Example Project

Hyperbaric Evacuation Plan

Example notes:

*This is an **example** only and should only be used for guidance in completion of a project specific hyperbaric evacuation plan – many areas are deliberately left blank for project specific completion.*

Throughout this document, italicized blue text provides explanatory commentary.

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Doc No	**Date**	**Rev**	**Custodian**	**Reviewer**	**Approver**

Table of Contents

1. Introduction

1.1. Background

Hyperbaric Evacuation is a safety critical process to protect the lives of saturation divers in the event of an evacuation from the DSV.

If there is an emergency on the Diving Support Vessel (DSV) that requires the vessel to be abandoned, such as a fire, the divers move into a hyperbaric chamber which is inside a dedicated lifeboat that they can then release to abandon the DSV. This lifeboat is called a Self-Propelled Hyperbaric Lifeboat (SPHL).

The SPHL is fitted with life support capabilities that include; environmental control, breathing gas delivery and scrubbing of carbon dioxide, oxygen and power. The breathing gas in the chamber must be maintained at the correct mix and pressure. The environment of the hyperbaric chamber also needs to be cooled *(or heated)* because without it the temperature in the chamber would rise to fatal levels, due to the body heat of the divers within the chamber.

After the saturation dive team has mustered to the SPHL and it has been deployed with the divers inside it; there is on-going potential for the SPHL to fail. Such a failure has the potential to cause injury, sickness and fatalities to the dive team. The potential causes for SPHL failure are many, but include physical (from deployment) mechanical, chamber system, including Life Support Package failure, adverse weather or operator error. An SPHL failure is considered a Major Accident Event (MAE) as multiple fatalities will occur.

The risk associated with divers being inside an SPHL increases with exposure to that environment and therefore the time spent being exposed to this risk should be minimized – it is therefore a major aim of this plan to expedite the movement of the divers to a fully controlled environment.

This plan aims to minimize exposure to the SPHL environment by having a Hyperbaric Rescue Vessel (HRV) on site which is capable of recovering the SPHL and moving it to a Hyperbaric Reception Facility (HRF) onshore. The HRV is fitted with means to recover the SPHL onto its deck and into a dedicated cradle where it can be connected to a Life Support Package (LSP). This Life Support Package provides the necessary supply of breathing gas, power and cooling for the divers within the SPHL.

Albeit it extremely low likelihood, the extreme consequences of an SPHL Major Accident Event are the reason why this procedure safety critical.

1.2. Purpose

Hyperbaric Evacuation is a safety critical process to protect the lives of saturation divers in the event of an evacuation from the DSV – a Major Accident Event.

The purpose of this plan is to detail the mechanism for evacuation of the dive team from the DSV through to and including decompression at the HRF, the process of which is summarized in Figure 1.

Figure 1. Hyperbaric Evacuation Plan – General Overview

This plan is project specific for the conduct of diving at the *[HOLD – field name]* field, which is located *160n.m.* from *[HOLD – port name]*, the closest port.

It should be remembered that this is an example only - of hypothetical nature.

This plan includes all necessary elements in accordance with IOGP Report 478, paragraph 5; concordance mapping is shown in Annex B.

1.3. Scope

This plan is a detailed project specific plan which details only the arrangements that are specific to Hyperbaric Evacuation. It "falls" under the Project Emergency Response plan. The focus of this plan is operational; elements such as media response are covered in the generic Emergency Response Plan.

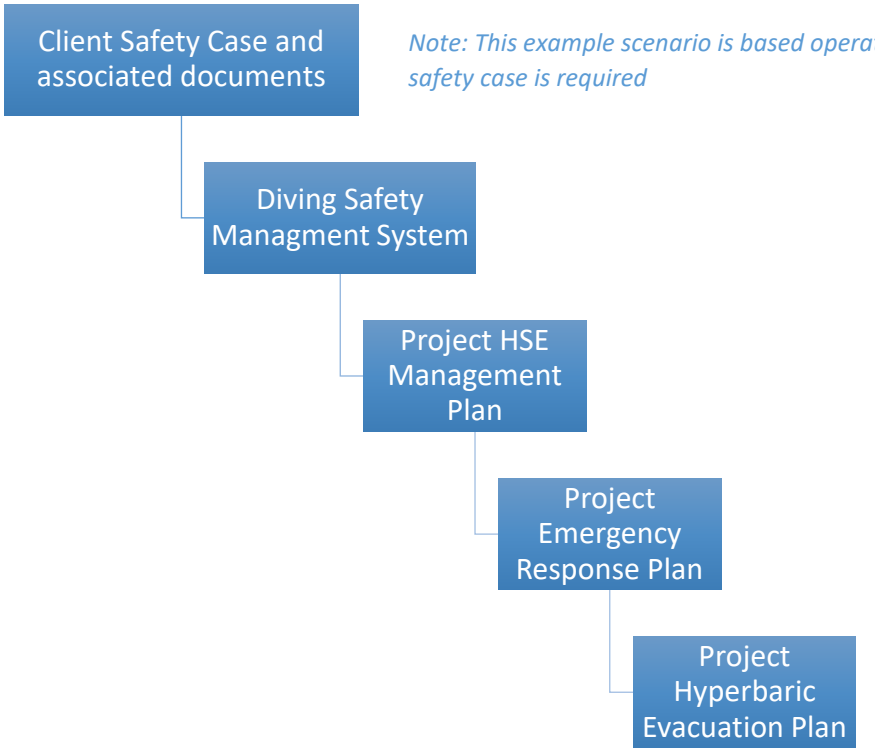

Figure 2. Document Hierarchy

1.4. Location of Plans

This plan shall be kept hard copy in the following locations at all times whilst diving operations are being conducted (or divers are in saturation) for this project:

1.4.1. Offshore

- DSV Bridge
- HRV Bridge
- Dive Superintendents Office
- Saturation Dive Control
- Air Dive Control
- Onboard the SPHL
- CSRs Office
- Inside the LSP

1.4.2. Onshore

- HRF Control Cabin
- *(Diving Contractor)* Head Office Emergency Control Room
- Operator / Client Emergency Control Room

1.5. Management of Change

This Hyperbaric Evacuation Plan is a safety critical procedure. A change to this procedure cannot occur if the change:

- Increases risk;
- Reduces or removes performance standards;
- Reduces or removes the:
    - Functionality;
    - Availability;
    - Reliability;
    - Survivability;
    - Dependency; or
    - Compatibility of Safety Critical Elements.

This plan shall not be changed without the following processes being completed:

- Formal revision to the Hazard identification and risk assessment;
- Sign off of the Statement of Fitness (where it would be altered);
- All work members and stake holders that are part of the Plan are consulted regarding any proposed changes to the Plan. Including at a minimum the following:
    - Diving Superintendent;
    - Diving Supervisor(s);
    - OCM / Offshore Project Manager;

- Operator / Client Representative;
- Operations Manager;
- Project Manager; and
- Government regulator (as required).

1.6. Key Contacts and Communication Lines

Key personnel contact details and lines of communication are shown in Annex A.

2. Abbreviations & Acronyms

Abbreviations and acronyms are detailed in **Error! Reference source not found.**.

Table 1. Abbreviations and acronyms

Abbreviation / Acronym	Explanation
ASOG	Activity Specific Operating Guidelines
CSR	Client Site Representative
DMT	Diver Medic Technician
DPP	Dive Project Plan
DSV	Dive Support Vessel
ERP	Emergency Response Plan
FRC	Fast Rescue Craft
HEP	Hyperbaric Evacuation Plan (This document)
HRF	Hyperbaric Reception Facility
HRV	Hyperbaric Rescue Vessel
ID	Internal Diameter
IMCA	International Marine Contractors Association
IOGP	International Association of Oil & Gas Producers
LSP	Life Support Package
LSS	Life Support Supervisor
LST	Life Support Technician
MAE	Major Accident Event
OBG	On Board Gas
OD	Outer Diameter
OGP	Refer / now called IOGP
PCOA	Primary Course of Action
SCE	Safety Critical Element
SCOA	Secondary Course of Action
SDC	Surface Decompression Chamber
SPHL	Self-Propelled Hyperbaric Lifeboat
SWL	Safe Working Load
TRA	Task Risk Assessment
TUP	Transfer Under Pressure
msw	Metres sea water

3. References

3.1. Industry Codes and Standards

a) IMCA D 02/06 Technical Note – The evaluation and Testing of the Environmental Control of Hyperbaric Evacuation Systems
b) IMCA D 004, The initial and period examination, testing and certification of hyperbaric evacuation launch systems
c) IMCA D 010, Diving Operations from Vessels Operating in Dynamically Positioned Mode
d) IMCA D 022, The Diving Supervisors Manual;
e) IMCA D 025, Evacuation of divers from installations;
f) IMCA D 050, Minimum Quantities of Gas required offshore
g) IMCA D 052, Guidance on Hyperbaric Evacuation Systems, May 2013
h) IMCA D 053, Guidance on DESIGN for the Hyperbaric Reception Facility
i) OGP Report 478, Performance of saturation diving emergency hyperbaric evacuation and recovery, Version 1, September 2014

3.2. Operator / Client Documents

a) Facility Safety Case
b) Diving Standards
c) [HOLD – Client Emergency Response Procedures to be listed here]

3.3. *(Diving Contractor)* Internal Company Documents

a) *(Diving Contractor)* Diving Safety Management System (DSMS)
b) Project Emergency Response Plan
c) Project HSE Management Plan
d) Project Execution Plan
e) SPHL thermal balance analysis reports
f) Dive decompression tables
g) SPHL Davit operations Manual
h) SPHL Operations Manual
i) A-Frame Operations Manual
j) LSP Operations Manual
k) HRF Operations Manual

4. Project Overview

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Details should include:

- *Purpose of the project*
- *Water depth of diving operations*
- *Associated assets in the field*
- *Assets in the region that may be of benefit / use in an emergency*
- *Duration of saturation diving project*
- *Location of saturation diving project*
- *Expected weather during the project. Include prevailing direction and statistical metocean data.*
- *Geography and areas of lee*

5. Hyperbaric Evacuation Plan Overview

5.1. The Plan

The purpose of this plan is to detail the mechanism for evacuation of the dive team from the DSV through to and including decompression at the HRF, the process of which is summarized in Figure 3.

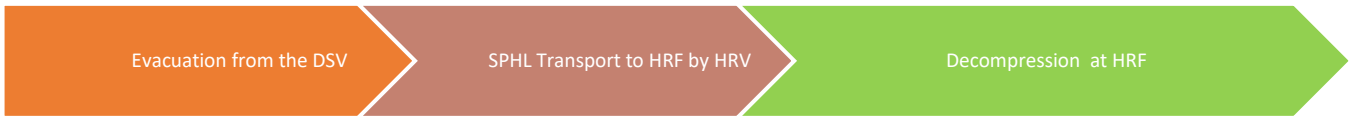


Figure 3. Hyperbaric Evacuation Plan – General Overview

During saturation, the HRV shall be within *(2 hours - scenario example)* of the DSV.

