
<td>2591</td>
<td>3048</td>
<td>28,000</td>
<td>N/A</td>
<td>N/A</td>
<td>Includes 2 hose reels, slip rings, 3 x 450 m umbilicals and all fittings and hardware</td>
</tr>
<tr>
<td>2a</td>
<td>Umbilical Reel Skid Assembly - 300 m depth rating</td>
<td>3048</td>
<td>2591</td>
<td>3048</td>
<td>18,000</td>
<td>N/A</td>
<td>N/A</td>
<td>For 300 m depth rating only one hose reel and 450 m umbilical is required</td>
</tr>
<tr>
<td>3</td>
<td>Compressor Module</td>
<td>6094</td>
<td>2591</td>
<td>2591</td>
<td>12,000</td>
<td>310</td>
<td>3</td>
<td>Power distributed from Compressor Module to Control Module and A-frame Skid Assembly</td>
</tr>
<tr>
<td>4</td>
<td>Control &amp; Vacuum Module</td>
<td>6094</td>
<td>2591</td>
<td>2591</td>
<td>10,000</td>
<td>20</td>
<td>5</td>
<td>Includes vacuum system and all control and monitoring</td>
</tr>
</tbody>
</table>

**Notes:**

1. All weights and dimensions subject to change based on detailed design and final system specification.
2. Subsea intervention asset (diver, ADS or ROV) requires additional deck space, services and weight allowance.
TYPICAL SUBMARINE DECK

SRF WITH KNOCK-OUT PLATES
FITTED FOR STREAMLINING

RESCUE MATING SEAT & HATCH AREA

TYPICAL SUBMARINE DECK OUTER CASING

SRF ADAPTED TO EXISTING SUBMARINE PIPING AND HULL STOP VALVES
**SUBMARINE RECEIVING FITTING (SRF)**

**SAFETY & FUNCTION**

- **Submarine Receiving Fittings** (SRF)

  Unique pressure balanced air line quick connect maintains double hull stop integrity during all stages of the connection cycle.

  Single step, self aligning SAU installation connects air lines and submarine internal hull stop valve actuator.

  SRF interface to existing air and valve actuator connections without modification to submarine pressure boundary.

  Low maintenance design with positive prevention of sediment accumulation.
SUBMARINE ADAPTER UNIT (SAU)
SAFETY & FUNCTION

- Submarine Adapter Units (SAU)
  ROV – ISO-13268-9 and NATO 1450 compatible
  Single step alignment and positive lock to SRF
  360 degree, two axis, pressure balanced hose swivel protects hoses and connection during operation
  Double hull stop maintained during hose connection cycle
  Pressure test of connection and hose integrity before hull valve is opened
  ROV/ADS/Diver hull stop valve mechanical actuation without internal assistance

SAU configuration is driven by need for ROV operation. If only ADS or DIVER connection is required the SAU configuration is greatly simplified
COMPRESSOR MODULE LAYOUT

- MAIN POWER IN 310 kVA VOLTAGE TO SUIT SHIP
- SECONDARY POWER IN - 310 kVA
- INPUT POWER CHANGE OVER SWITCH
- CHANGE OVER
- 3 PH DIST PANEL
- 1 PH DIST PANEL
- LIGHTS – 3 X OH FLOURESCENT OUTLETS – 8 DUPLEX ON 2 x 15A CIRCUITS
- MP COMPRESSOR 60 kVa
- MP COMPRESSOR 60 kVa
- COMPRESSOR INTAKE OVERHEAD
- HP COMPRESSOR 10 kVa AND FILTERS
- HVAC
- LOUVER FOR VENTILATION
- RECESSED POWER AND COMMUNICATIONS CONNECTION PANEL - POWER IN AND OUT
- RECESSED AIR HOSE CONNECTION PANEL
- HP AIR BOTTLES
- POWER
- MP AIR
- HP AIR

- 20 kVa 3 PHASE TO CONTROL VAN
- 5 kVa 1 PHASE TO CONTROL VAN
- 150 kVa 3 PHASE TO LARS HPU
- INTERCOM IN - OUT
- 20 kVa 3 PHASE TO CONTROL VAN
- 5 kVa 1 PHASE TO CONTROL VAN
- 150 kVa 3 PHASE TO LARS HPU
- INTERCOM IN - OUT

DOORS – STD CONTAINER

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CONTROL & VACUUM MODULE LAYOUT

