NORSOK STANDARD

MANNED UNDERWATER OPERATIONS

U-100
Rev. 1, Aug 1999

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FOREWORD

NORSOK (The competitive standing of the Norwegian offshore sector) is the industry initiative to add value, reduce cost and lead-time and eliminate unnecessary activities in offshore field developments and operations.

The NORSOK standards are developed by the Norwegian petroleum industry as a part of the NORSOK initiative and supported by OLF (The Norwegian Oil Industry Association) and TBL (Federation of Norwegian Engineering Industries). NORSOK standards are administered and issued by NTS (Norwegian Technology Standards Institution).

The purpose of NORSOK standards is to contribute to meet the NORSOK goals, e.g. by replacing individual oil company specifications and other industry guidelines and documents for use in existing and future petroleum industry developments.

The NORSOK standards make extensive references to international standards. Where relevant, the contents of a NORSOK standard will be used to provide input to the international standardisation process. Subject to implementation into international standards, the NORSOK standard will be withdrawn.

INTRODUCTION

This standard is a consequence of an industry- wide effort to make a NORSOK standard for manned underwater operations.

This document has been produced to establish a single common standard for manned underwater operations.

1 SCOPE

This NORSOK standard defines basic requirements for personnel; equipment and systems for manned underwater operations related to the petroleum industry.

2 NORMATIVE REFERENCES

Manned underwater operations comprised by this NORSOK standard are ruled by the authority of acts and regulations in force in the area where the underwater operation is going to take place.

In addition, the following guidelines and standards include provisions that, through reference in this text, constitute provisions of this NORSOK standard. Other recognised standards may be used, provided it can be shown that they meet or exceed the requirements of the standards referred to below.

Combinations of different recognised standards covering the same topic should be avoided. However, if such combinations are considered necessary, documentation regarding the quality of the combinations, as opposed to the quality of the individual standards, shall be available.

At the time of publication, the edition indicated was valid. All standards/references are subject to revision, and parties to agreements based on this NORSOK standard are encouraged to investigate the possibility of applying the most recent edition of the standard/references indicated below.

2.1 NS-EN-ISO 9000 series Quality Systems Model for quality assurance in design, development, production, installation and servicing.

2.2 Guidelines for vessels with dynamic positioning systems, issued by IMO. MSC Circ. 645.

2.3 NORSOK Standard J-003 Marine Operations.

2.4 Guidelines for doctors concerning medical examination of divers, as issued by the NBH. Department of Social Affairs, Oslo 1990.

2.5 Health and Safety Executive (HSE). Guidance Note MA 1: The Medical Examination of Divers. Revised 1992.

2.6 Guidelines concerning first aid equipment and medical life-saving kits for deep-sea diving in connection with exploration and drilling operations for submarine petroleum deposits on the Norwegian Continental Shelf issued by Department of Social affairs.

2.7 ISO 6385 - 1981, Ergonomic principles in design of working systems.

2.8 Code for interior lighting, issued by "Selskapet for lyskultur".

2.9 Code on noise levels on board ships A 468 and recommendations on methods for measuring noise levels A 343, issued by IMO.

2.10 Industrial control-sources in fixed installations (Norwegian Radiation Protection Authority). Industrielle kontrollkilder i faste installasjoner, Statens strålevern (National Institute for Radiation Protection).

2.11 Administrative standards for contamination in the working atmosphere, issued by DAT. (Order N° 361).

2.12 NPD safety notes and letters in pursuance of the regulations.

2.13 Guidelines to regulations concerning implementation and use of risk analysis in the petroleum activities issued by NPD.

2.14 Recommended guidelines (Specification) for training of first aid personnel on the Norwegian continental shelf, OLF.

2.15 *Det Norske Veritas Rules for Certification of Diving Systems.

2.16 *Rules and regulations for the construction and classification of submersibles and diving systems, Lloyds Register of Shipping.

2.17 International convention for the safety of life at sea (SOLAS) issued by IMO.

2.18 Code concerning safety for diving systems A 536 (13) with amendment A 583(14), issued by IMO.

2.19 Code of Practice for the Safe Use of Electricity Under Water, issued by AODC (IMCA).

2.20 AODC 016 Marking and colour of gas cylinders, Quads and banks for diving application. IMCA March 1994.

2.21 NORSOK Standard U-101: Respiratory Equipment - Diving apparatus - Requirements, testing, marking.

2.22 Military standard "MIL-STD-1472, Human Engineering Design Criteria for Military Systems, Equipment and Facilities", with relevance to speech intelligibility.

2.23 NPD report, OD-91-12: Report regarding comparison of saturation diving tables and frame conditions for standardisation.

2.24 Norwegian Diving and Treatment Tables, ISBN: 82-992411-0-3.

2.25 Guidance Note No. IMCA D010: Diving Operations from Vessels Operating in Dynamically Positioned Mode.

2.26 Guidelines to regulations concerning emergency preparedness in the petroleum activities issued by NPD.

* One of the two referenced classification society rules shall be used.

Informative references are given in annex A

3 DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

In this document, the following definitions of words and expressions shall apply:

Accident	Event which causes personal injury, fire, environmental/material damage or loss of production
Assistant Life Support Technician	Person undergoing a period of planned work experience for his training to become a Life Support Technician.
Bell run	The period of time between disconnection and reconnection of the diving bell from and to the surface chamber complex when a diving bell is used for transport of divers to and from the work site.
Competent person	Person with authorisation/documented qualifications for performing a specified function.
Compression period	The compression period commences at the start of pressurisation and is during saturation diving completed upon arrival at the planned living depth, including stand-off periods and HPNS screening time.
Decompression period	During saturation diving, the decompression period commences from the start of build-up of the pO_2 in preparation for the final decompression phase, and lasts until arrival at atmospheric pressure.
Diver	Person holding a diving certificate issued by an approved authority
Deep diving depth	The NORSOK standard does not use a fixed limit for deep diving. For dependent requirements, the depth is therefore explicitly given in each case.
Diving bell	Submersible compression chamber designed for transport of personnel between the surface and the work site at atmospheric pressure or under increased pressure.
Diving operation	Activity where the diver is directly exposed to increased ambient pressure.
Diving superintendent	Person who has been appointed in writing by the underwater contractor to be the person in charge and responsible for a manned underwater operation
Diving supervisor	Person who has been appointed in writing by the underwater contractor to be in charge of a manned underwater operation or parts of such operation
Diving work-site	Site from which the diving is performed also referred to as diving platform

Excursion	Any descent or ascent from living depth
Informative references	Shall mean informative in the application of this standard, i.e. to be regarded as recommendations or examples of acceptable standards or methods.
Life Support Supervisor	Person who has been appointed in writing by the underwater contractor to act as Person in charge of the operation of a chamber complex with associated equipment
Life Support Technician	Person operating a chamber complex with associated equipment
Living depth	The depth at which the saturation divers stay in the chamber complex following compression and intermediate compressions/ decompressions, and prior to final decompression, (also called "storage depth").
Manned underwater operation:	Activity when humans stay below surface and/or are exposed to increased ambient pressure.
May.	Verbal form used to indicate a course of action permissible within the limits of the standard.
Near Accident	Also called "Near Miss". Event that, under slightly different circumstances, could have caused personal injury, fire, environmental/material damage or loss of production.
Normative references	Shall mean normative in the application of this standard, i.e. to be regarded as requirements.
Operator	Oil company, responsible as the obligated party.
Recognised certifying/ classifying societies for Lloyd's Register of Shipping diving systems	Det Norske Veritas.
Recognised standard for Qualification	This standard 11. Annex B. IMCA (AODC) personnel qualification diving personnel standard , for LST′s and Diving Supervisor EDTC training standards.
Shall	Verbal form used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted, unless accepted by all involved parties.
Should	Verbal form to indicate that among several possibilities one is recommended as particular suitable, without mentioning or excluding others or that a certain course of action is preferred but not necessarily required.

Stabilising period	The defined period of time according to tables/procedures utilised for stabilising the divers at depth.
Stays at working depth	Period of time between completed compression, or first compression if work is to take place at several levels of pressure, and commencement of the final decompression.
Submerged habitat	Submerged chamber or device positioned below surface and designed so as to allow personnel to work there.
Supervisory personnel	Personnel on the diving team acting in a supervisory role (diving/ ADS supervisors, life support supervisors, superintendents, etc.)
Surface oriented diving	Diving operation where the diver enters and leaves the water at normal ambient pressure.
Time in water, general	Continuous and total time in water within a 12 hours period.
Time in water, bell diving	Period of time from when a diver leaves the bell on a lock-out until he returns to the bell after completed lock-out, including any rest periods required during the lock-out.
Trainee diving supervisor	Diver undergoing a period of planned work experiences for his training to become a diving supervisor
Underwater contractor	Diving Company or firm undertaking petroleum related manned underwater operations.
Wet bell	Platform used to lower and to bring up a diver to and from a work-site under water. The upper section contains a gas pocket of breathable gas.
Working depth	The depth of the diver at work

3.2 Abbreviations

ADS	Atmospheric Diving System
AODC	Association of Offshore Diving Contractors (now part of IMCA, and also called International Association of Underwater Engineering Contractors)
Ar	Argon
BA	Breathing Apparatus
BIBS	Built In Breathing System
CO_2	Carbon dioxide
DAT	Direktoratet for arbeidstilsynet (The Norwegian Directorate of Labour Inspection)
DMAC	Diving Medical Advisory Committee
DNV	Det Norske Veritas
DP	Dynamic Positioning
DSV	Diving Support Vessel
ECU	Environmental Control Unit
EDTC	European Diving Technology Committee