Note: The maximum distance from the HRV to the diving location should be calculated on a case by case basis. IOGP Report 478 requires the HRV to be on site within a maximum of 12 hours (as well as achieving compliance with other performance standards).

The HRV should comply with the above requirements until officially dismissed by the Master of the DSV, the divers are decompressed to atmospheric conditions, or evacuation of the DSV at which point this evacuation plan comes into effect.

Upon notification of saturation divers mustering to the SPHL, the HRV shall make way to the DSV and if required assist (by towing) the SPHL clear of the DSV and then as soon as possible recover the SPHL to the deck of the HRV. The SPHL is then connected to the life support systems on board the HRV. The HRV should then rapidly transit the dive team to port allowing subsequent movement to the HRF.

An overview HEP contingency flowchart is shown in Figure 4.

In the event that multiple [non-diving] casualties are in the water, the HRV shall stay in position and support recovery of personnel from the water until other support vessels arrive on site or diver health regains the priority – this decision shall be made by the HRV master in consultation with available support personnel.

In the event that the weather or other conditions do not allow recovery of the SPHL, the SPHL should be towed to a lee to allow recovery. For this project, the small island (Eranus Island) located 15n.m. to the South East provides a good lee from weather.

In the event of system failure on board the SPHL (whilst it is under tow), the LSP shall be connected via umbilical and recovery assessed / tow recommenced.

In the event that the weather or other conditions do not allow towing, the SPHL is to be escorted to the closest point of shelter (as above) to connect the LSP and towing bridle to assist transit to port with continual re-evaluation regarding recovery to expedite arrival at the HRF.

Upon arrival at port, the shore based crane is to be used to load the truck with the Life Support Pack (LSP), Generator, a portable water tank, the SPHL cradles and the SPHL. The truck is then to transit to the HRF where the SPHL is to be offloaded and mated to the HRF.

Decompression shall not be undertaken whilst inside the SPHL and shall only commence once the dive team are safely mated and inside the HRF.

5.2. Primary Course of Action (PCOA)

The Primary Course of Action (PCOA) is that the SPHL will be recovered onto the HRV as soon possible, and connected to the HRV LSP. The HRV will then transit to port and the dive team will arrive at the HRF in approximately 18.5 hours.

PCOA and SCOA are a contingency planning summary method whereby the likely best and second best likely planned events are summarized. Planning emphasis should be put towards minimizing the PCOA and SCOA time duration(s). In accordance with IOGP Report 478, the PCOA should be able to be completed within 54 hours (75% of the 72-hour limit); ie. Divers in HRF.

Note this value of 18.5 hours is taken from Figure 4 and is the calculated likely arrival time based upon this example (2+1+14.5+1=18.5). The purpose of which is to give all persons a clear understanding of how long it is expected to take to get the dive team to a fully controlled environment.

5.3. Secondary Course of Action (SCOA)

The Secondary Course of Action (SCOA) is that the SPHL will be towed to the lee location, recovered onto the HRV, the HRV will then sail to port and the dive team will arrive at the HRF in about 23.25 hours.

5.4. Matrix of Permitted Operations (MOPO)

The HEP MOPO can be seen in Figure 5; this details the permitted operations and limitations of operations based upon various situations and other associated key risks.

The Safety Critical Elements are listed within the MOPO and any failure, partial failure or operational limitation of such a system shall be checked for criticality, refer Annex C. HEP Safety Critical Element (SCE) Analysis.

5.5. Extreme environmental events

Cyclones are managed by the DSV using avoidance strategies; ie. Running from the cyclone. Therefore, cyclone management has not been addressed within this HEP.

Similarly, tsunamic events are also managed by the DSV using avoidance strategies; ie. When risk is present heading out to sea / leaving risk areas. Therefore, tsunamic management has not been addressed within this HEP.

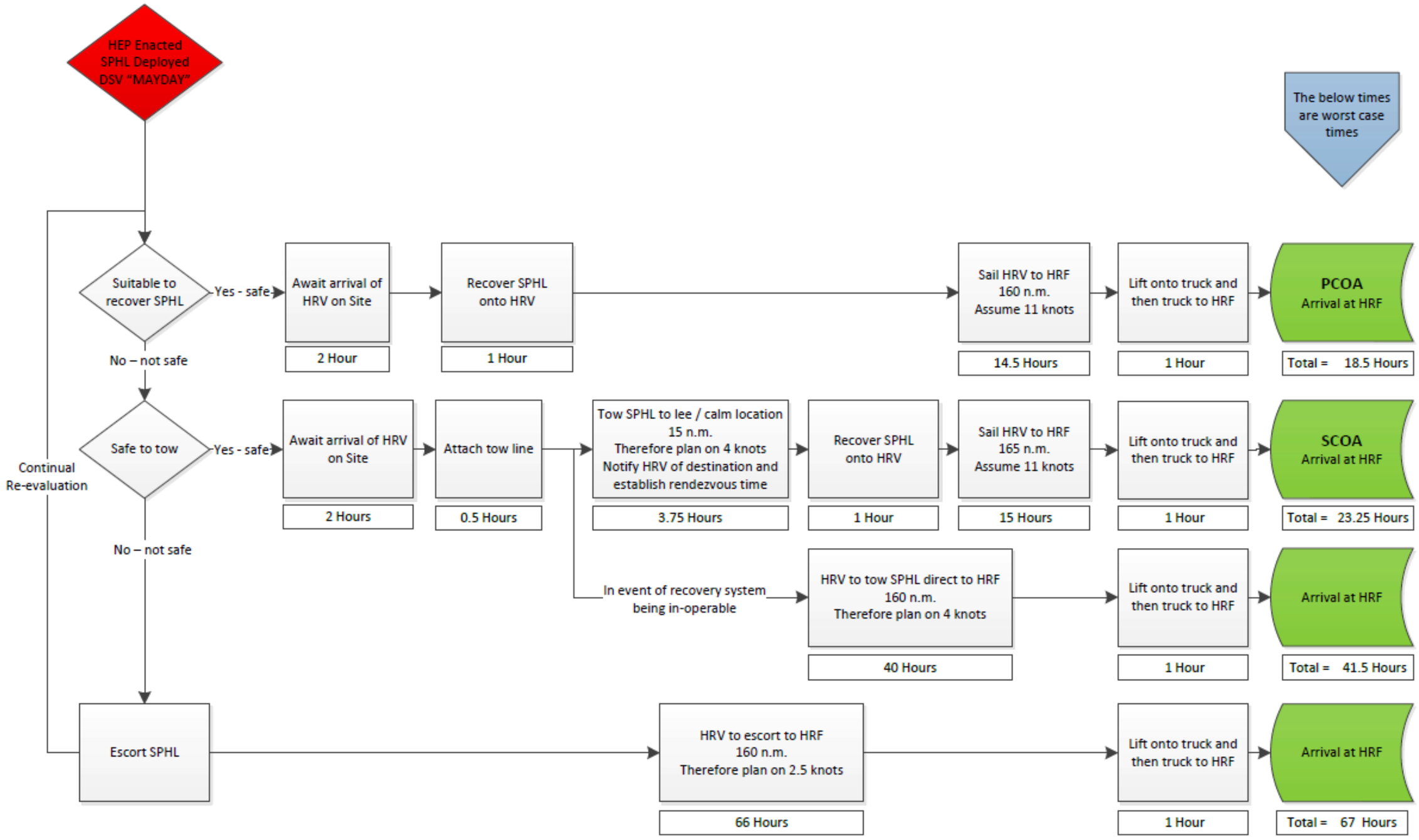


Figure 4. HEP contingencies flowchart

THIS MOPO DOES NOT OVER-RIDE THE MASTER'S DECISION TO STOP A JOB OR NOT TO COMMENCE IF HE/SHE THINKS IT IS UNSAFE

ACTIVITIES

BARRIERS	**Compromise to Safety Critical Elements (SCEs) for DSV & HRV**	Failure of Fire Fighting Systems	Failure or Damage of Life Support Systems onboard MED	Failure or Damage to LSP or LSP umbilical onboard HRV	Loss of Emergency Power (HRV)	Loss of Communication Systems	Damage to Dive Chamber Structure	Damage to Hull Structure	Failure of critical Life Saving Equipment	Loss of On-Board Gases for SPHL and LSP	Damage to Lifting Appliances/ davits for SPHL	Damage to SPHL Cradle on HRV or lack of dedicated space on HRV	No LSS, dive tech, coxswain, supervisor, DP2 crew coverage for 24 hours	Loss of HRV	HRV greater than 2 hours from DSV	Maintenance/Testing on the SPHL	**Compromise to Safety Critical Elements (SCEs) for HRF**	Unavailability of HRV SPHL lifting systems	Loss of treatment gas at HRF	Unavailability of Lifting Slings/Rigging	Unavailability of suitable Land Transport	Unavailability of SPHL cradles onshore	Docking with SPHL towards Quay	**Site specific Operations**	Alongside material barge/ support vessels from starboard side	Alongside material barge/ support vessels from port side	SPHL towards platform	Collision Imminent	Inclement weather conditions	Night Operations	H2S Release within 500 m zone or H2S detected on deck
Saturation Diving Operations															4	2		8					1				6	5	6		7
Divers decompressing at sea																2													6		7
Divers decompressing at port																2															
Post decompression bend watch ashore		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		3		3	3		3		3	3	3		3	3	3
Post decompression bend watch at sea																2							1						6		7

LEGEND:

- Combination Allowable
- Activity Permitted with Additional Controls/deviation (See Notes)
- Activity not permitted in these circumstances (See Notes)
- Not Applicable

NOTES:

1. Provided a suitable crane is positioned and dedicated on the quay for SPHL lift off.
2. Provided the maintenance/testing is not altering the readiness of the unit and conducted under Permit to Work.
3. Divers are treated in a shore based chamber.
4. HRV to be infield and cannot perform Port calls during this time. HRV cannot be engaged in any platform activities and is to be available for HRV duties without delay in the event of emergency.
5. Ceased Operation, confirm Divers in safe position, bring vessel to Safe position. Abort operation/Exit 500m zone/work area immediately.
6. Dependent of Vessel's Activity Specific Operating Guidelines (ASOG). Close monitoring required of Thruster loading.
7. Abort operation/Exit 500m zone/work area immediately. Instigate H2S Emergency procedures as per Bridging document
8. An alternative method of SPHL transfer to shore, such as towing must be a suitable option.

