



Performance of saturation diving emergency hyperbaric evacuation and recovery

*OGP Report No. 478
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Publications

Global experience

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Contents

| | |
|--|-----------|
| 1. Introduction | 1 |
| 2. Scope | 2 |
| 3. Hyperbaric Evacuation Plan | 3 |
| 4. Validation, audit and review of the Hyperbaric Evacuation Plan | 3 |
| 5. Contents of the Hyperbaric Evacuation Plan | 4 |
| 6. Performance capabilities | 5 |
| 7. Equipment | 6 |
| 8. Operational factors | 8 |
| 9. Emergency drills and training | 9 |
| 10. Glossary | 10 |

1. Introduction

OGP provided recommendations for assisting companies with the management of diving operations in Report No. 411, *Diving Recommended Practice* in 2008. Industry experience and understanding of the importance of methods for the successful evacuation of saturation divers has developed since then.

This Recommended Practice is about the evacuation and recovery of saturation divers maintained on-board a vessel or facility. It also includes divers deployed in submersible compression chambers (diving bells) and habitats when the need for evacuation is required. An evacuation and recovery operation is considered complete when all divers have completed the required decompression, any therapeutic treatment and bend watch and are safely back at atmospheric pressure.

Divers in saturation are constrained by a pressure boundary which requires careful decompression or else significant risks to the health of the divers may occur. To prevent the occurrence of fatal incidents, the pressure boundary and the atmosphere inside the pressure vessel must be maintained by suitable equipment and competent personnel. This Recommended Practice is also about the capability to evacuate divers to a place of safety while providing the necessary life support.

This report has been prepared by the Diving Operations Subcommittee (DOsC) of the OGP. Input and feedback was obtained from Diving Companies, Diving Trade Associations, Classification Societies, Regulators and diving personnel, for which the OGP Diving Operations Subcommittee is appreciative.

2. Scope

This report provides guidance for managing emergencies requiring the evacuation of saturation divers to a place of safety. It provides a framework to assist companies to manage hyperbaric evacuation at their worksites.

The framework also provides guidance on the development of a structured Hyperbaric Evacuation Plan (HEP). The Hyperbaric Evacuation Plan assists operational staff with understanding their roles and responsibilities. It also includes elements such as the location, provision and status of all equipment required during execution of the plan. Such a structured plan should provide opportunity for consistency in the industry and so should minimize the possibility for diverging approaches and misunderstandings.

This report recommends minimum performance criteria for key areas of the evacuation, and the use of two management tools: Matrix of Permitted Operations (MOPO) and the SCE List. These tools will assist operational staff in evaluating the status of operational controls as situations change and any actions that may then be required.

The report does not provide technical solutions. Many technical solutions are produced by Regulators, Industry Associations and Classification Societies as industry guidance.

3. Hyperbaric Evacuation Plan

Every Saturation system should have a Hyperbaric Evacuation Plan for divers in saturation (HEP).

The HEP should be based on the worst case scenario of evacuation from a diving vessel or facility with its full complement of diving bell(s) deployed and requiring recovery and evacuation of all saturation divers including those deployed in any welding habitat.

4. Validation, audit and review of the Hyperbaric Evacuation Plan

The HEP should be validated by a Statement of Fitness (SOF), written approval from the contractor's Asset Manager or activity Manager (project manager or operations manager) that confirms that the relevant requirements of the HEP have been met and that an effective system for evacuation is in place. The saturation system may be then be used for saturation diving.

The HEP should be subject to audit as part of the contractor's HSE Diving Safety Management System. The audit should verify that the HEP implementation remains fit for purpose.

5. Contents of the Hyperbaric Evacuation Plan

The HEP should include:

- a) details of all the required health and safety critical tasks and the key personnel with their allocated location, roles, responsibilities, and competencies to achieve them:
 1. Asset custodian (SOF signatory)
 2. Divers
 3. HEP Custodian
 4. HEP Owner
 5. HRF Team
 6. Maintenance Team
 7. Operational Leader (if not VM) and Operational support crew
 8. Recovery Team
 9. SPHL crew
 10. Support Team
 11. Vessel Master (VM)
- b) a list of Safety Critical Elements (SCE), their location, status and required controls. This SCE list should be specific to the area of operation, the vessel or facility
- c) a list of all SCEs that are classified as single point failures and the mitigation provided
- d) design standards for the hyperbaric evacuation system (HES)
- e) maintenance and inspection requirements
- f) personnel manning levels and their required training and competency
- g) a description of planned emergency drills, and their frequency and logging
- h) the specification of the on-board life support equipment, its capacity and the limit duration for the occupants of a lost diving bell(s), habitat or hyperbaric evacuation system
- i) a plan for the support, recovery and transfer of the occupants of a lost diving bell or abandoned habitat
- j) a procedure for the launch, support, recovery of chamber occupants and support crew of the Hyperbaric Evacuation System(s)
- k) the recovery to, and transfer into, a dedicated Hyperbaric Reception Facility (HRF), either fixed or portable, for final controlled decompression
- l) a plan that details the capability of providing specialized medical intervention at the location and inside the facility should it be required
- m) a Matrix of Permitted Operations (MOPO).

6. Performance capabilities

6.1 Hyperbaric Evacuation System

All self-propelled hyperbaric lifeboats (SPHL) should be maintained in a state of immediate readiness and with any pressure boundaries maintained to provide safety and optimum evacuation performance. A selection process should be based on the following capabilities:

- *Dual SPHL*: Each SPHL should provide 100% evacuation capability and redundancy for the saturation diving team.
- *Single SPHL*: SPHL should provide 100% evacuation capability.

The Hyperbaric Evacuation System (HES) should have a proven capability of achieving the following, based on the vessel's best speed in median weather conditions for the region and the time of year:

- a) The total elapsed time between the instructions to evacuate divers from the chamber complex until the time when the SPHL is launched should not exceed 15 min.
- b) The total elapsed time for the SPHL to have transited 100 metres away from the evacuated launch site should not exceed 30 min.
- c) Vessel(s), equipment and marine services necessary to protect and support the SPHL(s) should be at the SPHL location within 12 hours of the launch of the SPHL.
- d) Transfer of all occupants from the SPHL(s) to the designated Hyperbaric Reception Facility (HRF) should be achieved within 54 hours or 75% of the SPHL survival endurance capability.

If these performances are not achievable for a specific operation, mitigating actions will have to be agreed in advance between the Operator and the Diving contractor.

6.2 Recovery of divers from a lost and stricken bell

A successful recovery of divers from a lost and stricken bell should be achievable within 75% of the maximum accepted and proven life support capability endurance of that lost diving bell.

A successful recovery and transfer of occupants of a lost habitat should be achievable within 75% of the maximum accepted and proven life support capability endurance of that habitat.

7. Equipment

7.1 Evacuation of divers from the diving bell

For evacuation of divers from the diving bell, a dual entry Submersible Decompression Chamber (SDC) should be considered that provides access to the SDC in the event of a blocked internal door (unconscious or paralysed divers in the bell).

7.2 Codes and standards for design, construction, test and maintenance

IMO Resolution A.831 (19), *Code of Safety for Diving Systems* and IMO Resolution A.692 (17), *Guidelines and Specifications for Hyperbaric Evacuation Systems* should be applied to hyperbaric evacuation facilities.

All Hyperbaric Reception Facilities (HRFs) should be designed, constructed, tested and maintained to certifying authority and appropriate industry requirements with a recognized classification society. (A goal for the industry would be to have HRFs designed, constructed, tested and maintained in class with a recognized classification society.) These facilities should have no overdue surveys and should be free of all overdue Conditions of Class and/or Conditions of Authority.

7.3 Launch and recovery equipment

The system should be capable of being launched independently of the vessel's supply system. This capability should use gravity or stored mechanical energy such as accumulator banks.

Recovery systems should be managed in accordance with the man riding requirements of the OGP Report No. 376, *Lifting & hoisting safety recommended practice*.

7.4 Critical System Monitoring and Tracking

Critical System Monitoring and Tracking (CSMT) equipment should be provided. The CSMT equipment should be a system capable of monitoring, tracking and communicating critical system information from the SPHL to a specified location. This information will assist the recovery support crew on the SPHL's status and location.