FMEA	Failure Mode and Effect Analysis
HAZOP	Hazard and Operability Study
HRV	Hyperbaric Rescue Vessel (Hyperbaric Lifeboat)
HSE	Health and Safety Execution
HPNS	High Pressure Nervous Syndrome
IMCA	The International Marine Contractors Association (former AODC and DPVOA)
IMO	International Maritime Organisation
kPa	Kilopascal
LSP	Life Support Package
msw	Meters of Sea Water
MUO	Manned Underwater Operations
N_2	Nitrogen
NBH	Norwegian Board of Health (Statens Helsetilsyn)
NMD	Norwegian Maritime Directorate
NPD	Norwegian Petroleum Directorate
O_2	Oxygen
OLF	Oljeindustriens Landsforening (The Norwegian Oil Industry Association)
QA	Quality Assurance
pAr	Partial pressure of Ar
pN_2	Partial pressure of N_2
pCO_2	Partial pressure of CO_2
pO_2	Partial pressure of O_2
ppm	Parts per million
RH	Relative Humidity
ROV	Remotely Operated Vehicle
SHE	Safety, Health and Environment
SJA	Safe Job Analysis
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
TUP	Transfer Under Pressure
UBA	Underwater Breathing Apparatus
UV	Ultra Violet

4 ADMINISTRATIVE REQUIREMENTS

4.1 General

If there are areas in this standard that are not covered with regard to safety aspects, an independent responsibility to maintain the safety level of this standard is imposed on anyone engaged in MUO.

The contractor's organisation shall include administrative functions responsible for areas that ensure a safe and efficient operation. As a minimum, these functions are: Manned Underwater Operations; Safety, Health and Environment; Emergency Preparedness; Quality; Personnel; and Management of Diving Equipment including, if relevant, the Work-site. (According to Ref. 2.1)

4.2 Documentation

The contractor shall document the diving methods relevant for the scope of work to be conducted under the contract. This document shall be based on the contractor's general diving/ADS procedures for MUO and, if relevant, include a description of DP-operations. (According to Ref. 2.2 and 2.3)

Management systems and quality assurance shall be implemented in accordance with Ref. 2.1. Technical and operational documentation shall be in accordance with national legislation.

The contractor shall have a documented system for systematic maintenance, including updating of certificates, covering all diving related equipment, systems and machinery.

As a minimum, the contractor shall define, document and make available, procedures which cover:

- normal and emergency operation of the equipment;
- function and verification testing, including acceptance parameters;
- limits for monitoring parameters, including early warning;
- check lists for routine operation - for technical equipment and operational aspects;
- manning requirements;
- detailed job descriptions for all personnel categories involved in the MUO;
- SHE activities related to the work-site (if relevant)/diving activities.

These procedures shall include minimum requirements in order to commence an operation, criteria for suspension and emergency procedures.

Operational and emergency procedures on all levels shall be subjected to risk analysis. All findings of the risk analysis shall be thoroughly evaluated and critical findings counteracted by procedural and/or technical improvements. (See 5.3.)

Check lists are to be part of the operational documentation, and shall be an aid to ensure that the preconditions for initiation, implementation and termination of a safe operation are met. Check lists should have a simple and straightforward layout and should include items from normal operations as well as from emergency situations.

Emergency procedures shall be specific to the equipment and work-site. Detailed emergency procedures covering all emergency scenarios shall be available. The scenarios shall include provision of medical care for a critically injured/sick diver under pressure.

Emergency procedures at all levels shall be subjected to risk analysis. All findings of the risk analysis shall be thoroughly evaluated and critical findings counteracted by procedural and/or technical improvements to reach acceptable risk levels.
Reference is also made to Section 9.

4.3 Compliance measurement

An in-date compliance measurement matrix with regards to this standard and relevant regulatory requirement shall be available. Compliance's shall be documented. The contractor shall evaluate all items of non-compliance. Qualified alternative solutions may be suggested. This document shall state the administrative function responsible for handling non- compliance's.

All non- compliance's shall be forwarded for acceptance of the operator. Only non-compliance's accepted by operator can be forwarded to the authorities as a deviation request.

4.4 Certification/verification

Documentation shall be provided to demonstrate that equipment for MUO have been manufactured and function tested in accordance with the requirements of this NORSOK standard.

The contractor shall document that procedures and equipment critical to SHE, and used in connection with manned underwater operations at any iven time, comply with functional and technical requirements in this standard.

Prior to commencement of any MUO, the contractor shall ensure that the above documentation, with certificates for the diving system/ADS, including all relevant components, auxiliary and emergency equipment, are issued and valid. Certificates issued shall be specific and identify the equipment they cover. Limiting factors for the above shall be included in the operating instructions. The contractor shall have a system for ensuring that the documentation is kept valid for the duration of the operation.

4.5 Document availability

As a minimum, the contractor shall ensure availability of updated editions of the documentation referred to in Table 1.

Table 1 - Documentation required

Description	Contractor	Work-site
Contractor's project QA manual/plan	X	X
Contractor's SHE plan for the work-site	X	X
Contractor's operational manuals, pertaining to the relevant contract	X	X
Contractor's contingency plan for the relevant contract, interfaced with operator's plan for the relevant concession areas	X	X
Contractor's personnel documentation, including sub-contracted personnel	X	X
Contractor's compliance measurement matrix for the contract with regards to the operator, the contractor and regulatory requirements	X	X
All relevant regulations	X	X
All normative references applicable for the operation to be undertaken	X	X
Relevant informative references listed in Annex A. or equivalent	X	
Updated crew-lists and shift schedules, including sub-contracted personnel	X	X
Documentation to satisfy Section 6.3 herein	X	
Certificates to satisfy Section 6.3 herein	X	X
Suppliers instructions for maintenance and operation of all equipment	X	X
Procedures for all activities pertaining to the relevant contract	X	X
All relevant safety notices	X	X
Copies of contracts relating to the operation	X	X
Applicable classification rules	X	X
Copies of any dispensations granted from operator and/or authority requirements, together with documentation for which the dispensation is granted	X	X
Relevant risk analyses	X	X
Decisions made in pursuance of regulations (letters from authorities)	X	X
Log books to document operational activities		X
Updated compliance measurement	X	X

4.6 Reporting

4.6.1 General

The contractor’s reporting of manned underwater activities shall be structured to provide the operator with data to meet regulatory and operator’s requirements for reporting.

The contractor shall have a system for recording data, which may be used by the operator to generate the required reports and statistics.

4.6.2 Contractor's scheduled reporting responsibilities

4.6.2.1 Daily operation

A daily progress report shall include MUO data. Copies of all logs and reports shall be made available for the operator’s representative upon request.

4.6.2.2 Experience feedback reporting.

Experience gained during operation shall be systematically reported back to the discipline department, where it shall be analysed and evaluated by competent personnel.

Where required, corrective actions shall be implemented as a result of this process.

4.6.2.3 Monthly activity report

The contractor shall if relevant at the end of each calendar month submit to the operator a summary of the previous month’s activities, specifying abnormalities, technical and operational problems of relevance to the safety or health of the personnel, and detailing corrective actions taken.

An evaluation of the medical aspects of the operation, shall be included. The working environment committee shall have reviewed this evaluation report.

4.6.2.4 Annual/final experience report

Within 3 weeks after completed demobilisation, or other defined work period, e.g. season, the contractor shall submit to the operator a complete evaluation report, prepared in co-operation with the safety delegates and the responsible competent diving doctor. All aspects relevant to the applicable regulations, safety, occupational health and technical/operational shall be included.

4.6.3 Accident/Near Accident notification and reporting

The contractor shall have an established system for notification, investigation and reporting of accidents and near accidents in order to satisfy regulatory and the operator’s requirements.

4.6.3.1 Notification

In case of an accident or near accident at the work-site, the operator's representative shall be notified immediately, in accordance with the emergency preparedness plan, of the following details:

- accident/incident location and time;
- name and personal details of any injured persons;
- details of the accident;
- plans for following up the injury;
- name of contact person.

4.6.3.2 Reporting

Every fatal accident, accident, near accident and illness shall be reported as soon as possible to the operator, and as required, to the authorities. Such reporting shall comply with relevant national legislation to preserve anonymity of the individual patient (medical confidentiality).

In addition, during manned underwater operations, every incident resulting in first aid, medical or hyperbaric treatment and near accidents when no person is present in the dive-system, shall also be reported.

For requirements in operations under the Norwegian petroleum law refer to annex C.

Examples of accidents, near accidents and illness to be reported in a MUO:

1. every case of fire in the plant
2. unintentional halt in the function of any unit necessary to maintain life and health of personnel working under water
3. every form of unconsciousness
4. accidental change of ambient pressure
5. decompression sickness
6. gas supply cut-off
7. faulty gas mixture
8. aborted operation due to illness
9. external ear infection

The report should include information on:

- planned depth;
- depth at which the first symptoms occurred;
- gas mixture;
- purpose of the ongoing operation;
- location of personnel;
- operational method;
- name of persons in the operation management;
- wind and wave conditions, visibility etc.