DEFINITIONS:

1. Barriers : Controls that exist for normal operations.
2. Activities : Work related activities carried out under normal operations

Figure 5. Matrix Of Permitted Operations (MOPO)

6. The Hyperbaric Evacuation System

This hyperbaric evacuation plan is based upon the following Hyperbaric Evacuation System:

6.1. Additional Support Personnel

In the event of a hyperbaric evacuation, both the crew and occupants of the SPHL are likely to be extremely fatigued, suffering acute seasickness and dehydration. Therefore, the following additional personnel will be mobilized to the HRF to assist in the ongoing support of the decompression phase:

- DMT to be available to commit into saturation to administer treatment, if required.

The on-shore Emergency Response Team shall contact these personnel and manage their movement to site; the contact details of these personnel are listed in Annex A.

6.2. The Dive Support Vessel

- The DSV (refer Figure 6) has a fully integrated, 18 man single saturation spread, fitted with a single SPHL on the starboard side.

Figure 6. The [HOLD] DSV

6.3. Self-Propelled Hyperbaric Lifeboat (SPHL)

The SPHL (refer Figure 7) is connected to the saturation dive system via a manway trunking, through which divers exit the saturation complex. The trunking and SPHL are both maintained at chamber depth and temperature. The SPHL associated equipment is maintained in a state of readiness throughout diving operations.

Figure 7. SPHL

The SPHL is designed to provide safe evacuation for the divers from the chamber complex on board the DSV in the event of emergency. The SPHL, its chamber and supporting equipment built into the lifeboat are designed for autonomous life support for 72 hours.

6.3.1. Certification / compliance

The SPHL is compliant with the following:

- Chapter III of the International Convention for the Safety of Life at Sea, 1974
- The International Life Saving Appliance (LSA) Code,
- Resolution MSC 81(70) revised recommendation on testing of Life Saving Appliances Part 1, Chapter 6;
- IMCA D 051 Rev. I (October 2014) and IMCA D 052 (May 2013);
- IMO Resolution A.692(17), Guidelines and Specifications for Hyperbaric Evacuation Systems.

6.3.2. SPHL Specifications

The SPHL specifications are detailed in Table 2.

Table 2. SPHL specifications

SPHL Specifications	
Manufacturer	
Capacity	18 x Divers 2 x Dive Support Personnel 2 x Crew Total: 22 PAX
Construction	Fire retardant glass reinforced polyester (GRP)
Overall Length	10.5m
Beam	3.3m
Height	3.6m
Weight	18.8t Fully loaded
Max Speed	5 knots
Fuel Capacity	600 litres
Fuel Endurance	72 hours
Fresh water and provisions	Per SOLAS Requirements
CO2 absorbent	425kg
SPHL Chamber Specifications	
Design	
Manufacturer	
Capacity	18 divers
Depth Rating	350msw
Design Standard	
Volume	
Dimensions	[HOLD] mm OD, [HOLD] mm Length
Man-way	[HOLD] mm ID
Medical Lock	X 1, [HOLD] mm ID
Communications	VHF and UHF Radio
Lighting	6 x internal 2 x crew cabin 2 x external strobe
BIBS	18 + 1 spare = 19
Onboard Gas	6 x 50L 200 bar Oxygen 6 x 50L 200 bar mixed gas 7 x 50L 200 bar Air
Fittings	2 x viewports, 145mm diam Hyperbaric toilet
Features	8 x CO2 scrubbers 2 x heating, 2 x cooling units
Thermal Balance Performance (time to maximum survival temperature)	120 minutes

6.3.3. SPHL Thermal balance

Thermal balance testing for this SPHL (in the event of failed environmental control systems) typically demonstrates thermal increase in hyperbaric conditions exceeding the safe temperature of 34.5 degrees within 120 minutes if the cooling systems were to fail. (FMEA requires redundant cooling / heating systems).

Note: Each SPHL should be tested on its own merits which should drive each projects HEP maximum time to recovery and connection to the LSP on the HRV. SPHL thermal balancing should be appropriate for the environmental conditions at the location of the project and the number of divers in saturation. This testing should be completed in accordance with IMCA D02/06.

6.3.4. Gas supplies

During normal operations the SPHL internal environment and the connecting manway are continuously monitored in sat control to ensure a breathable mix is maintained at all times.

Gas supplies during normal operations are supplied to the SPHL via an umbilical that is connected to the saturation control room.

6.3.5. Chamber monitoring and control

The SPHL is fitted with an Analox CO2 5001 and O2 G21 analysers for gas monitoring of the internal environment.

Temperature control of the chamber is provided by an environmental control system within the SPHL which is driven by the SPHL main engine, secondary power is provided by the backup generator.

When the SPHL is connected to the saturation system the temperature is controlled via hot and cold supplies from the vessel.

When the SPHL is connected to the LSP on the HRV, the temperature is controlled via hot and cold supplies from the LSP.

6.3.6. Power supplies

During normal operations, the SPHL is connected to the DSV via umbilical which provides a trickle charge for the SPHL on board batteries, this system runs continuously as long as the air vent purge system is running. As a safety precaution if the purge system is shut down the battery charge system is automatically isolated. When the SPHL is launched the batteries are charged through the main engine. In the event of an engine failure, the on-board generator is capable of running all 12V and 24V systems on the SPHL.

6.3.7. Tag Lines

Prior to commencement of saturation operations, fire retardant tag lines should be fitted to the SPHL at the bow and stern and routed back to the coxswain position to assist in recovery onto the HRV.

6.3.8. Launch system

The SPHL is launched via a purpose-built davit and wire fall system. The davit system meets and is certified to IMO MSC 1206/SOLAS 74 regulations. The launch of the SPHL can be done either by a person on the DSV deck with a remote console or by use of a remote wire from within the SPHL.

Under emergency conditions where electrical power is not available, the launch system is powered by an integrated stored hydraulic accumulator system.

6.4. The Hyperbaric Rescue Vessel (HRV)

The HRV (refer Figure 8) is a 53m offshore Platform Supply vessel, fitted with a Hyperbaric Recovery System (which in this case is an A-Frame type lifting appliance), all of which is DNV certified. In addition to the recovery system, the HRV is fitted with the following:

- Custom cradles designed for the SPHL and recovery system;
- Life Support Pack (LSP);
- Winshackle;
- Emergency generator; and
- Quantity of gas quads (refer Table 5).

The LSP and generator have seafastening which are designed for removal without hotwork. This allows the LSP and generator to be loaded onto the truck without a welding team.

Figure 8. The HRV

Key characteristics of the HRV are as follows:

- Cruising speed: 11 knots
- Maximum speed: 14 knots
- Crew: 13 PAX

One Life Support Supervisor and one Life Support Technician are to be permanently on the HRV to maintain the LSP and associated systems in a state of readiness.

6.4.1. Hyperbaric Recovery System

On this vessel, the hyperbaric recovery system (refer Table 3) is certified for recovery of the SPHL in up to 2m significant wave height. The system is operated by the LSS and LST with support from the marine crew. Training will be provided at the time of installation by the manufacturer. Additional familiarity will be achieved through the conduct of recovery drills.

It is fitted with a Winshackle to allow remote control connection of the SPHL masterlink to the hook limiting manual handling during this dangerous operation.

Table 3. Hyperbaric Recovery System Specifications

Hyperbaric Recovery System Specifications	
Manufacturer	
Model	
Type	A-Frame
Safe Working Load	25t personnel with a 1.8 DAF included 50t equipment with a 1.8 DAF included
Certification	DNV 2.22 personnel lifting
Recovery wave height	2m Significant Wave Height

Winch Type	Man riding, dual independent automatic fail safe brakes
Wire diam	32mm
Electrical supply	440v 3 phase, 60 Hz

6.5. Life Support Package (LSP)

The purpose of the LSP is to supply the SPHL environmental monitoring control equipment and services necessary to maintain the SPHL environment during transfer of divers to HRF.

Sufficient equipment and consumables are included to allow a complete decompression of the divers; however, a decompression would only be commenced in extreme unplanned circumstances if the HRV could not transit to the HRF within 72 hours.

The LSP is a control van of 3.1m x 2.4m x 2.4m, consisting of the following equipment (refer Table 4), travelling with the LSP is a quantity of gas (refer Table 5):

Table 4. LSP Contents

Qty	Description
1	Emergency services umbilical
1	Two station gas diver radio
2	Depth gauges
1	CO2 Analyser
1	O2 Analyser
1	Environmental Control Unit (ECU)
1	Hyperbaric First Aid Kit
Deliberately left blank	Soda Sorb
"	Purafill (20kg drum)

Table 5. LSP Gas

Qty. Required	Item
Deliberately left blank	2% HeO2
"	Bottom mix (5% HeO2)
"	Treatment Gas, 60% HeO2
"	Treatment Gas, 40% HeO2
"	Treatment Gas, 20% HeO2
"	Oxygen
"	Cal gas CO2 PPM-627 / O2% 10
"	Zero Gas (100% Helium)

6.6. Shore Crane

A 200t, man riding, mobile shore based crane is on call and would be erected at the port to lift the SPHL and associated equipment onto a truck.

The crane load chart is shown in Annex E.

The crane is to be coordinated by the On-shore Emergency Response Team. Upon arrival of the HRV to port, the seafastenings holding the LSP and Generator are to be disengaged in readiness for lift off.

6.7. Land Transport

The Hyperbaric Reception Facility (HRF) has been set up away from the port at a secure facility, located 2km via road from the port. During monsoon season, the primary road can flood; there is a secondary route which is a 9km drive.

A suitable truck is on 24/7 call to transport the following equipment from the port to the HRF, the truck shall be loaded in accordance with Figure 9:

- SPHL;
- SPHL cradles;
- LSP;
- 100kVa Genset;
- 1cu.m water tank; and
- Chiller (from LSP).

Note: The following items are stored at the transport yard in readiness for loading onto the truck. They should be loaded prior to the truck departing the yard:

- SPHL cradles; and
- 1cu.m water tank.

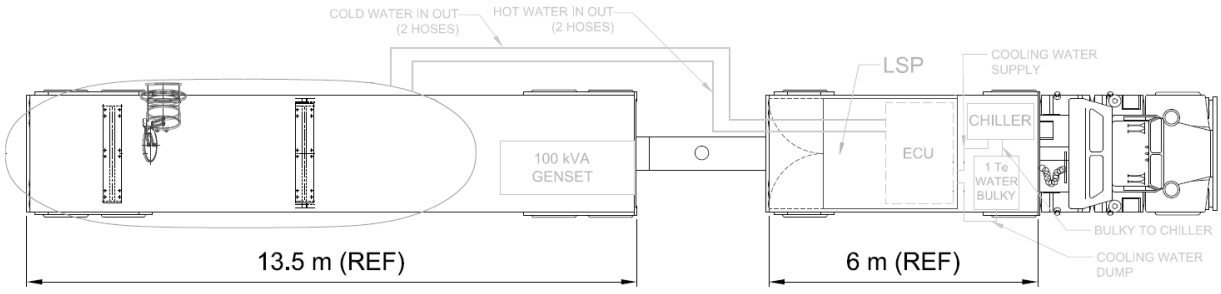


Figure 9. Truck Loading Diagram

The truck shall travel in accordance route A or alternate route B, refer Figure 10. Both routes have been checked for height and weight clearance and do not require permits.