The following should be covered in the design of a CSMT:

- a) to have satellite communication capability from inside and outside the SPHL
- b) the CSMT to be a stand-alone system, providing battery-backed data acquisition, recording and transmission of parameters from the SPHL via a global satellite communications network

- c) to have a high availability terrestrial server system that will receive all data from SPHLs. This should be distributed globally via the Internet to allow remote monitoring and incident management from any location (either on land or at sea)
- d) the CSMT to be operable in a hot-standby mode continuously
- e) to provide assured readiness by the use of periodic self-test diagnostics.

Critical mission data to be recorded and transmitted should include:

- a) identification of the SPHL and its occupants
- b) live GPS coordinates of the SPHL
- c) time-stamped historical log of any evacuation event
- d) emergency signalling data (e.g. 'real' or 'drill' status, critical condition status from the SPHL crew)
- e) environmental data (air temperature, seawater temperature, heave/pitch/roll maxima)
- f) chamber depth
- g) chamber temperature
- h) chamber oxygen partial pressure
- i) chamber carbon dioxide partial pressure
- j) on-board gas storage bottle pressures (HeO_2 and O_2)
- k) rate of change of depth
- l) chamber relative humidity
- m) status of engine (running/stopped), battery condition, cooling/heating system status, and fuel tank levels.

8. Operational factors

8.1 Matrix of Permitted Operations (MOPO)

The diving contractor should produce a Matrix of Permitted Operations (MOPO). The MOPO is an information tool to assist supervisors and line managers during the planning and coordination of operations and activities. Copies of the MOPO should be available on the vessel.

The MOPO should include:

- a) the operation or activity operating envelope and safe operating limits
- b) all operational activities associated with the vessel that could impact the integrity of the HES
- c) Actions necessary for the crew to take if situations arise that could compromise safe operations.

The MOPO should specify all 'line of fire' (in the trajectory of moving hazards) scenarios and their controls. Single SPHL systems should be protected from line of fire risks, e.g. overhead lifts or the operation of a diving vessel alongside a platform with the SPHL facing the installation – problematic in the event of a dynamic positioning (DP) incident.

8.2 Operation in a harbour

When the DSV is in harbour, no single SPHL system should be placed alongside a quay unless it is identified in the HEP and the site has the required personnel and equipment to launch the SPHL. The HEP should not impact upon the normal vessel evacuation of marine personnel.

The SCE List and HEP should identify the control of seaboard harbour obstructions (e.g. any obstructions on the side of the ship opposite of the quay, where a SPHL could be launch to the water) and depth for a launch.

8.3 Managing Safety Critical Elements in operation

SCE must function on demand. The HEP should include risk control and mitigation measures to manage risks arising from impaired SCE(s). These risks should be properly identified, documented, implemented and monitored.

9. Emergency drills and training

An Emergency Drills Matrix with a guidance section laying out the actions recommended of each member of the diving project, marine and shore side personnel in the event of an emergency occurring during operations should be provided.

The diving contractor should develop generic emergency training scenarios and procedures. Trials and drills should be undertaken to train personnel and to test the efficiency of the procedures, the interfaces and the equipment that affect the successful execution of the Hyperbaric Evacuation Plan (HEP). A functional drill to the nominated Hyperbaric Reception Facility (HRF), including proven SPHL fit up and testing to the maximum working pressure, should be carried out and verified by a competent person.

All SPHL should be launched within a period that does not exceed six months. These periodic launches should be verified by a competent person

10. Glossary

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| Bendwatch | Period of time required for divers to be in the vicinity of a recompression chamber following decompression. |
| Habitat | Remote temporary fixed structure allowing access by divers to carry out work activities such as welding under pressure in a dry environment. |
| Hyperbaric Evacuation System (HES) | Whole plant, equipment process, procedures and personnel necessary to accomplish hyperbaric evacuation. |
| Hyperbaric Reception Facility (HRF) | Facility for the transfer, life support, decompression and bendwatch of divers from the Self Propelled Hyperbaric Lifeboat (SPHL) with dedicated on-board support crew to normobaric pressure. A HRF includes a Transfer Under Pressure (TUP) capability for transferring personnel and equipment in and out of the facility. |
| Normobaric | Barometric pressure equivalent to sea level pressure. |
| Safety Critical Element (SCE) | Item of equipment or process whose purpose is to prevent or limit the consequences of a High Risk Hazard that if realized could result in the fatality of one or more diver's or support crew. |

For further information and publications, please visit our website at:

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