With respect to injury or illness, the following should be included:
- a description of the injury or illness;
- the first symptom;
- type of first aid;
- who administered first aid;
- further treatment;
- location of the injury or presenting symptoms;
- an assessment of contributing causes to the injury or illness.

4.6.3.3 Equipment failure

The contractor shall have an established system for registration/notification and correction of equipment failures.

4.6.3.4 Investigation

All accidents and serious incidents shall be investigated, and the conclusions drawn from this investigation shall be reported to the operator, together with planned measures to prevent reoccurrence.

The investigation shall take place as soon as possible after the event. The scene of the accident shall not be disturbed until all investigations are completed.

The investigation shall be carried out in addition to any investigation implemented by a public authority, or a public appointed accident commission.

5 HEALTH, WORKING ENVIRONMENT AND SAFETY

5.1 Health

5.1.1 General

The contractor shall establish, maintain and use procedures, which prevent harmful effects on divers/ADS pilots in both short and long term, Ref. annex A. 1.

The contractor shall routinely evaluate and update procedures based on empirical data from available sources.

All use of medication shall be logged and evaluated by the health service.

5.1.2 Health service

5.1.2.1 Organisation

The health service shall be responsible for the supervision of all health-related aspects of manned underwater operations. This includes planning, operation and review of the activities.

The health service shall have a free and independent position in the organisation. It shall be able to carry out its tasks and activities safely and ethically from a medical point of view.

The lines of reporting shall be documented, and must be clear and unambiguous. The health service of the contractor and of the operator shall co-operate, identify and document interfaces between the two organisations.

5.1.2.2 Medical responsibility

A medical practitioner who is qualified in diving medicine and approved as such by the national authorities shall have the medical responsibility for the health service. The doctor must be able to provide documentation that he or she has an adequate theoretical background and practical experience suitable for the task. The doctor must have more than five years practice after authorisation and must be able to provide documentation corresponding to at least two years working with diving medicine.

5.1.2.3 Duties

The health service system shall be designed to prevent and, if applicable, to handle and communicate experience from any possible health injury or illness that may occur in connection to diving. The health service shall be involved in planning and engineering, to promote the level of safety of the operation. The health service shall be available to assist with basic preventive efforts.

The health service shall give advice to line management and relevant personnel regarding conditions of significance to health, and shall see that other professional staff engaged in the MUO is familiar with such conditions.

The health service shall ensure that a medical contingency plan is prepared. The plan shall be approved by the responsible competent diving doctor and be in compliance with the operator’s medical contingency plan.

The plan shall describe all aspects related to both surface and hyperbaric medical problems, e.g. descriptions of:

- the procedures for hyperbaric evacuation;
- how to bring the personnel to surface pressure;
- how qualified medical treatment can be given to the personnel until they are brought to surface pressure;
- the drills to be carried out in order to be able to meet an accident or a hazardous situation adequately.

5.1.2.4 Duty doctor arrangement and qualifications.

A duty doctor arrangement shall be established to provide diving medical treatment in cases of illness or injury. A doctor who is participating in such an arrangement must provide documentation of his/her competence, theoretical background and practical experience. The doctor shall be formally trained in diving medicine through any internationally accepted course lasting a minimum of five days, and shall additionally have two years of practical experience in diving medicine. The duty doctor shall be medically fit for hyperbaric work as evaluated by a doctor competent to examine divers (5.1.3). To be considered medically fit, the doctor should be without illness or injury that may interfere with his professional capacity under pressure or impose a safety risk for him or others. A diving duty doctor shall, in addition, be qualified in accordance with national authority requirements.

The contingency plan should describe, in more detail, the distribution of responsibilities and duties between the doctors named in agreements with licensee and contractor.

5.1.2.5 Requirements relating to staffing in the health service.

Job description shall be drawn up for nurses. The job description shall describe the responsibilities and duties of nurses, lines of reporting, and liaison with other health personnel, operators and supervisor authorities. (When working under Norwegian jurisdiction see also Regulations relating to health services in the petroleum activities. Issued by the Directorate of Health 12 November 1990)

The presence of a nurse is required on the installation at all times so that the instructions in force can be complied with.

5.1.3 Evaluation of medical fitness and health monitoring

Personnel engaged in MUO shall have a valid certificate from a medical practitioner confirming that he/she, in compliance with regulations, has been found medically fit. This based on an evaluation of whether the medical condition of the person in question represents a danger to him/herself or to others.

As a minimum, personnel involved in monobaric (ADS) operations are required to hold a certificate of medical fitness as identified by national regulations for offshore workers.

In addition, divers shall hold a certificate of medical fitness for personnel required to work under increased ambient pressure. The medical practitioner shall be registered with the approving governmental body, and the examination shall be carried out in accordance with national regulations according to Ref. 2.4 or 2.5 and approved code of practice, Ref. annex A. 2 or equivalent.

The diving contractor shall establish a system to assure the diver’s medical fitness. A personnel matrix containing information of medical certificates and their expiry dates shall be available to the operator on request.

The contractor shall establish a medical file for all divers/ADS pilots. This file shall contain information about health status, previous work experience and exposure to possible hazardous working conditions. Disease or injury, particularly related to this work, must be noted. The file shall be in accordance with all applicable regulations.

A system for monitoring long and short-term health effects shall be established. As a minimum, this system shall include pre- and post-dive medical checks to be conducted by a nurse or properly trained medic. These checks shall be performed routinely for all divers entering/surfacing from saturation dives. For air divers these checks shall be performed prior to and after completion of work periods. Reports from these checks shall be part of the individual follow-up of the divers.

Special attention should be paid to health monitoring of divers participating in deep dives. Organ systems known or expected to be subject to long-term health effects should be examined before and after such dives. When diving deeper than 200 msw divers shall be followed up in accordance with Ref. annex A. 3 or equivalent.

In following up the health of the individual diver, diving exposure data is an important parameter. The contractor shall therefore maintain a system for collecting and storing such data in a manner enhancing a prompt retrieval of each individual diver's exposure to pressure' data. He shall further contractually require that divers make available, to the health service, all his diving exposure data from diving taking place outside the confines of employment/appointment with the contractor.

5.1.4 Hygienic arrangements

The responsible competent diving doctor (see 5.1.2.2) is responsible for supervision of the hygienic arrangements on the work-site. Special care must be taken in the choice of detergents and disinfectants during saturation diving. The responsible competent diving doctor shall evaluate such substances before being taken into use.

Specific and customised hygienic regimes are to be defined for divers' personal hygiene, divers' personal equipment, chamber interior, domestic fresh water supply and taps, heating hot water supply and gas supply. All critical phases of performing the procedure shall be documented.

Disinfectants used must have a documented effect on the specific microbiology in saturation environments, and must further be documented not to emit toxic or otherwise unhealthy compounds to the atmosphere.

All parts of the diver's personal equipment shall be taken out from bells and TUPs and cleaned and dried during periods of shutdown.

Prior to start of saturation after a longer period of shut down (>one month), specific microbiological analysis of fresh water supply shall be performed. Control samples shall be taken both from inside and outside saturation systems on board. Water pipes to the chambers shall be flushed prior to pressurisation, and "old" water shall be dumped outside the chamber complex.

Recommended procedures are described in Ref. annex A. 4, annex A. 5 .

5.1.5 Nutritional arrangements

The contractor shall establish a system for the provision of adequate nutrition, including the hygienic properties of the nutrients as well as their suitability to fulfil the need for adequate nutrition and a satisfactory fluid balance during diving. Sufficient drinking water shall be available.

5.1.6 Medical contingency preparedness

The contractor shall supply medical equipment according to applicable standards. A medical stock according to Ref. 2.6, annex A 1 (15,28) or equivalent, shall be available during diving operations. The responsible competent diving doctor can deviate from this list if an equal or higher medical contingency can be assured by other means. Such changes shall be documented.

5.1.6.1 Mandatory contingency medical supplies

The contractor shall make use of a system ensuring that there is always a supply of the following materials:

- first aid equipment, with user's manual;
- medical supplies and medical equipment for medicine chest intended for use during manned underwater operations, with user's handbooks;
- medical supplies and other material for medical contingency in disaster situations.

The stores shall be kept separate from each other and shall be checked regularly.

5.1.6.2 Advanced first aid

It shall be possible to provide advanced first aid to a person who is ill or injured at the same pressure level. Supervisory personnel and a sufficient number of divers and other personnel engaged in manned underwater operations shall be qualified to carry out advanced first aid and to handle equipment and medical remedies. The responsible competent diving doctor is responsible for first aid instruction.

As a general rule, the vessel's master or a nurse should handle medicines. The responsible competent diving doctor must nevertheless ensure that executive personnel and anyone who is required to give advanced first aid receives the required instruction in the handling of medicines, particularly with an emergency situation in mind.

5.1.6.3 Access to telecommunication

The person performing advanced first aid shall have priority and unimpeded access to suitable telecommunication with the responsible doctor, or with any other necessary professionally competent personnel.

The operation management shall always be kept informed of every case of illness, injury or accident. Such reporting shall comply with relevant national legislation to preserve anonymity of the individual patient (medical confidentiality).

5.2 Working environment

The contractor shall ensure a working environment that, in all respects, enhances the safety, well being and efficiency of all personnel. Reference is made to relevant clauses in Ref. annex A. 6 or equivalent.