Provide map showing truck route and alternate route.

Figure 10. Map of Trucking Routes

A minibus will be used as an escort vehicle to travel with the truck and concurrently transport the life support team from the wharf / SPHL to the HRF. This vehicle shall stay in close proximity to the SPHL during transit to allow immediate management of any situation that may arise – ie. Flat tyres.

6.8. HRF

The Hyperbaric Reception Facility (HRF) is of mobile type with a capacity for 24 persons, consisting of:

- 2 x 300m rated twinlock decompression chambers, each fitted with:
  - Shower and toilet
  - Twelve bunks in the main lock
  - *Further details omitted in this example*
- 1 x 300m rated Transfer Under Pressure, fitted with:
- HRF Control Container, divided into two compartments:
  - Machinery compartment
  - Control Panel

Design codes: PD 5500, 2003 CAT1

Working pressure (internal): 300msw (30 bar)

Certification: Lloyds Register

It is powered by mains electricity, with an additional emergency generator.

Service requirements include:

- Power: 440V three phase 50amp, 60Hz
- Cooling Water: 15lpm @ 2-8 bar
- Fresh water: 15lpm @ 2-8 bar
- Air supply: 2.8m3 / min @ 6-8 bar

Table 6. HRF Gas Inventory

Comments	Gas Mix	Qty.
Treatment and make up	Oxygen	*Deliberately left blank*
Blow down and Make up gas	2% HeO2	"
Treatment mix	20% HeO2	"
Bottom mix treatment	10% HeO2	"
Bottom mix treatment	12% HeO2	"
Treatment mix	60% HeO2	"
Treatment mix	35% HeO2	"
Treatment and make up	O2	"

7. Drills

Drills shall be conducted in accordance with Table 7.

Table 7. Drills

Drill	Frequency
Muster divers to the SPHL	Prior to the commencement of diving operations by each dive team committed into saturation
Launching of the SPHL	Prior to the commencement of diving operations after system mobilization Minimum every 6 months
Full recovery cycle from deployment of SPHL through to mating of the SPHL at the / a HRF	Yearly
Towing of the SPHL	Yearly to include connection of the towing bridle, LSP and umbilical functioning via the LSP
Recovery of the SPHL to the HRV	At commencement of a new HRV
Mating of the SPHL to the HRF	At first use of the HRF post any movement/modification; or At first use after a period of stand-down greater than 6 months. After mobilization
Emergency Desktop Drill for Onshore and Offshore Response Teams	Prior to diving after mobilization Monthly

7.1. Logging of drills

Drills shall be logged and a lessons learnt workshop should be conducted after each drill.

8. Roles and Responsibilities

8.1. DSV Master

- Designated person responsible for the Evacuation of the SPHL from the DSV
- Prior to and during diving operations, the Master shall ensure that the SPHL and launching systems are maintained in a state of readiness. Note that his responsibility is passed to the Chief Officer.

8.2. Dive Superintendent

- Coordinates the hyperbaric evacuation and will be responsible for activating the Emergency Response Plan.
- Delegates responsibility to the Dive Supervisor manning the SPHL when the SPHL is launched
- Contacts HEP Duty manager and instigates this HEP

8.3. Onshore Emergency Response Team (Designated Person Ashore)

- Leads onshore operations

- Manages the liaison with the DSV and coordinates emergency response for the DSV
- Contacts all relevant stakeholders in this HEP
- Contacts and liaises with the HRF
- Facilitates onshore activities for hyperbaric evacuation
    - Mobilization of personnel to HRF
    - Wharf activities
    - Trucking
    - Cranes

8.4. Client Site Representative (CSR)

- Responsible for activating the Operator / Client Emergency Response Procedure for any critical situation on the DSV.
- Liaise with OCM and Diving Superintendent
- Liaise with Operator / client onshore Emergency Response Team

8.5. Diving Supervisor(s)

- Will ensure that the SPHL Chamber and SPHL escape trunk are prepared for use at all times prior to, and during diving operations with valve positions correctly configured, survival equipment in place, adequate diver's food and water rations in place and scrubber consumables available.
- Will coordinate the hyperbaric evacuation in consultation with the dive superintendent.
- Will delegate a team to man the SPHL for Hyperbaric Evacuation

8.6. Life Support Supervisor (LSS)

- Ensure that the chamber atmosphere is maintained in the optimum condition in preparation for safe transfer of the divers and that the SPHL life support systems are in a state of readiness in all regards
- Maintain the SPHL chamber atmosphere in a state of readiness prior to, and through the hyperbaric evacuation. This will be done from the Saturation Control Room which will remain manned by a minimum of two qualified life support personnel until such time as the SPHL is released from the davit hooks.
- Note: It is assumed that at all times, the chamber within the SPHL is maintained at a depth 10msw shallower than deepest storage depth within the chamber complex

8.7. Life Support Personnel

- When the SPHL is released from the davit hooks, the life support personnel shall proceed to their designated lifeboat stations

8.8. Dive System Technician

- 1 x Dive System Technician is responsible for manning the SPHL as support crew through the hyperbaric evacuation. This will be done from the Saturation Control Room onboard the SPHL

8.9. Coxswain

- Will man the SPHL and follow directions from the on-board Dive Supervisor on-shift

9. Evacuation from the DSV

The detailed SPHL launch procedures are located in reference [HOLD].

9.1. Roles and Responsibilities

On-shift diving crew

The on-shift dive crew supervised by the on-shift Diving Supervisor will coordinate recovery of the bell in accordance with instructions from the Diving Superintendent / Subsea Offshore Construction Manager.

The four crew to man the SPHL will be designated by virtue of their shift patterns at the time of the incident; whilst duties are detailed in Table 8 and Table 9:

1. Off-duty Saturation Dive Supervisor
2. Off-shift (LSS) Life Support Supervisor
3. Off-shift Dive Systems Technician
4. On-shift Coxswain

Table 8. On-shift crew duties

Role	Duties
Diving Supervisor (Panel)	Recover the bell and transfer divers to chamber Maintain log of events
Assist Diving Supervisor	Coordinates launch of the SPHL from the boat deck
Deck divers 1 & 2	Assists in bell recovery
Deck divers 3	Assists in SPHL launch at boat deck
LSS / LST	Transfers divers through to the SPHL On completion transfer to the HRV via FRC if possible
Dive technicians	Recover bell
Senior dive tech	On completion transfer to the HRV via FRC if possible

Table 9. Off-shift crew duties

Role	Duties
DSV Chief Officer	Boards the SPHL
Off duty sat supervisor	Boards the SPHL
LSS	Boards the SPHL
Dive Systems Technician	Boards the SPHL
LST	Assist with disconnection of the SPHL at boat deck

9.2. High-level Checklist

A high-level check list that should be used in conjunction with the detailed procedure, the high-level checklist is shown in Table 10 (below).

Table 10. DSV Evacuation Checklist

Description	Check
Preparations for deployment	
Divers and crew are notified that an evacuation by SPHL is imminent.	
Dive bell is recovered to surface and all divers transfer through to the system.	
HRV Master is notified to prepare for recovery of the SPHL.	
Designated Person Ashore notified.	
All divers transfer into the SPHL led by the designated 1st diver	
1st diver will establish communications in the SPHL with sat control	
Complete internal valve and equipment checks	
DSV deck crew check external valves and equipment in preparation for deployment.	
DSV deck crew release the SPHL tie-downs.	
Vent the trunking between the SPHL and the sat system. Confirm the seal in the SPHL and that the SPHL is locked off.	
Standby for launch command	
In Water	
Once safely landed in the water, onboard support crew will disconnect SPHL from the launch davit and steam SPHL away from imminent danger. Upon evacuation from the DSV, the SPHL coxswain shall control the dive team and SPHL.	
If required, activate EPIRB and flares.	
SPHL to engage HRV via onboard radio and await instructions	
If possible the on-shift Dive Supervisor, LSS, Dive Tech will transfer to the HRV via the FRC.	

10.Lost Bell

In event of a lost bell incident concurrently occurring with a vessel evacuation, the closest DSV would be called upon for emergency recovery of the bell. The [HOLD – *another companies DSV*] DSV will be operating [HOLD]n.m. from the field; contact details for this DSV are located in Annex A.

The company generic “lost bell” procedures in accordance with [HOLD] shall be followed.

11.SPHL Escorted / Unescorted

- The SPHL shall commence sailing towards the lee [HOLD] approximately 15n.m. from the field.
- Establish communications with the HRV
- Agree on recovery plan based on weather conditions and location of HRV and SPHL
- Ensure all personnel are consuming seasickness tablets as required

12.SPHL Towing by HRV

12.1. Introduction

In the event that recovery of the SPHL onto the HRV is not possible due to sea conditions or Hyperbaric Recovery System failure, pending suitable conditions, the SPHL should be towed.

Towing allows improved management of the SPHL; reduces the workload of onboard crew and in good conditions may allow the SPHL to be connected to the LSP on the HRV.

The towing connection point on the SPHL is a permanently fixed bracket with a Safe Working Load (SWL) of 14 tonnes. This bracket is attached to the main bow structure of the SPHL and is designed specifically for towing the SPHL. Shackled to the towing bracket is a 15 meter long, galvanised wire rope pennant with a SWL of 17 tonnes. Shackled to the pennant is a 70m long dyneema line, refer Figure 11.

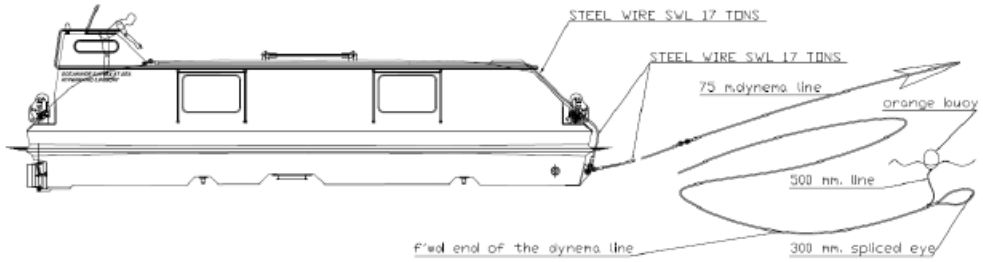


Figure 11. SPHL tow arrangement

12.2. Connecting the Tow

The SPHL coxswain should establish VHF communications with the HRV and coordinate the connection operation. The coxswain shall have overall control and authority of the towing operation. The HRV will operate under the instructions of the coxswain.