POWER IN 20 KVA
POWER IN 5 KVA

POWER DIST PANEL

WORK BENCH AND DRAWERS

LIGTHTS – 2 X OH FLOURESCENT OUTLETS – 4 DUPLEX CIRCUITS

VACUUM PUMP 1
VACUUM PUMP 2

VACUUM VOLUME TANK
FILTERS

MANUAL CONTROL SUPPLY & EXHAUST
ANALYSIS DEPTH PRESSURE CO, CO2, O2 OTHER
AUTOMATIC MASS FLOW CONTROL SUPPLY & EXHAUST

LIGHTS – 2 X OH FLOURESCENT OUTLETS – 8 DUPLEX CIRCUITS

DESK, CABINETS, COMPUTER

DOOR

RECESSED HOSE CONNECTION PANEL
EXHAUST IN FROM SUBMARINE

DESK, CABINETS, COMPUTER

RECESSED HOSE CONNECTION PANEL
EXHAUST OUT TO SUBMARINE – VACUUM EXHAUST

AIR IN FROM COMPRESSOR MODULE
AIR OUT TO SUBMARINE – VACUUM EXHAUST

HVAC

DOORS – STD CONTAINER

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SEVDS Breathing Air

- Breathing air compressors, filters, and volume tanks provide air to the DISSUB through a single hose
- Air quality is monitored
- Air quantity and pressure is computer controlled with manual back up
SEVDS Gas Exhaust

- Multiple non collapse hoses remove exhaust gas from the DISSUB
- Exhaust gas constituents are monitored
- Exhaust gas quantity is controlled automatically
- DISSUB pressure is monitored and controlled
SEVDS Gas Exhaust

- Dual vacuum pumps create a vacuum at the surface to maintain flow of exhaust gas as the DISSUB pressure drops and approaches 1 bar(a)
SEVDS Deck Systems

CONTROL VAN

CONTROL VAN (TYPICAL INTERIOR)

MACHINERY VAN

WORK & STORES AREA (TYPICAL)

COMPRESSOR CONTAINER

GENERATOR (OPTIONAL)
SEVDS Deck Systems

Reel Skid Configuration:

Dimension restrictions for transport result in need for 1 or 2 reels:

DUAL REEL – 365 to 600 M DEPTH

SINGLE REEL < 365 M DEPTH

UMBILICAL REEL 2
(TYPICAL)

UMBILICAL REEL 1
(TYPICAL)

A-FRAME SKID – FOLDED FOR TRANSPORT
(TYPICAL)
SEVDS CONNECTION - COMPARISON

EARLY PROTOTYPES
(French Navy)

FRENCH ADAPTER
ADS or DIVER only
1990’s

FRENCH ADAPTER
ADS or DIVER only
2008

NOTE: The new OceanWorks SAU has been developed for divers, ADS and ROV. Configurations for divers and ADS can be simplified if ROV compatibility is not required.

Photos courtesy of French Navy showing OCEANWORKS ADS using early prototype connection adapters which are not ROV compatible.

Diver, ADS & ROV COMPATIBLE
(Canadian Navy)

DESIGNED AND BUILT TO COMPLY WITH:

ISO: 13268-8 – Remotely Operated Vehicle Interfaces on Subsea Production Systems

&

STANAG 1450 (Draft)
SEVDS CONNECTION

OceanWorks SUBMARINE ADAPTER UNIT (SAU) - 2012

SAU PANEL AND CONTROLS ARE DESIGNED TO:

ISO: 13268-8 – Remotely Operated Vehicle Interfaces on Subsea Production Systems & STANAG 1450 (Draft)

This ensures ROV compatibility and makes connection by ADS and divers easier than more conventional systems which rely on high degrees of dexterity and hand or other custom tools.

The following are approximate connection times, including deployment of the down wire and umbilical from the surface.

DIVER CONNECTION TIME: 2 HOURS
ADS CONNECTION TIME: 2 HOURS
ROV CONNECTION TIME: 3 HOURS

Times vary with weather, vessel type and positioning, intervention asset type and configuration and operator skill.
OceanWorks SEVDS SYSTEMS HISTORY

- OceanWorks has delivered 4 SAU & 24 SRF units to the Canadian Navy for installation on 4 Victoria class submarines.
- OceanWorks is currently under contract and building 3 complete 600 meter rated SEVDS systems for delivery to the Turkish Navy for outfitting of 2 rescue and towing ships (Kuryed) and 1 rescue MOSHIP for delivery in 2014.
- The OceanWorks 600 meter SEVDS is the deepest rated system ever built.
- The OceanWorks SRF and SAU system is the only NATO STANAG compatible connection system built for ROV compatibility to a recognized international standard.
THANK YOU!