5.2.1 Ergonomics

The design and lay-out of plant and equipment shall aim at reducing environmental factors which may induce negative effects on the user's safety, efficiency or comfort. This may be obtained by the incorporation of ergonomic principles, such as system models, into the design process according to Ref. 2.7 and Ref. annex A. 7.

5.2.2 Physical work environment

5.2.2.1 General

The physical environment for divers; in water, chambers, bells, monobaric craft and/or habitats, shall be subject to particular and close monitoring, with control of all parameters relevant to the safety and well being of the diver.

Methods to achieve optimum conditions shall be implemented by the contractor by actively seeking and evaluating new knowledge.

5.2.2.2 Temperature

Thermal control systems for divers in the water, and the atmosphere of hyperbaric chambers, bells, habitats and in monobaric crafts shall have the capacity and be accurate enough to ensure thermal balance and comfort for the divers/occupants during all phases of a normal manned underwater operation.

For an emergency situation, in which the divers/occupants cannot be returned to a safe environment, the life support systems shall provide the means to ensure the divers/occupants thermal status to remain within safe limits for the time required to perform the rescue operation (see 7.7.2).

The minimum capacity for emergency situations shall be:

- Divers in the water: 10 minutes.
- Diving bells: 24 hours
- Chamber and HRVs: 72 hours
- Habitats: 48 hours

5.2.2.3 Humidity

The ECUs for living chambers and in monobaric crafts shall have the capacity to control the relative humidity to between 40 - 60% RH at any relevant depth of the system and with a full complement of divers in the chamber(s).

5.2.2.4 Lighting

Lighting shall be adequate for the tasks to be performed, including (but not limited to) the chambers, bells (internal and external), habitats and at the divers work site, Ref. 2.8.

It shall be possible to adjust the light to a comfortable level.

5.2.2.5 Noise

Exposure to noise shall be as low as practically possible, and below the level that may represent a reduction in the safety of the operation. Personnel exposed to harmful noise levels shall use protective equipment. The use of equipment reducing the possibility for oral communication shall be kept to a minimum.

In chambers serving as accommodation for personnel and in control rooms, noise levels shall, in normal operations and under realistic operational conditions, not exceed the values stated below but shall preferably be in accordance with Ref. 2.9. and Ref. annex A. 6 or equivalent. Values should be corrected for gas composition and pressure.

Sleeping chambers	60 dB(A)
Living chambers	65 dB(A)
Control room	65 dB(A)
Diving bell	65 dB(A)
*Habitats	65 dB(A)
*Diver in water	70 dB(A)

*Note: This does not include self-induced noise

For other areas values shall be in accordance with Ref. 2.9 and Ref. annex A.6 or equivalent

All personnel shall wear noise protection, wherever located, whenever noise levels exceed 83 dB(A). This noise protection shall not interfere with the personnel's ability to communicate.

5.2.2.6 Radiation

Use of radioactive sources and materials shall be limited and shall conform to Ref. 2.10.

Exposure to non-ionising radiation shall be kept as low as practically possible and in accordance with relevant recommendation.

5.2.3 Chemical work environment

When diving in locations where the seabed or seawater may be contaminated, measures shall be taken to ascertain the level of contamination and to protect the divers from effects of such contamination.

The contractor shall document a system to ensure that all materials utilised in chambers, bells and breathing circuits etc., do not contain or produce gases or vapours that may be harmful to the divers during normal operational conditions. Prior to introducing new materials, verification shall be performed in accordance with Ref. annex A 8, annex A 9, and annex A 10 or equivalent.

The partial pressure of components making up the breathing gas shall be kept within safe limits.

The level of all relevant gases and trace substances of importance to the safety of the diver(s) shall be monitored and controlled to an acceptable standard. As a minimum the relevant national standard (According to Ref. 2.11) shall be adhered to. For additional information see Ref. annex A 11.

At regular intervals the breathing gas in relevant systems shall be analysed for all components known to be potential hazards (Ref. annex A.12 or equivalent).

O_2 may cause harmful effects to the lungs, in both the short and long term, and shall be kept at a level as close as possible to 21 kPa (210 mbar), balanced against the diver's need for a higher than normal pO_2.

Impurities in the breathing gas shall be kept at a minimum level; and always below the maximum limits stipulated in recognised standards according to Ref. 2.11 and Ref. annex A. 6 and annex A. 10 or equivalent. Generally, administrative standards for contamination in hyperbaric chambers (in the unit µbar) are stipulated as 1/3 of the 8-hour standard stipulated by the recognised surface standard (in the unit ppm). These standards are stipulated irrespective of the length of the saturation period. Measurements in hyperbaric chambers are related to these standards by giving the concentration as the 24-hour mean value. In the case of hyperbaric work operations with an 8-hour exposure time the values of the recognised surface standard are applied uncorrected.

In the case of substances where Ref. 2.11 and annex A. 6, annex A. 10 or equivalent has indicated a short-term standard (STEL), this is applied as administrative standard for maximum concentration over a 15 minute period.

In the case of substances without STEL or upper limit value the excess factors of Ref. 2.11 shall be used.

The 8-hour standard for unspecified welding smoke from hyperbaric welding shall be 5 mg/m^3.

For the assessment of the combination effect of several substances and of skin absorption, reference is made to Ref. 2.11.

In the case of the substances CO_2 and CO, exception is made from the general rule of 1/3 of the 8 hour standard of recognised surface standard.

5.2.3.1 Carbon dioxide

For stay of longer duration: a pCO_2 standard of 1 kPa (10 mbar).The short term exposure limit (15 minutes) for pCO_2 is 3 kPa (30 mbar).

5.2.3.2 Carbon monoxide

Table 2 - Administrative exposure limit for CO for varying exposure times and O_2 contents.

Administrative standard for CO	Duration of exposure	Basic standard norm pO_2 = 20 kPa (0.2 bar)	Maximum value pO_2 > 40 kPa (0.4 bar)	Correction factor for O_2 pressure	Type of administrative standard
Breathing gas at work or at rest in bell, chamber, welding habitat etc.	Continuous	1.2 Pa (12 μbar)	1.2 Pa (12 μbar)	No adjustment permitted	Average
	8 and 12 hours	2.0 Pa (20 μbar)	4.0 Pa (40 μbar)	Administrative standard = $pO_2/10000$	Average
	15 minutes	5.0 Pa (50 μbar)	10.0 Pa (100 μbar)	Administrative standard = $pO_2/4000$	Average
Ambient gas when diver is using breathing apparatus		100.0 Pa (1000 μbar)	200.0 Pa (2000 μbar)	Administrative standard = $pO_2/200$	Upper
Breathing gas in emergency situations	No exposure planned but system to be active for minimum 24 hours	5.0 Pa (50 μbar)	10.0 Pa (100 μbar)	Administrative standard = $pO_2/4000$	Average

It is emphasised that efforts should be made in general to keep the concentration of CO at the lowest possible level, irrespective of the existing standards.

For all MUO where high concentrations of CO may be expected, all personnel should be familiar with the symptoms, and the first aid measures required in case of this type of poisoning.

Partial pressure effects of the oxygen

The administrative standards of CO are based on an atmosphere where O_2 represents a partial pressure of 20 kPa (200 mbar). The administrative standard for carbon monoxide is allowed to be adjusted upwards in accordance with the increase of the O_2 pressure.

Maximum adjustment of the 8 hour standard for CO is 100 percent. This means that it is not allowed to compensate for an increase in pO_2 exceeding 40 kPa (400 mbar). For exposure to CO lasting longer than 12 hours (“continuous”) no compensation for an increased pO_2 is allowed due to lack of knowledge of the combination effects of exposure to CO and O_2.

This increase of the standard is however not allowed during continuous exposure, due to insufficient knowledge of the effects of increased O_2 pressure during exposure to low concentrations of CO for longer periods of time.

Emergency situations

The diving plant and/or the welding habitat should be designed to be able to keep the partial pressure of carbon monoxide below 5 Pa (50 µbar) in the inhalation gas during an emergency. This may be achieved by installation of a self-contained breathing system ("BIBS"), a purification system, safety zones or similar. The maximum partial pressure of CO in the inhalation gas shall not be exceeded for a duration of minimum 24 hours or until the time when the divers are expected to be rescued.

Concentration of carbon monoxide in ambient gas

An administrative standard for ambient atmosphere has also been stipulated. Even if the divers breathe from a separate gas source, i.e. a mask, the partial pressure of CO in the gas surrounding the divers must not under any circumstances exceed 100 Pa (1000 µbar) when the O_2 pressure (pO_2) is equal to 20 kPa (0.2 bar). This limit has been set taking into consideration the possibility of leakage or the mask being taken off for short periods, etc.

5.2.3.3 Argon and nitrogen.

The presence of Ar and N_2. together in the breathing gas produces additive narcotic effects.

Table 3 - Limit values of argon and nitrogen

	WHEN NOT IN SATURATION DECOMPRESSION			**DURING SATURATION DECOMPRESSION**
	CEILING VALUE	**8 HOURS THRESHOLD VALUE (TVA)**	**CONTINUOUS**	**CONTINUOUS**
pN_2	350 kPa (3.5 bar)		150 kPa (1.5 bar)	80 kPa (0.8 bar) and < 10 %
pAr	150 kPa (1.5 bar)	100 kPa (1.0 bar)	50 kPa (0.5 bar)	1 kPa (10 mbar)
(2 x pAr) + pN_2	350 kPa (3.5 bar)			

5.3 Safety

The contractor shall in all activities and on all levels in the organisation strive to enhance safety. Responsibility for safety is in the line organisation, and each individual shares this responsibility e.g. Ref. annex A. 13 and according to Ref. 2.12 and/or annex A. 14.