If necessary, the connection operation should be carried out in lee of another larger vessel, other than the towing vessel.

If the SPHL has its own propulsive power, it should manoeuvre to be in the optimum position and orientation to facilitate connection. If the SPHL does not have propulsive power, assistance should be sought from other boats to enable the SPHL to be orientated onto the optimum heading to prevent excessive rolling.

The HRV or tow vessel shall use the supplied dyneema rope as the tow line – not a tow wire.

The HRV Master must ensure that the wash does not adversely affect the SPHL or any craft assisting it, nor should the tow rope be allowed to become too tight nor too slack.

The HRV must take great care when taking up the weight of the SPHL to ensure that the SPHL's towing system is not damaged in any way. Where possible, the coxswain will manoeuvre the SPHL to minimise the impulse load as the HRV takes up the weight.

12.3. Towing

The SPHL must always be towed at a speed that is compatible with the safety of those on-board, so as to minimise the effects of motion and remove any possibility of damage to the SPHL and its systems. In the event of excessive SPHL motions towing speed must be reduced immediately and / or heading modified.

The coxswain will remain in constant VHF contact with the Master of HRV and will advise the status of the SPHL and condition of the divers and support crew. The coxswain will instruct the master regarding the power to be applied and speed to be maintained such that the SPHL is towed in a safe and as comfortable as possible condition, considering the prevailing weather and sea conditions.

Where necessary the coxswain will steer the SPHL under tow, to minimise yawing and to create optimum conditions for towing.

The SPHL is not designed to be towed at speeds greater than 5 knots.

12.4. Tow and Umbilical Connection Procedure

Table 11 highlights the key steps and should be read in conjunction with the SPHL operations manual [refer].

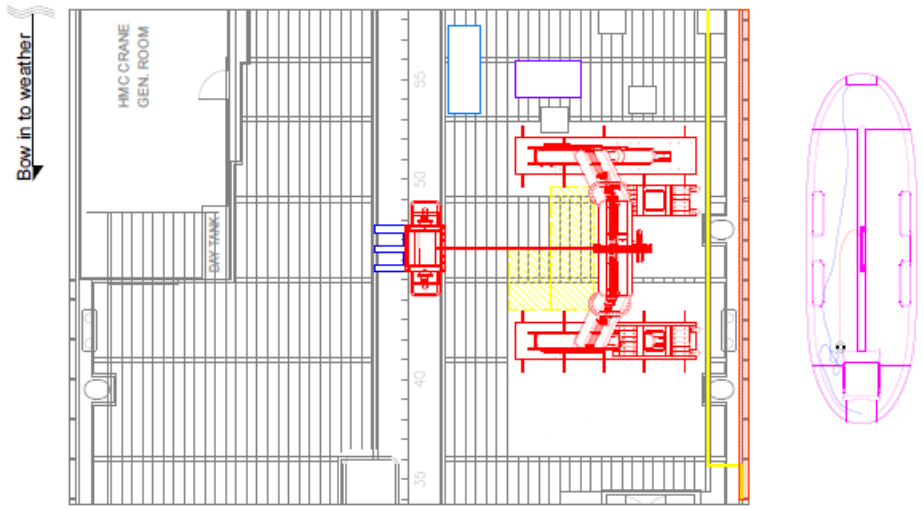
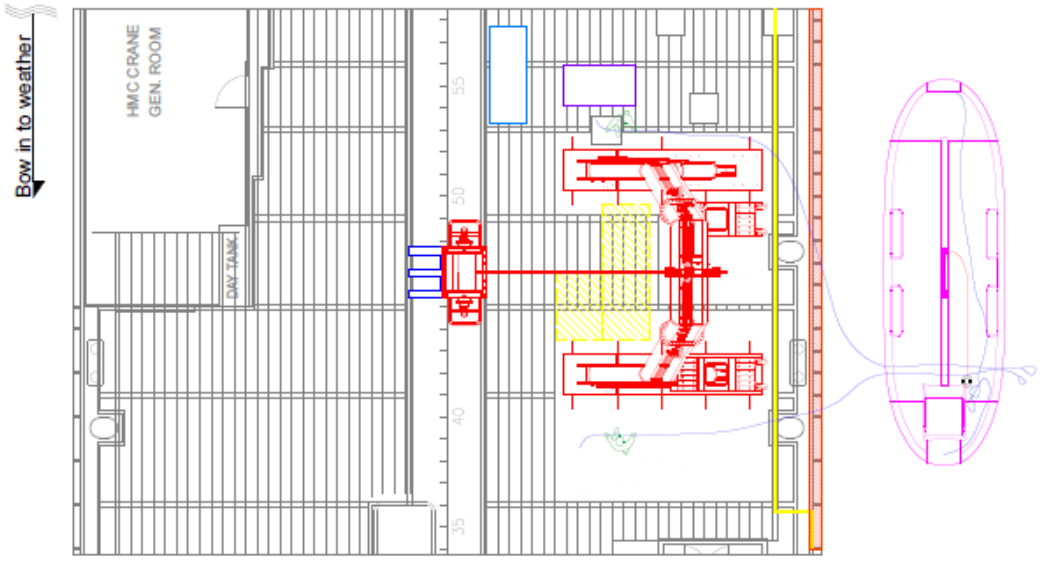
Table 11. SPHL Tow connection procedure

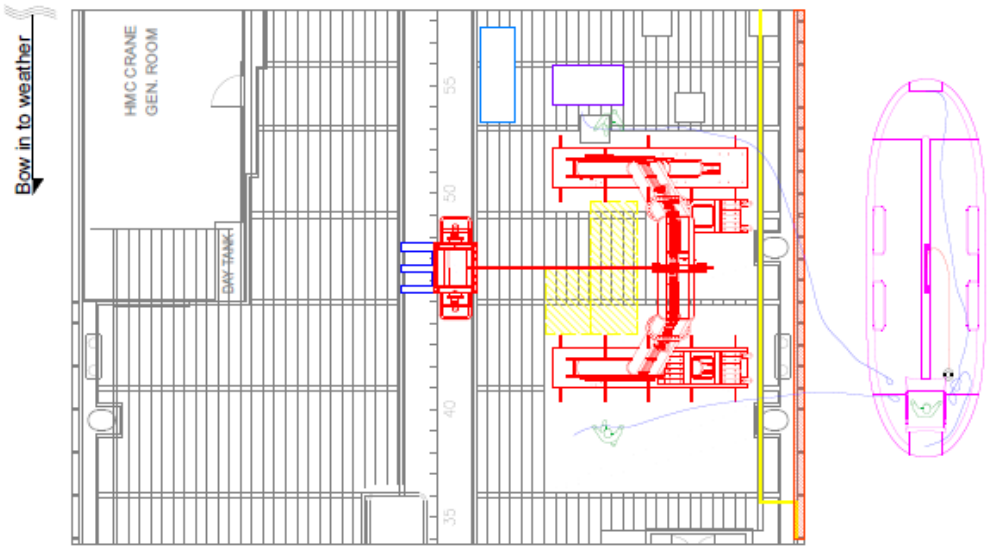
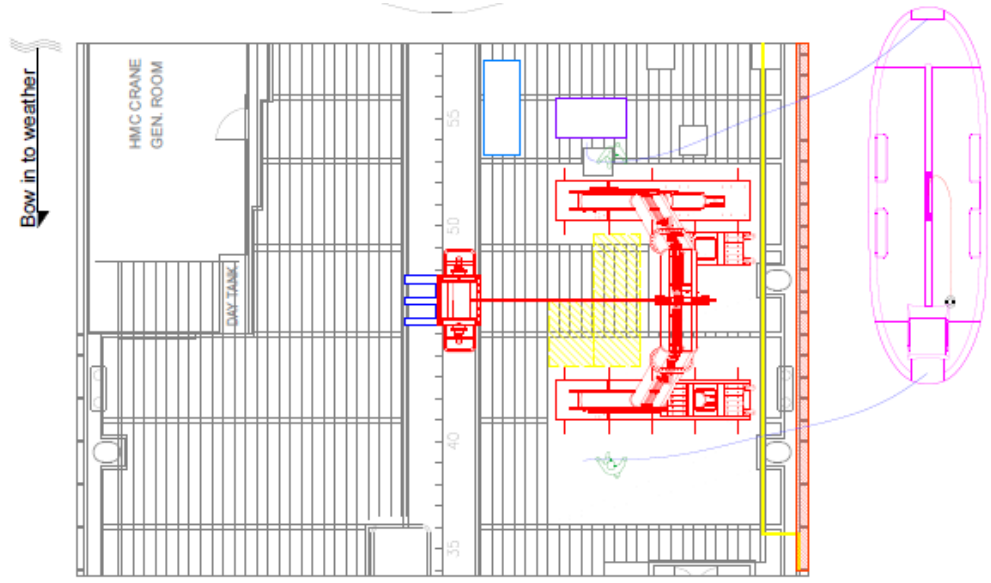
Description	Check
Sail SPHL to HRV stern If SPHL unable to steam under its own power, HRV to transit to SPHL	
SPHL crew to overboard or pass SPHL tow bridal to HRV	
HRV crew to pickup SPHL tow bridal, recover to deck and fasten to A-frame padeye via 13Te shackle - SPHL support crew to assist where required.	
If conditions allow, HRV crew to pass the LSP services umbilical to support crew onboard SPHL.	
SPHL support crew to connect LSP services umbilical to SPHL penetration plate.	
If possible, the LSS onboard the SPHL shall board the HRV and operate the LSP	
HRV shall tow SPHL to port or closest lee	
If sea conditions improve during the tow, recovery shall be reassessed and completed as and if deemed appropriate by onboard Dive Supervisor.	