However, top management holds a particular responsibility for creating an atmosphere and a psychosocial work environment within the organisation that enhances safety, puts safety issues on the daily agenda and rewards the safe conduct of work.

5.3.1 Safety Objectives

Safety objectives shall be defined to manage the activities in order to avoid or withstand accidental events. The safety objectives shall entail a dynamic process, keeping the risk level as low as possible and further reducing risk over time according to Ref. 2.13.

Risk acceptance criteria shall be established for activities involved in MUO, prior to the execution of risk analyses. To a practical extent, no single failure during operation, whether operational errors or equipment failure, shall entail unnecessary health hazard or life-threatening situations for the involved personnel.

All critical equipment and phases of the operation shall be subject to thorough risk analyses to disclose consequences of single failures and series of failures, and to evaluate the possibilities for such failures. Operational and technical expertise and experience shall be brought into these assessments. The results shall be compared to the acceptance criteria, and on this basis, risk-reducing measures shall be taken. These analyses and resulting measures shall be documented.

Risk analyses shall be performed using recognised methods, Ref. annex A. 15 or equivalent, e.g. FMEA, fault tree analysis, event tree analysis, HAZOP studies, HAZID studies and SJA.

6 PERSONNEL QUALIFICATION REQUIREMENTS

6.1 General

Personnel engaged in MUOs shall have undergone instruction in and be qualified for the work they are asked to perform. Qualifications shall be kept up to date and documented.

Supervisory personnel shall have leadership training and a course in the use of QA principles. In addition supervisors and others with responsibility for decisions effecting the working environment shall have same or equivalent training as safety delegates and members of the working environment committee.

Personnel going offshore shall have safety training in accordance with Ref. annex A. 16 or equivalent.

Good leadership and the ability to co-operate and communicate with team members are required of all supervisory personnel.

All personnel shall be familiarised with the installed systems, equipment, tools, etc. that they are going to use and with the tasks they are going to perform. The familiarisation programme shall include emergency procedures (Ref. annex A. 17).

The contractor shall provide sufficient personnel to ensure safe and efficient performance of the work.

Crews; marine, diving and other shall be selected so as to ensure the necessary element of experience on all levels and within all specialities.

During saturation diving an authorised nurse shall be present on board.

The qualifications required for personnel listed in this document are to be regarded as minimum requirements.

Personnel involved in lifting operations shall have a relevant course in the use of lifting appliances.

6.2 Special requirements for marine personnel on board diving vessels

Marine personnel on board a DSV shall have sufficient knowledge of/experience with diving operations enabling them to understand the relation between their own job performance and the safety of the divers.

This knowledge shall be documented for critical positions such as captain, DP operator, chief engineer, electrician and crane operator.

The duties, responsibilities and authorities of senior personnel shall be described in accordance with Ref. 2.1.

6.3 Requirements for diving personnel

Diving supervisors, life support personnel and divers shall hold valid certificates recognised by relevant national authority.

Certificates shall be issued based on documented training at qualified schools, where the course syllabus is in accordance with annex B.

The personnel qualification requirements listed below shall be regarded as minimum requirements. If any of the below positions are combined, i.e. if one person covers more than one position, this person shall fulfil the requirements for all positions that he covers.

6.3.1 Diving superintendent

Recognised standard for diving superintendent requires that the superintendent shall:

- comply with the requirements applicable to a diving supervisor with regard to the operation he is responsible for;
- have at least 4 years of practical experience as a diving supervisor;
- have at least 8 years of practical experience in the diving industry.

Additional requirements:

- Minimum two years technical or administrative education, or similar level of career development;
- Introductory DP-course.

6.3.2 Diving supervisor

6.3.2.1 Air diving supervisor

Recognised standard for trainee air diving supervisor requires that the trainee shall:

- be a qualified surface oriented diver;
- be at least 24 years of age;
- have at least two years' practical experience as a commercial diver and have carried out at least 100 commercial dives. At least 25 of these dives shall have been carried out from a vessel operating on dynamic positioning;
- have undergone a training course at a qualified institution and have completed the final examination for trainee air diving supervisors.

Recognised standard for air diving supervisor requires the supervisor to:

- comply with the requirements for a trainee diving supervisor,
- have at least one year of practical experience as a trainee air diving supervisor. At least 200 hours of this practical experience shall have been served at an air diving control panel;
- have carried out at least 200 commercial dives;
- have completed a course in advanced first aid and have received management training;
- have passed the examination for air diving supervisors.

Additional requirement:

a) Introductory DP-course, if a DP vessel is directly engaged in the dive operation.

6.3.2.2 Bell diving supervisor

Recognised standard for trainee bell diving supervisor requires that the trainee shall:

- be a qualified bell diver;
- be at least 24 years of age;
- have at least three years practical experience as a bell diver and have carried out at least 50 commercial dives. At least 25 of these dives shall have been carried out from a vessel operated by dynamic positioning;
- have undergone a training course at a qualified institution and have completed the final examination for trainee bell diving supervisors.

Recognised standard for bell diving supervisor requires the supervisor to:

- comply with the requirements for a trainee bell diving supervisor;
- have at least 350 hours of practical experience at a bell diving control panel as a trainee bell diving supervisor;
- have at least 30 days of practical experience as a trainee LST;
- have acted as trainee air diving supervisor during at least 10 surface oriented dives;
- have completed a course in advanced first aid in accordance with Ref. 2.14 and have received management training;
- have completed the examinations for air diving supervisor and for bell diving supervisor.

Additional requirements:
a) Introductory DP - course, if a DP vessel is directly engaged in the dive operation.

6.3.3 Life support supervisor (LSS)

Recognised standard requires that the life support supervisor shall:

- comply with the requirements applicable to an LST;
- have at least 200 days of practical experience as an LST;
- have at least 4 years of practical experience from the diving industry;

Additional requirements:

- Documented knowledge of operation and maintenance of gas supply and monitoring systems and other specialised equipment relevant for the position.

6.3.4 Life support technician (LST)

Recognised standard for trainee life support technician requires that the trainee shall:

- have undergone a training course at a qualified institution in accordance with minimum requirements, and have completed the final examination,
- alternatively be trained as a bell diver.

Recognised standard for life support technician requires that the operator shall:

- comply with the requirements for a trainee LST.
- have at least 200 days of practical experience as a trainee LST,
- alternatively, if he is a trained bell diver with a total of 5 years of diving experience and at least 3 years experience as a bell diver, he must have at least 30 days of practical experience as a trainee LST.
- have completed the examination for LSTs.
- have completed a course in advanced first aid.

6.3.5 Divers in saturation.

At any given time, a minimum of 80% of the divers in saturation shall have undertaken a documented advanced first aid course according to Ref. 2.14. During operations, minimum two of the divers at each pressure level shall possess this qualification.

6.3.6 Diving technician/Maintenance engineer

- Electrical or mechanical trade education. (Both trades shall be covered at a work-site at any given time);
- Sufficient documented knowledge of or experience with diving operations/systems enabling them to understand the relation between their own job performance and the safety of the divers.

6.3.7 Nurse

- Documented training in emergency and hyperbaric medicine, including diagnosis and treatment of injuries and illness related to diving;
- Medically fit as described in 5.1.2.4.
- Competence in relevant aspects of occupational hygiene related to diving;
- Minimum 2 years experience in handling medical emergencies, or 1-year experience in handling medical emergencies and 1 year experience in occupational health.

6.3.8 ADS supervisor

- Certified diving supervisor;
- A minimum of 3 years of experience as a diving supervisor;
- Advanced first aid certificate from an approved source.

An advanced first aid certificate is not required for assistant ADS supervisor

6.3.9 ADS operator/Pilot

a) Course in ADS piloting on the relevant equipment;
b) Completed courses in use of all tools to be utilised;

6.3.10 ADS handling equipment operator

Fully conversant with all operational, emergency and contingency procedures;
a formal course in the operation of the actual handling system supervised or generated by the manufacturer of the handling system.

6.3.11 ADS technician

a) Completed technical trade education in electrical and/or mechanical field;
b) Formal courses in operation and maintenance of all systems comprising the ADS, and associated systems and tools, supervised or generated by the manufacturer of the systems;
c) Knowledge of verification and certification of systems and the associated test procedures.

6.4 Deviations - equivalent qualifications

6.4.1 Divers' certificates

As an interim arrangement, according to certain criteria, diving certificates have been issued to personnel without training according to the requirements stipulated.

This interim arrangement came to an end 01.06.1988.

Personnel having certificates issued after 01.06.1988 must be able to provide documentation of training in accordance with the stipulated minimum standards.
This applies to divers' certification from all recognised authorities.

6.4.2 Diving superintendents/ Diving supervisors

As an interim arrangement for air- and bell- diving supervisors appointed the first time before 01.06.1986. for diving superintendents appointed to diving supervisors prior to that date, the normal requirements for supervisors according to 6.3.2 of the standard do not apply.

They are instead required to have:

- completed the examination for air- / bell- diving supervisor
- completed a course in advanced first aid

This interim arrangement came to an end 01.07.1988.

6.4.3 Life support technicians/ Life support supervisors

In the case of life support technicians appointed first time before 01.08.1986, and to life support supervisors appointed to chamber operators prior to that date, the requirements to practical background and experience according to 6.3.3 and 6.3.4 of the standard do not apply.

They are, however, required to have completed the examination for chamber operators.

7 TECHNICAL REQUIREMENTS

7.1 General

Plant and equipment used in MUO shall be designed, constructed, tested, e.g. Ref. annex A. 18 and annex A. 19 and maintained in compliance with current regulatory requirements and normative references, and shall be certified by a recognised classifying society according to Ref. 2.15 or 2.16. Auxiliary equipment, only covered by DNV's certification rules, i.e. HRVs etc., shall be certified to meet Ref. 2.15 and Ref.. annex A. 20 or equivalent.

The design shall ensure that efficient integration between the users and all parts of the plant and equipment is obtained, according to anthropometric dimensions and other human factor aspects of the relevant users in accordance with Ref. 2.7.

Further it is a prerequisite that the entire plant is in compliance with the requirements laid down in Ref. 2.17, 2.18, 2.9, and 2.2 and Ref. annex 21. In cases where obvious safety advantages will be achieved through the use of new technology in existing installations and plants, provisions should be made to cater for this.

The diving systems shall be designed to give early warning of abnormal conditions with significance to safety. When a warning is given it shall be possible to make corrective actions before an emergency situation occur.

All use of electricity in diving operations shall comply with Ref. 2.19.

Each section of a plant used in MUO where personnel may be staying, shall have or be connected to a primary and a secondary facility maintaining correct and uniform atmosphere. This does not apply to smaller locks where personnel are not staying for any length of time (i.e. passing through).

Auxiliary equipment, which can affect the safety of the MUO, and which is normally not covered by the rules of a classifying society, shall be certified and/or verified to a standard compatible with national regulations, and the procedures thereby followed shall be available and documented.

Where limits for MUO set by existing plant, equipment and procedures are exceeded, and the MUO entail the use of new technology and new procedures, the contractor shall prepare a plan for the development, testing and introduction of such new technology and procedures.

The change out of electrical penetrators or other components critical to the pressure integrity of the system, shall be performed in accordance with detailed procedures ensuring that the pressure integrity of the system is maintained.

7.2 Dimensions and lay-outs

7.2.1 Chambers

Interior design, decor and colours should be carefully selected to promote safety, efficiency and comfort for the users.

Chamber complex size, architecture, lighting and lay out shall support and optimise all the functions planned to take place in the chambers for the maximum number of occupants who are to make use of it.

It shall be possible to bring personnel, equipment and provisions safely into and out of the chamber complex, and each pressure compartment where personnel are staying, shall be provided with one BIBS for each occupant plus one spare.

To avoid an unacceptable change of pressure, it shall be possible to close all pipe penetrations both internally and externally by valves mounted as close as practically possible to the chamber wall. It shall be possible to conduct the exhaled BIBS gases out of the chamber.

7.2.2 Saturation chambers

The saturation chamber complex shall have toilet facilities, shower and wash basin at each living depth. This can however, be deviated from for short periods i.e. transfer of personnel during split level operations and the cleaning of a chamber. The chamber complex shall also be designed for simplicity of cleaning, to allow divers to be evacuated and to allow divers having undisturbed rest periods.

The inner height of the saturation chamber complex shall be no less than 200 cm over the deck plates (measured in the middle of the chamber), and the inner volume shall be at least 4 m^3 per person. The specified volume shall be usable, i.e. apportioned where there is normally sufficient height for a diver to stand up. The distribution of the specified minimum volumes between living, sleeping and TUP compartments shall be such that it meets the requirement for normal personal comfort.

Chambers used as living and sleeping accommodation shall be equipped with seating and individual bunks to cater for the number of divers who are to make use of this part of the chamber complex. The total internal dimensions of a bunk should be as a minimum 200 cm x 70 cm. Permanently installed equipment shall be of non-flammable materials. In general, flammable materials shall be kept at a minimum inside the chamber (i.e. loose items such as newspapers etc.).

7.2.3 Surface oriented diving chambers

During surface oriented diving operations a decompression chamber shall always be available at the work-site.

When surface oriented diving operations with decompression stops are planned or where the surface oriented diving spread is standby for saturation diving, the inside diameter of the chamber shall at least be 180 cm.

The length of the chamber shall be minimum 200 cm. It shall be possible for the occupants to lie down in the chamber.

Note: When diving under NPD jurisdiction the inside diameter of the chamber shall be at least 180 cm under all circumstances.

7.2.4 Diving bell

7.2.4.1 Diving bell ergonomics

The diving bell, including all assemblies, components and equipment e.g. Ref. annex A.22 shall be designed to support the divers in their operational functions inside and outside the bell.

Diving bells intended for two divers should have an inside volume of at least 4.5 m^3. Diving bells intended for more than two divers shall have an extra inner volume of 1.5 m^3 per diver in excess of two. A reduction in the volume requirement may be acceptable in cases where the bell ergonomics have been significantly improved i.e. by storing the diver's umbilical on the outside of the bell. The specified volume should be usable, i.e. apportioned around what is normally within the height required for a diver to stand up. The tunnel for entry into and exit from the diving bell shall have an inner diameter of minimum 80 cm.

Principles of ergonomics shall be duly taken into account with regard to the location of equipment in the diving bell.

It shall be possible to close all pipe penetrations both internally and externally.

The diving bell shall be adequately equipped for the bell-man to bring an unconscious or injured diver into the bell and to a position where first aid can be administered.

7.2.4.2 Diving bell supply

The diving bell shall contain equipment that will ensure that vital functions are maintained, in situations when the primary supply is not available, until the situation has been brought under control e.g. Ref. annex A.23 and annex A.24. The functioning time shall be at least 24 hours.

Diving bells shall have an onboard gas supply for use in emergency situations. The minimum capacity shall be 1250 usable litres of breathing gas for each diver, calculated to the ambient pressure. (Equals 20 minutes at a breathing rate of 62.5 l/min.)

7.2.4.3 Emergency connectors for diving bells, habitats and HRV`s

An emergency connector panel shall be provided, in accordance with IMO requirements (Ref. 2.17) and the following specification.

Item	Type	Diver and ROV operable connectors.	
		Yes	No
Breathing gas	Note. Until new standard for emergency connectors has been established, connections shall be in accordance with IMO requirements (Ref. 2.17) and NPD (Guidelines to regulations relating to manned underwater operations §28)		
Hot water			
Depth			
Communication			
Emergency power			
O_2 NB: HRV only			

7.2.4.4 Micro-biological control
Water traps for gas reclaim shall be designed for simplicity of cleaning, disinfecting and drying.

7.2.5 Locking mechanisms

Any pressurised lock, container or accompanying equipment under pressure, where opening may entail danger to personnel, shall be physically secured so that unintentional pressure drop or injury to personnel cannot occur. Locking mechanisms are to be design so that correct position is ensured before the pressure is applied. The pressure in the unit, shall directly control the locking mechanism, ensuring that the unit cannot be opened unless the pressure is at ambient level.

7.2.6 Wet bell and diving basket

Wet bells and diving baskets shall be of adequate size, be equipped to cater for the number of divers intended to man them and be equipped for handling unconscious or injured divers e.g. Ref. annex A. 25.

Wet bells and diving baskets shall have an on-board gas supply for emergency situations. The minimum gas capacity shall be calculated as for diving bells.

A wet bell must contain equipment to monitor important parameters in all situations, such as depth, pressure of gas supply from surface, pressure of on-board emergency gas supply and length of diving umbilical in use.

7.2.7 Atmospheric diving system (ADS)

The ADS shall be designed, fabricated and tested in accordance with relevant standards. This shall be documented through certificates from a recognised classification society Ref. 2.16. Corrosion protection shall be implemented.

All materials, equipment and clothing used inside the ADS shall be non-flammable.

The ADS locking mechanism shall be designed to prevent accidental opening in any situation, including contact with external objects or forces, with maximum possible over-pressure inside the suit.

The ADS shall be equipped with a pressure relief system ensuring that the absolute pressure build-up inside the suit cannot become significantly higher than 100 kPa (1bar).

All penetrations of the hull shall be equipped with shut-off valves where it is practically possible.

The emergency facility of the ADS shall be capable of maintaining vital functions for 48 hours.

7.2.8 Submerged habitat

It shall be possible to rescue personnel from a submerged habitat even if the normal access cannot be used.

The habitat shall provide a dry and safe working area for the divers, shall be equipped with an adequate number of breathing masks (see 7.2.1), and should include a non-contaminated compartment.

Habitats shall be designed to make complete flooding impossible, leaving sufficient gas volume to allow personnel to dress into survival equipment and to allow personal occupancy in an emergency situation.

It shall be possible to close all pipe penetrations both internally and externally.

Habitats shall be equipped to maintain vital functions, for a minimum of 48 hours, when primary supplies are not available, and have an outside panel for emergency connections including gas, heat and communication. Connectors shall be in accordance with recognised standard. (see 7.2.4.3).

Entrances and exits should be clearly marked in order to allow easy identification.

7.2.9 Control room

In the design of control rooms, attention shall be given to ergonomic matters such as communication and a systematic arrangement of equipment, according to a documented traffic flow chart. Further, it should be ensured that noise or other disturbance to work does not occur.

It shall be possible to carry out work and to communicate effectively in the control room even if there is no normal breathable atmosphere in the room. Release of dangerous quantities or mixtures of gas from chamber or gas plant shall never take place in the control room.