13.Recovery onto HRV

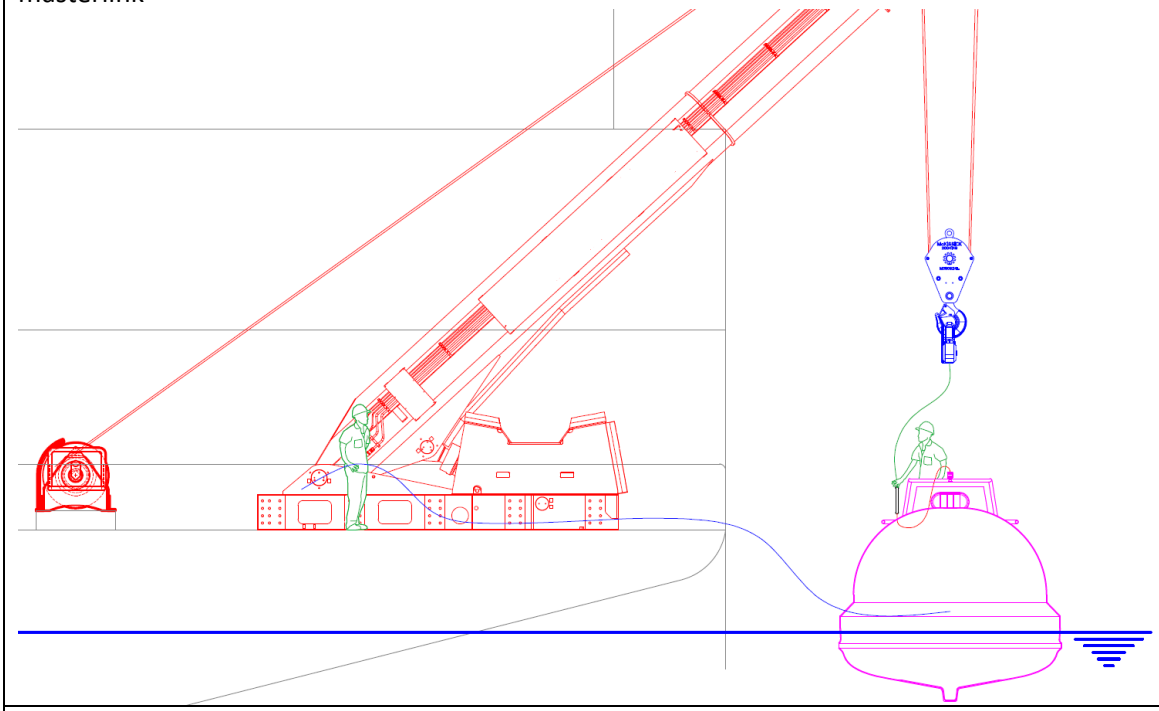
The SPHL shall be recovered at earliest safe opportunity in accordance with Table 12.

Table 12. SPHL Recovery procedure

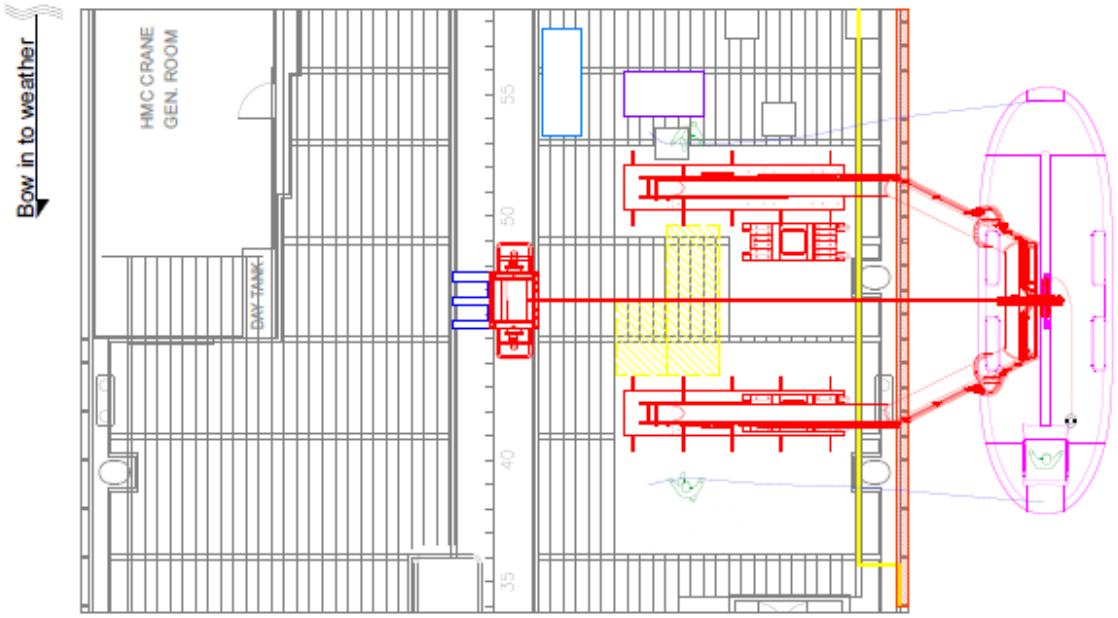
Step	Check
1. SPHL to establish communications with deck foreman. Position the SPHL alongside HRV. Bow into weather 	
2. HRV crew throw tag lines to the SPHL coxswain 	

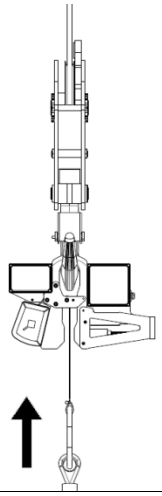
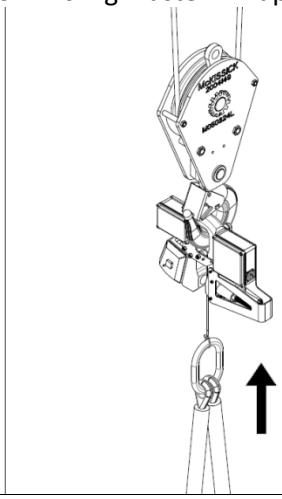
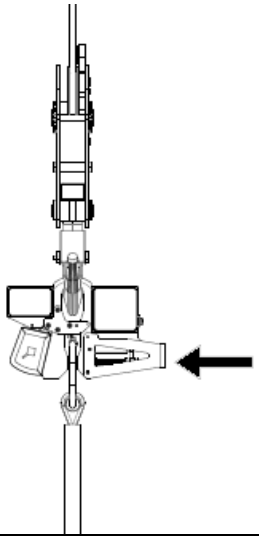
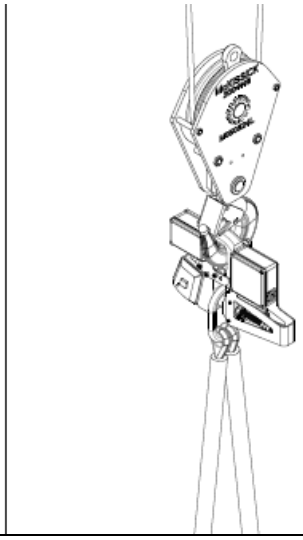
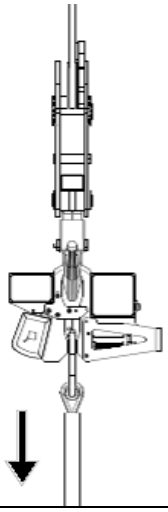
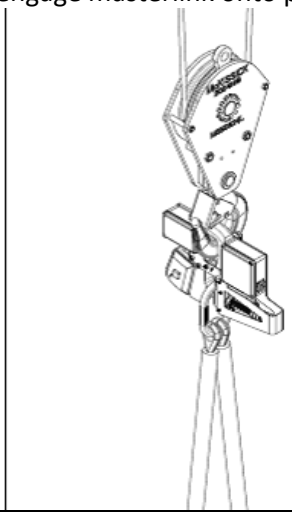
3. SPHL coxswain connects the HRV tag lines to pre-positioned tag lines on SPHL 	
4. SPHL moves forward such that the A-Frame is centered above the SPHL coxswain. 	

5. A-Frame luffed over SPHL and Winshackle is paid out to lower the remote connection line to the SPHL coxswain. SPHL coxswain connects the remote connection line to the SPHL lifting sling masterlink