7.3 Handling systems (bell, wet bell, basket and ADS)

The handling system for diving bell shall include means of safe guidance of the bell through the surface of the water, such as a moon-pool cursor or a bell cursor tower system.

The handling facility shall be secured against uncontrolled pay-out as a result of technical failure of the system. This normally implies that the facility should be equipped with automatically applied mechanical breaking devices providing primary and secondary protection. Furthermore the facility shall be equipped with limit switches preventing the handling of the bell/ wet bell/ basket/ ADS outside the handling area.

The design load for the facility shall be calculated on the basis of maximum static and dynamic loads, which may be expected under specified maximum operational limits. The design load shall be at least twice the maximum static load.

The main lifting wire shall be calculated using a safety factor of at least 4.0 related to the maximum design load.

In the case of cross hauling, such equipment shall fulfil the same requirements for strength as the rest of the handling system.

Umbilical shall be handled by a system compatible with the system handling the diving bell.

Bell and guide-wire winches used for dry transfer into a habitat shall include a heave compensation/ constant tension system.

Where direct visual monitoring of the winch drums from the winch control station is not practical, TV monitoring shall be fitted.

Primary and emergency lighting in all critical handling areas shall be provided.

Records shall be maintained of umbilical and wire cut-backs, re-termination, end-for-ending and replacements.

The main handling facility shall be operable even if essential components such as a power source or a winch motor is out of action.

An alternative handling system shall be provided and shall comprise a dedicated system ready for immediate use, with the capability to bring the device back to the surface and into position to be connected to the chamber complex in the event of the main handling facility being out of action.

The alternative handling system shall comply with the same requirements for load strength as the main handling system.

Guide wire equipment may, in addition to functioning as an alternative handling facility, ensure a controlled movement of the device in the water and may also provide an arrangement for stopping the device in the event of failure in the primary lifting wire.

7.3.1 Special requirements for ADS handling systems

The ADS shall be locked to a device ensuring safe and quick transit through the surface of the water during both launch and recovery.

This device shall comprise a TMS (tether management system) designed to enable the ADS to leave and re-enter the device in a safe manner. The TMS shall have a positive locking system, and shall be operable independent of the ADS pilot.

If operated from a vessel, the handling system shall be equipped with a heave compensation system. Static and dynamic calculations demonstrating the performance of the system shall be available.

7.4 Hyperbaric Rescue Vessel (HRV)

Facilities for saturation diving shall have equipment for adequate work-site evacuation of all divers under pressure.

HRV(s) shall be capable of being launched in situations when normal power supply is unavailable. An HRV shall withstand the stresses it may be subjected to in connection with handling, and shall have equipment enabling safe and efficient handling out of the water. It shall be equipped with lifting appliances/towing arrangements corresponding to the relevant recovery procedures. The HRV should comply with Ref. annex A. 26.Operational procedures for HRV(s) shall contain information regarding limitations in launching, towing and lifting operations, etc. relevant to different weather conditions according to Ref. 2.17.

Control and monitoring of the HRV(s) compression chamber environment shall be from the outside and it shall be possible to lock materials in and out. When connected to the chamber complex on board the work-site, the control and monitoring shall be performed from the saturation control room.

The HRV shall be capable of maintaining an acceptable environment for a minimum of 72 hours or until the personnel can be brought to safety. It shall be capable of sustaining vital functions even if primary HRV power supply is not available.

The HRV shall have its own propulsion facility, which shall be capable of functioning for at least 72 hours. It shall be reasonably powered and strengthened for its size and mass when fully equipped and manned. It shall further contain equipment for oral communication with other craft, e.g. a two-way marine VHF radiotelephone.

The emergency connector panel shall be accordance with the standard for diving bells. A connector for O_2 supply is also required (see 7.2.4.3).

In case the HRV crew has to leave the HRV, it shall be possible to secure the chamber system in a way that makes it possible for the divers inside to take over the control of O_2 make-up and gas supply.

Additional/ emergency life support equipment for the contractor shall provide the HRV. The contractor shall ensure that the equipment is properly maintained and ready for use at all times during MUO.

The Life Support Package (LSP) shall be kept at a suitable location from where it can reach the HRV within reasonable time. Risk analysis shall be performed for verification. Compatibility of the LSP to the HRV shall be verified.

Procedures for use of the LSP shall be included in the contingency plan and shall be available with the LSP and inside the HRV.

Relevant emergency procedures shall be available in the HRV chamber, the HRV control and with the LSP according to Ref. 2.17.

7.5 Gas supply systems

The gas supply installation shall ensure correct and adequate gas supply during normal operation and in emergency situations. The installation shall have at least two independent sources of supply to the user. There shall be two independent sources of gas supply to each section of a chamber complex where people may be staying if the sections can be isolated by pressure.

The installation shall be marked according to Ref. 2.20 and Ref. annex A. 27. Each colour shall be as defined in the table on page 2 in Ref. annex A 28. The marking shall indicate the type of gas and its flow direction.

Where Ar is in use, the gas cylinder shall be coloured grey with dark green shoulder. Where working air (not for breathing purposes) is in use the gas cylinder shall be coloured bright green.

All gas cylinders shall be clearly marked in writing.

Gas cylinders, quads or pipe work containing a pressure in excess of 200 bar shall be specially marked at the outlet connection point and at control panel connection points.

Two independent supplies are required to the gas panel supplying the gas to the main umbilical. One supply shall be dedicated as emergency supply and shall be activated if the downstream gas analyser to the diver gives an alarm signal and/or the supply pressure drops below set values. The pre-set pressure on the emergency gas supply shall be lower than the main supply.

The bell-man shall have easy access to operate the gas panel in the diving bell. It is recommended that no more than two operations shall be required in order to activate the spare onboard gas supply in the event of a failure in the main supply.

When a leakage in enclosed spaces may produce a hazardous atmosphere, equipment giving necessary warning of the hazardous condition shall be installed.

O_2 and gases representing a fire or explosion hazard shall be stored in a suitable place. The pressure of supply pipelines from the place of storage shall be as low as possible. The routing of such gas lines shall be given special attention, regarding the effects of any possible leakage. Mixtures of gas where O_2 represents more that 25% shall be treated as pure O_2 with regard to fire and explosion hazard.

Suitable materials and components shall be used for transportation of the appropriate gas mixtures at the relevant pressures. Use of flexible hoses shall be reduced to a minimum.

Inert gases used in support of diving operations, must contain a minimum O_2 content of 2% unless special arrangements have been made to prevent that pure inert gases can be fed to the breathing gas lines.

There must be an O_2 analyser fitted with audio and visual hi/low alarm on the downstream gas supply to the divers.

Where a diver gas reclaim system is used, a CO_2 analyser with audio and visual low alarm must be installed into the down-stream diver gas supply.

Reclaimed chamber gases shall be analysed for O_2 and other possible contamination prior to their re-use.

7.6 ADS life support systems

7.6.1 Oxygen system

The O_2 reservoir shall contain enough O_2 to sustain the life of the pilot for at least 54 hours.

The reservoir must be arranged so that the accidental emptying of one of the bottles into the suit does not raise the internal percentage of O_2 in the suit to a level that is hazardous to the pilot.

The O_2 pressure shall be reduced at the reservoir, to a pressure that is high enough to ensure efficient mixing, but low enough to ensure against the dangers of high-pressure O_2. No high-pressure O_2 shall enter the pressure hull.

An automatic O_2 injection system shall be installed, which injects O_2 in the right amount relative to the actual O_2 consumption of the pilot.

A manual override shall be installed on the O_2 injection system, enabling the pilot to control the O_2 content of the suit.

7.6.2 Carbon dioxide scrubbing

The CO_2 scrubbers shall be designed so as to ensure effective scrubbing of the gas in the entire suit.

They shall contain enough scrubbing material to keep the CO_2 partial pressure in the suit within acceptable levels for 54 hours.

The electric motors and the scrubber fan assembly shall be designed so as to prevent sparks from occurring.

7.6.3 Other gases

The atmosphere during the 54 hours survival period shall be documented to be within accepted TLV values with regards to other gases according to Ref. 2.11 and Ref. annex A. 11 or equivalent.

7.7 Systems for thermal balance

Facilities for MUO shall be equipped to maintain thermal balance of personnel engaged in the operation, so that functional capability is maintained within safe limits. For surface orientated diving and ADS operations where active heating may not be available, it shall be possible to compensate for this and ensure that persons working under water maintain the correct thermal balance.

7.7.1 Normal operation

The environmental control system of chambers, bells and habitats shall have the capacity to control temperature variations due to compression and decompression, and to maintain any selected temperature between 22° to 33°C at all relevant operational depths for which the system is certified. The temperature control for divers in the water and the atmosphere of chambers, bells and habitats shall be sufficiently accurate to ensure thermal balance and comfort for the divers/ occupants at all times.

The environmental control system for ADS shall have the capacity to maintain the internal temperature of the ADS at a comfortable level for all relevant physical activities of the pilot(s). The comfort temperature shall be maintained independent of surrounding water temperature.

For wet diving the divers shall be equipped to avoid excessive heat loss from the body surface and through the respiratory system for the whole period in water. Active heated suits shall be used whenever necessary to maintain thermal balance, comfort and efficiency.

Active breathing gas heaters are to be used when diving deeper than 150 msw.