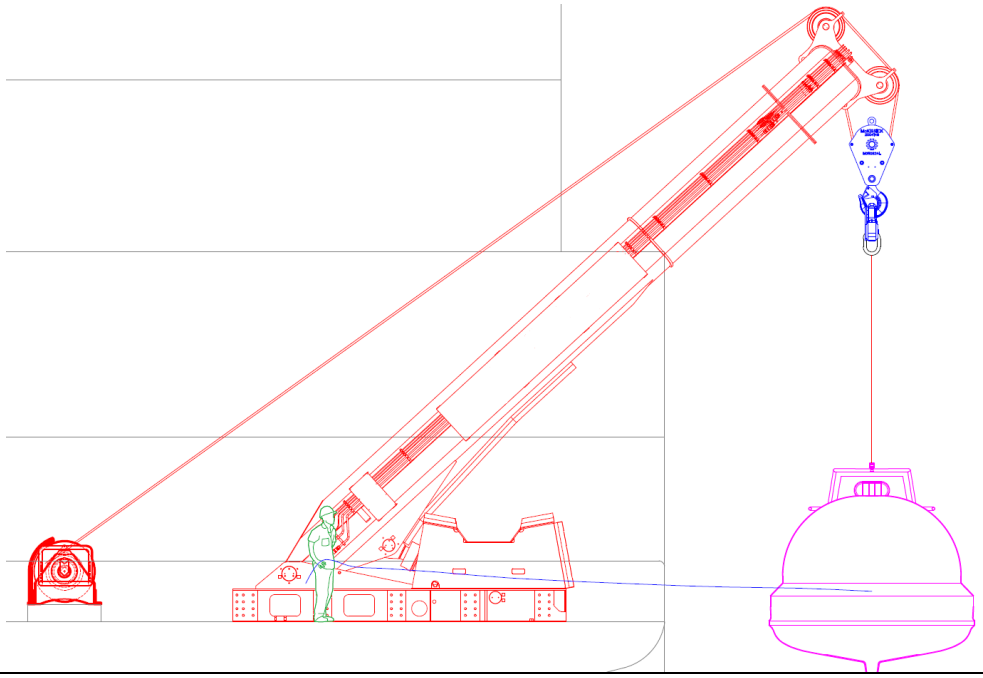


6. SPHL to move aft such that it is centered under the A-Frame hook ready for lifting

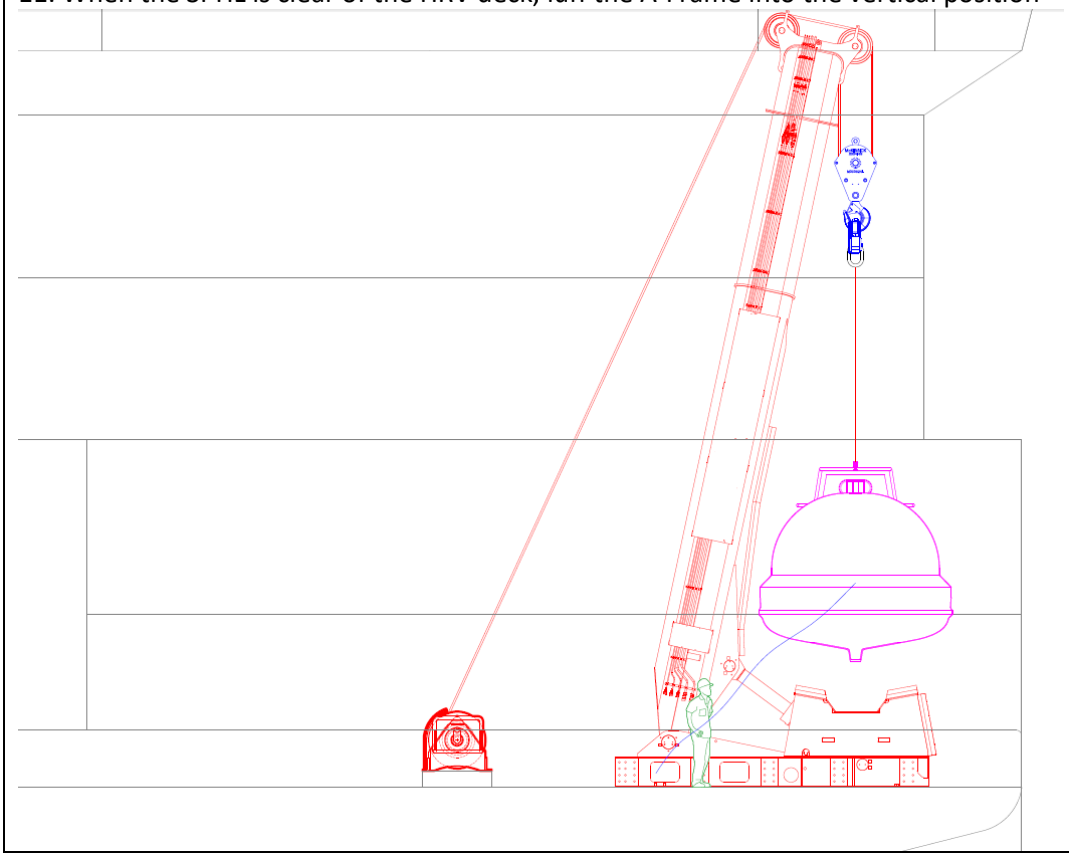


7. Actuate Winshackle to raise SPHL sling masterlink up to the hook  	
8. Lock the Winshackle into position to secure the SPHL onto the hook  	
9. Lower Winshackle winch to engage masterlink onto pin  	

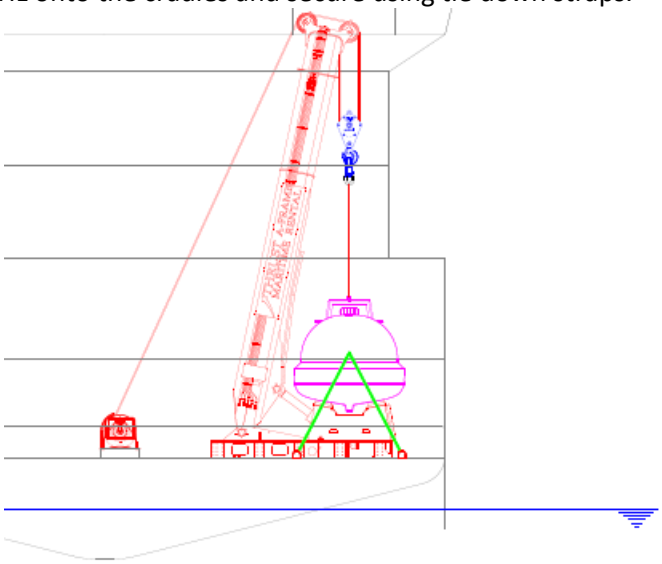
10. Keeping tension in the tag lines to reduce the SPHL from swinging, raise the SPHL out of the water

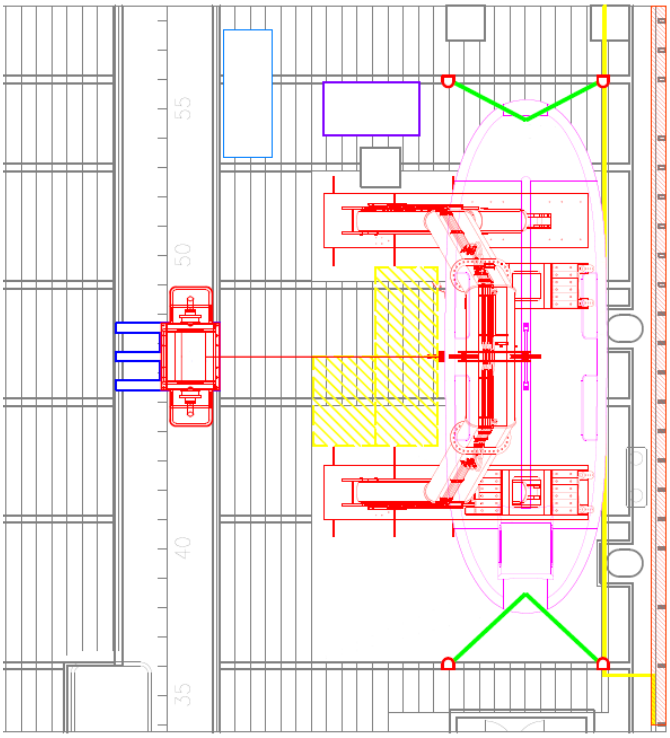


11. When the SPHL is clear of the HRV deck, luff the A-Frame into the vertical position



12. Lower the SPHL onto the cradles and secure using tie down straps.





14.SPHL on HRV

14.1. Connect SPHL to LSP

Operation and maintenance of the LSP shall be in accordance with the manual, refer [HOLD]. A summary of the SPHL-LSP connection details are shown in Table 13:

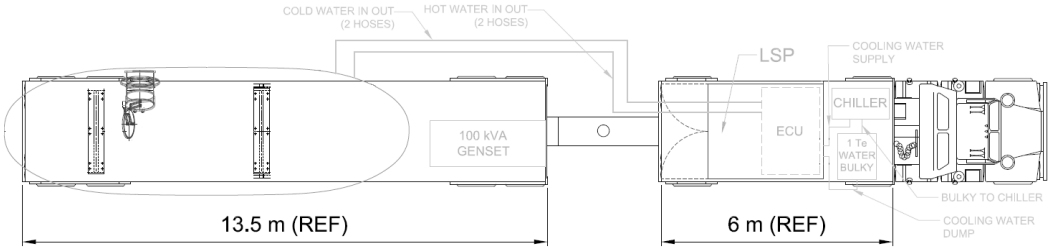
Table 13. Connection to LSP

Description	Check
Connect services umbilical from LSP to SPHL	
SPHL support crew disembark from SPHL where possible	

15.Road transport to HRF

The SPHL shall be transported from the HRV to the HRF in accordance with the steps outlined in Table 14.

Table 14. Road transport to HRF procedure

Description	Check
Isolate all LSP services from SPHL	
Disconnect SPHL from the LSP	
Unseafasten SPHL	
Check connection of tag lines to SPHL	
SPHL support crew to board SPHL	
Raise A-Frame out of way	
Crane driver to lower crane hook to SPHL	
SPHL support crew to connect crane to lifting sling	
Dive team and SPHL crew to brace for lifting	
Lift SPHL and land on transport cradle on truck as follows:  	
Disconnect crane from lifting sling	
Lift LSP onto truck	
LSS and systems techs hook up cooling system	
Fasten all cargo	
Transit to HRF as per route plan	

16.Decompression at the HRF

Upon the SPHL being successfully recovered to the HRF and the divers have transferred into the HRF, the decompression phase will commence under the instruction of the Diving Superintendent.

16.1.1. Mating Procedure of SPHL to HRF & Decompression

For mating the SPHL to the HRF, lift the SPHL over the reception cradle. Lower the SPHL onto the reception cradle.

Guide cones on the HRF reception cradle and alignment pins on the SPHL should be used to guide the SPHL to its correct location (extreme caution to be exercised while lowering and aligning the SPHL onto the reception cradle).

Once the SPHL is securely resting on the reception cradle the SPHL is to be aligned over the HRF TUP mating trunk using the hydraulic jacking system. The system Technicians shall confirm that the flanges have mated, aligned and are firmly engaged on to the mating flange. The mating clamp shall be closed to complete the mating connection process.

16.1.2. Decompression & Medical Support

Decompression of the divers shall be performed in accordance with the Diving Operations Manual, refer [HOLD]. Medical support will be provided by the DMT and Diving Doctor as required.

The following procedure (Table 15) outlines a summary of the key activities required onshore for the hyperbaric evacuation and should be read in conjunction with the HRF operations manual, refer [HOLD].

Table 15. HRF mating summary

Description	Check
HRF tech to ensure HRF chamber is prepared: • Full chamber pre blow down check • ECU function and control checks • Panel pre-blow down checks • Placing all gas on line after analysis • Final kitting out of chamber for reception of the dive team • Commence blow down of chamber to depth • Run up ECUs and all other systems to be put on standby	
HRF tech to conduct Toolbox talk with; crane and truck personnel, detailing; • Planned lifting / mating operations • Equipment laydown areas • Safety Concerns Refer to Annex E for details Lifts plans and truck layout.	
Mate SPHL to HRF and decompress divers as per HRF operations manual.	

17.Maintenance and inspection

The following assets will be maintained using normal planned maintenance schedules:

- DSV – refer [HOLD];
- HRF – refer [HOLD]; and
- LSP – refer [HOLD].

The following subcontracted assets will be maintained in accordance with Table 16:

Table 16. Subcontracted Items Maintenance Register

Asset	Responsibility	Associated Maintenance Plan Document Number
DSV	DSV Master	[HOLD]
SPHL	Sat Supt.	[HOLD]
HRV	HRV Master	[HOLD]
LSP	LSS on the HRV	[HOLD]
A-Frame	LSS on the HRV	[HOLD]
Generator	LSS on the HRV	[HOLD]
HRF	Lead HRF tech	[HOLD]

18.Personnel

18.1. Manning levels

Manning levels for normal operations and during the evacuation are shown in Table 17.

Table 17. Manning Levels Table

	Standard	During Operation / Evacuation
SPHL	4 crew 18 divers	• No change
HRV	13 marine crew 1 x LSS 1 x LST	• As many extra life support personnel, as possible via FRC pending conditions • Potential non-diver evacuees
Escort vehicle (Minibus)	1 x LSS	• All Life Support Personnel from HRV/SPHL (6 PAX)
Truck	1 x driver	• No change
HRF	2 x HRF tech	• 1 x DMT • All Life Support Personnel from HRV/SPHL (6 PAX)

18.2. Training requirements

A review of the company training matrix [HOLD] against this plan has been conducted, this highlighted shortfalls which will be met in accordance with Table 18:

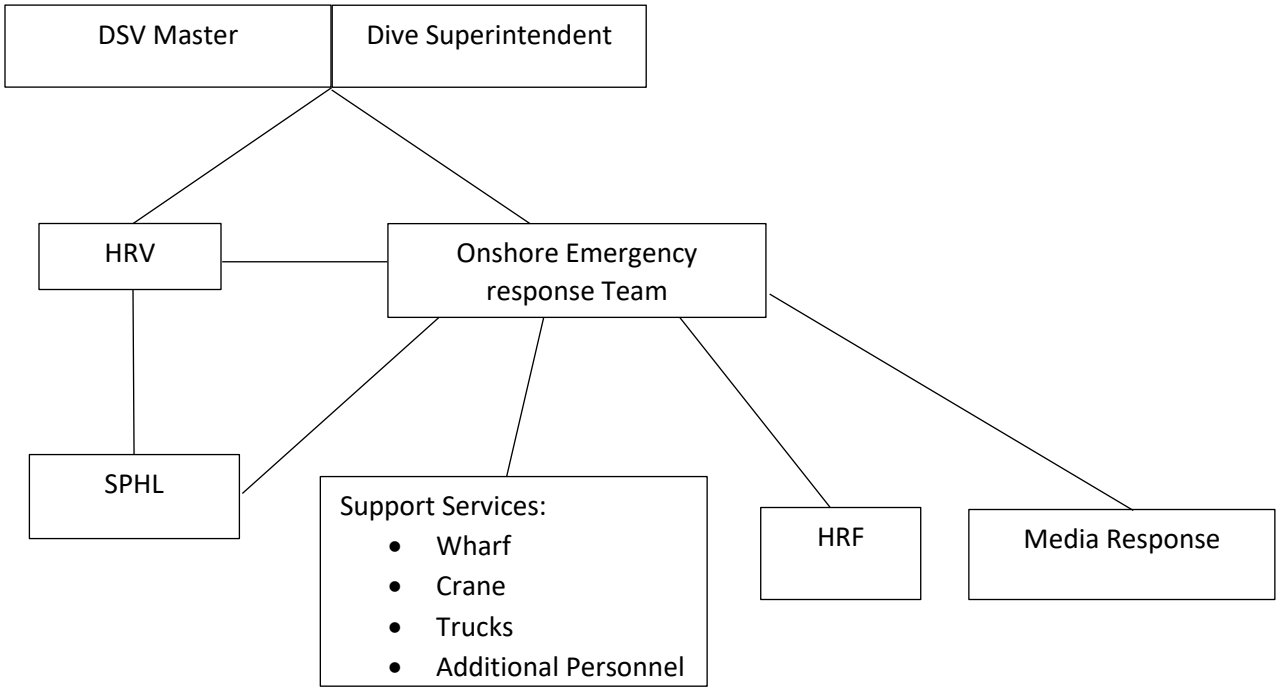
Table 18. Shortfall training requirements

Function	Applicable Personnel	Method
Project Hyperbaric Evacuation Plan	All project personnel including the DSV and HRV marine personnel, trucking company management, crane company management and the harbormaster.	Addition to Project Induction
Operation of Genset on HRV	LSS & LSTs	On site by rental company at time of installation onto the HRV
Operation of A-Frame	LSS, LSTs and marine crew	"
Operation of the Winshackle	LSS, LSTs and marine crew	"

Annex A. Key Contacts & Communication Lines

Table 19. Key Contacts List

Name	Company	Contact Details
DSV Bridge		
On-shore Emergency Response Team		
HRV Bridge		
Project Manager		
HRF Tech		
Transport Company Duty Manager		
Crane Company Duty Manager		
Harbour master		
Rescue DSV	(Refer Lost Bell requirement)	
DMT		
Doctor (Hyperbaric Specialist)		



Annex B. Concordance Map

The following concordance map (Table 20) details the location of the core elements as outlined in IOGP Report 478 Revision 2.

Table 20. Concordance Map

IOGP 478 Requirement	Paragraph
a. Roles and responsibilities (including Statement of Fitness)	8 Annex D
b. List of Safety Critical Elements, their location, status and required controls	Table 21 and **Error! Reference source not found.**
c. List of SCEs that are single point failures and mitigations	Table 21 and **Error! Reference source not found.**
d. Design standards for the hyperbaric evacuation system	6
e. Maintenance and inspection requirements	17
f. Personnel manning levels, training requirements	18
g. Description of planned drills, frequency and logging	7
h. Specification of life support equipment, its capacity and the limit duration for the occupants of a lost diving bell(s), habitat or hyperbaric evacuation system	6
i. A plan for the support, recovery and transfer of the occupants of a lost diving bell or abandoned habitat	10
j. A procedure for the launch, support, recovery of chamber occupants and support crew of the Hyperbaric Evacuation System(s)	0 and 11 - 16
k. The recovery to, and transfer into, a dedicated HRF	0 and 11 - 16
l. Details to provide specialized medical intervention at the location and inside the facility	6.1
m. Matrix of Permitted Operations (MOPO)	5.4
n. Concordance Map	Annex B. Concordance Map

19.Annex C. HEP Safety Critical Element (SCE) Analysis

19.1. Introduction

The HEP HAZID/HIRA in conjunction with system FMEAs was used to identify Safety Critical Elements (SCEs).

SCEs are defined as an item of equipment or process whose purpose is to prevent or limit the consequences of a High Risk Hazard / Major Accident Event (MAE) that if realized could result in the fatality of one or more diver's or support crew.

19.2. The SCE Identification Process

Based upon the process shown in Figure 12, the SCE list was developed.

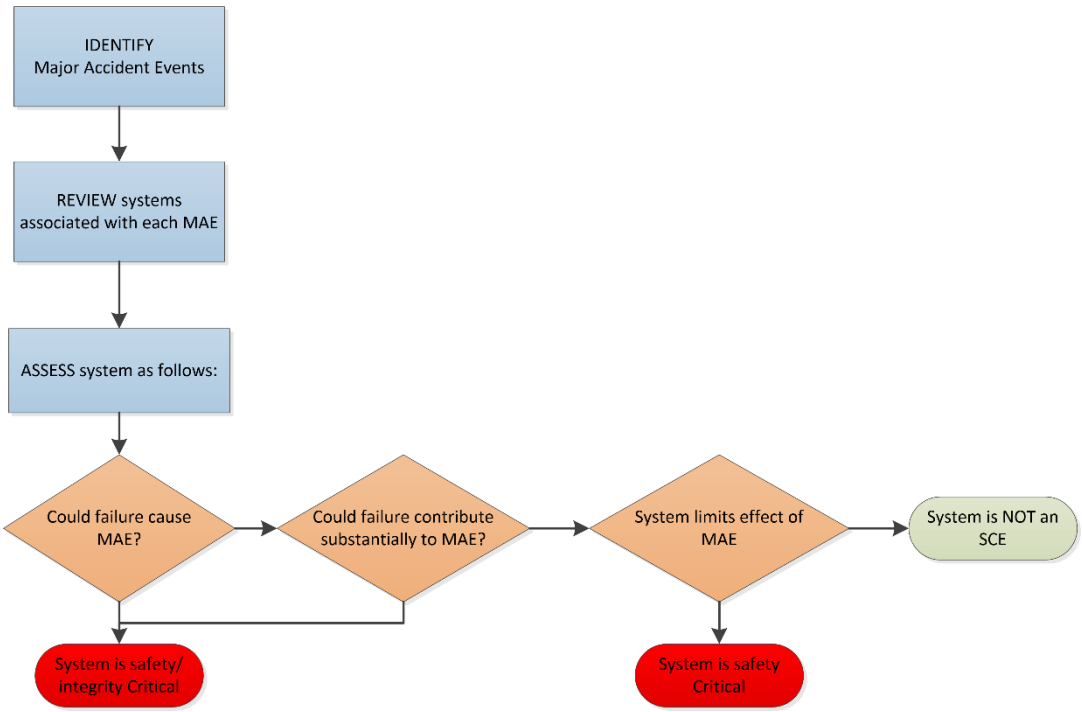


Figure 12. Safety Critical Element Identification Methodology

19.3. SCE Listing

The following were identified as SCEs:

- SCE-01- Fire Fighting Systems
- SCE-02- Life support systems
- SCE-03- Emergency Power
- SCE-04- Communication systems
- SCE-05- Chamber structure
- SCE-06- Hull Structure
- SCE-07- Life Saving Equipment
- SCE-08- NAVAIDS
- SCE-09- Lifting Appliances
- SCE-10- SPHL Cradle on HRV
- SCE-11- Dive Tech / Human Interaction
- SCE-12- HRV
- SCE-13- Land Transport

Table 21 outlines each of the SCE with their critical components and single points of failure.

Table 21. SCE Summary

Note: In the example SCE Summary below, many sections have been left deliberately blank - the purpose being to provide sufficient information for operators to complete the SCE summary based upon their systems.

SCE	Location of Critical System Components	Status	Controls	Single Points of Failure?	Mitigation for Single Point Failures
SCE-01 - Fire Fighting Systems	**SPHL:**				
	- External water spray system	Operational		Yes	
	- Fresh air supply system	Operational		No	N/A
	- Fire extinguisher(s)	Operational			
	HRV				
	- Fire extinguisher(s)				
	- Fire hydrants / hoses				
	- FIFI systems				
	Truck:				
	- Fire extinguisher(s)				
	- Local fire brigade				
	HRF:				
	- Fire extinguisher(s)				
	- Fire hoses				
	- Local fire brigade				
SCE-02- Life support systems	SPHL:				
	- Whisper generator - Main engine and generator - Heating and cooling systems - Gas supply				
	HRV:				
	- Power supply - Gas supply - ECU/LSP - Fresh water supply				
	Truck:				
	- Portable Generator - Water tank - ECU/LSP				
	HRF:				
	- Fresh water supply - Power supply - Gas supply - ECU/LSP				
SCE-03- Emergency Power					
SCE-04- Communication systems					
SCE-05- Chamber structure	-SPHL Flange -HRF Flange -General structure				
SCE-06- Hull Structure					
SCE-07- Life Saving Equipment	SART EPIRB Flares				
SCE-08- NAVAIDS	SPHL: -Steering gear & emergency steering gear - GPS - Compass HRV				
SCE-09- Lifting Appliances	-Structural integrity				
SCE-10- SPHL Cradle on HRV	-Structural integrity				
SCE-11- Dive Tech / Human Interaction	Dive tech inside SPHL and at HRF				
SCE-12- HRV	- Hyperbaric Recovery system - LSP -Power supply -Fresh water supply				
SCE-13- Land Transport	Ability to transport SPHL to HRF				

Annex D. Certificate of Statement of Fitness

I ……. (first name, surname) as the custodian of this Hyperbaric Evacuation Plan certify that this plan is Fit for Use.

- The risks associated with the Hyperbaric Evacuation are as Low As Reasonably Practical;
- All personnel associated with the execution of the plan will undergo sufficient training prior to commencement of diving;
- All Assets and Equipment are in (or will be in) place, in full working order to achieve the outcomes as described in this plan; and
- Operations will be managed to ensure continued compliance with this procedure.

Signed: ……

Name: ……

Date: ……

Annex E. Shore crane load chart and laydown plan