The actively heated suits shall have a thermal control system preventing local burns or local cooling.

7.7.2 Emergency systems

A survival system for diving bells and habitats shall be installed in accordance with Ref. annex A 29, with capacity to maintain the thermal condition in the system, within the limits required. The survival system shall ensure the occupants' safety for the duration of the rescue operation, and in a physical condition where they could contribute in the rescue, for the time required performing the rescue operation. The minimum capacity of these systems shall be in accordance with 5.2.2.2.

The effectiveness of the ADS survival equipment shall be such that thermal balance, or at least a non-critical thermal situation, is ensured for a minimum of the planned operation time plus 48 hours.

7.8 Breathing apparatus (BA)

7.8.1 General

The BA, including bail-out system, stand-by diver system, welders’ masks and BIBS, shall fulfil the requirements and recommendations according to Ref. 2.21 and e.g. annex A.30.

BA shall have individual documentation providing information on the history and the status of the equipment.

Microbiological monitoring/control of BA shall be performed on regular basis.

7.8.2 Stand-by diver system

The stand-by diver’s BA shall be so designed that the diver can dress himself and enter the water, without assistance, within one (1) minute.

The stand-by diver’s BA shall have adequate quantity of breathing gas from a dedicated bank on the diving bell (see 7.2.4.2). The stand-by diver’s BA gas supply shall be separated from the diver’s gas supply.

7.8.3 Bail-out system

The bail-out system shall be ergonomically adapted to the primary system, and it shall be possible to activate with no more than two operations. When a diving bell is used the bail-out system shall be designed to ensure easy entrance.

During diving operations the emergency gas supply shall be capable of providing breathing gas for a minimum of 10 min based on an average consumption of 62.5 l/min, calculated according to the ambient pressure.

7.8.4 Welding mask

The design of the welder's mask shall ensure that atmospheric contaminants within the habitat do not penetrate into the welder's respiratory system (i.e. over-pressure in the mask).

7.9 Diver/ADS umbilical

The umbilical shall:

- be designed so that it will ensure necessary supplies to the personnel;
- provide necessary transmission of communication;
- be sufficiently strong to allow personnel connected to it to be brought to safety.

The divers umbilical shall in addition be marked as follows.

5 meter: Red ring around the umbilical
10 meter: Black ring around the umbilical
50 meter: Wide black ring around the umbilical

(i.e. 15 meter are marked with 1 red and 1 black, and 45 meters are marked with 1 red and 4 black.)

Supply and communication on-lines shall not be subject to loads, which may entail failure during operations.

7.10 Tools

No tools shall be used that can cause harm to the user under predictable conditions, provided that proper procedures are followed for operation and maintenance.

The divers shall adjust weight and buoyancy of diver hand-held tools to ensure efficient handling .

All power tools shall have control systems that automatically isolate or divert the power, when the diver releases the operator handle.

Detailed procedures for the operation of any underwater tools, with emphasis on the safe operation of the equipment in conjunction with diving operations, shall be available. It shall be possible to carry out function tests of the underwater tools on deck or in shallow water.

7.11 Diving support vessel

7.11.1 General

The diving support vessel shall be classified by a recognised classification society for vessels (Ref. 2.15 or 2.16), and conform to Ref. 2.3.

7.11.2 Diving from small craft

7.11.2.1 The diving craft

The diving craft shall comply to relevant parts of standard (Ref. annex A. 31 and Ref. annex A. 32).

7.11.2.2 The support vessel

The support vessel for small craft diving operations shall be equipped with facilities for providing efficient assistance to the diving craft when required (Ref. annex A. 31. or equivalent). If the support vessel is an active part of the diving operation (i.e. used as mooring etc) it shall conform to Ref. 2.3.

7.12 Monitoring and control panels

Control and monitoring panels shall be designed in accordance with Ref. 2.7.

Controls and panels shall allow efficient supervision of the operations.

Parameters being monitored shall be displayed with appropriate units and a suitable scale. Standard metric units shall be applied.

All instrumentation shall allow easy viewing and shall be clearly identified and labelled in English and/or other relevant language.

7.13 Communication system

Communication shall be provided between divers in water/ bell/ habitat and chambers and to their relevant supervisor. The supervisors shall have the possibility to control all communication to and from the divers under their supervision.

Two independent main systems shall be installed for efficient communication between personnel engaged in MUO and the dive operation control room. An alternative facility for communication between personnel working below surface and the operation management shall also be provided. This facility shall be independent of the main communication systems.

The above requirements for two independent systems do not apply to the communication links in divers' umbilical.

In addition to hardwired communication lines between the surface and personnel positioned under water (diving bell, submerged habitat, ADS), equipment shall be provided based on wireless communication ("through-water-communication").

The communication system shall provide the possibility for all relevant parties to call the attention of those engaged in the operation.

The communication system for divers in both water and hyperbaric chambers shall be tested for intelligibility, under as realistic operational conditions as possible, with a "Modified Rhyme Test" and fulfil the requirements for operational communication systems in accordance with Ref. 2.22 and e.g. Ref. annex A. 18 or equivalent. Means for processing of speech (unscrambling) shall be installed when using helium mixtures. These requirements apply to diver's helmets, bells, chambers, habitats and between divers in water. Communication other than verbal may be acceptable for emergency communication, provided sufficient quality.

Switching of communication channels shall be possible so that all persons who need to communicate have the possibility to do so; uninterrupted and independent of other communication channels. The panel containing the communication system shall be arranged in a logical and ergonomic manner. A traffic flow matrix of the system shall be documented and available on board.

7.14 Fire protection

Facilities for MUO shall have fire fighting equipment capable of covering the entire plant both internally and externally. The equipment shall have adequate capacity to put out fires that may occur. There shall be facilities to control the temperature in the chamber complex during an external fire. The above includes the HRV`s and the HRV launch areas.

7.15 Remotely operated vehicle system used in conjunction with MUO

ROV s used in connection with MUO shall conform to Ref. annex A 33. or equivalent.

7.16 Water supply

The fresh water supply system (potable water) should be designed to tolerate weak acidification of the water (alkalisation will favour growth of infection-causing microbes).

Disinfecting by UV (Ultra Violet) demands extra filters prior to UV-radiation.

Evaporation of fresh water shall not be performed in close vicinity of oil platforms or other installations at sea.

A specific and customised microbiological examination of the fresh water supply to saturation chambers, prior to initial pressurisation of the system, and regular microbiological testing for coliform bacteria, shall be performed of the fresh water.

Specific and customised microbiological examination of hot water to suits prior to saturation operations shall be performed. Seawater to the divers hot water supply shall be disinfected to minimise skin infections. The filtered seawater should either be heated to 90-100 ^{o}C, or exposed to UV-radiation.

7.17 Maintenance

Facilities and equipment for manned underwater operations shall be maintained in accordance with a planned maintenance programme. This programme shall be based on design, construction and operation. Test conditions for components and the facility in general, shall be specified.

The maintenance programme should describe necessary maintenance and planned testing of single components or entire plants, and shall be based on manufacturer’s recommendations and the contractor’s experience of component wear and tear. The maintenance programme shall seek to avoid unforeseen equipment malfunction through routine checking and changing of components.

Maintenance records must be kept.

Critical equipment being maintained and/or repaired on board, shall be tested and verified to meet requirements (i.e. from classification societies) after maintenance/repair has been carried out and prior to use.

The technically and operationally responsible personnel shall perform modifications on the system, part systems or components, in accordance with a modification procedure, involving acceptance of the modification. All modifications shall be documented and included in the as-built documentation.

7.18 Testing and verification

Components and facilities for MUO shall be tested during fabrication and operation in accordance with the recognised standards to which the facility has been designed.

Functional tests shall be carried out on all components that are used or that may be used during normal operation and in emergency situations.

Vital functions shall be checked immediately prior to the commencement of the operation, as well as during the actual operation.

If visual inspection discloses conditions that may reduce the quality of the facility, further investigation shall be carried out. Measures shall be taken in order to ensure adequate quality of the facility.

In the event of failure during operation, the component and the plant in question shall be functionally tested after repair. Also following modifications, necessary testing shall be performed to verify the proper function of the system.

For intervals and detailed methods of testing see Ref. annex A. 18 and annex A. 19.

When new equipment is developed for MUO, tests shall provide the basis for the evaluation as to whether the equipment shall be deemed safe for use in operations.

8 OPERATIONAL REQUIREMENTS

8.1 Planning and execution

8.1.1 General requirements

Detailed operational procedures covering the planning, preparation, conduct and reporting of a MUO shall be available. The operational procedures shall be accessible to all persons involved in the MUO.

Documentation necessary for the safe implementation of the operation, including laws and regulations, shall be kept up to date and easily accessible at the diving location.

During MUOs all data relevant to the operation shall be recorded in an operation logbook. The log shall be signed by the person in charge of the operation and shall be kept for at least 2 years after the last entry.

8.1.2 Responsibilities

8.1.2.1 Management on installations and vessels

It must be ensured that other activities will not endanger those who are engaged in the MUO. Furthermore it must be ensured that information concerning matters that may affect safety is passed on to the operation management and to the shift management.

The vessel's master (captain)/ installation manager has the overall responsibility for the safety of all personnel on the work-site and the operation as such.

The chief engineer has the overall responsibility for the technical status of all plant and equipment integrated in the vessel/installation.

The electrician at the work-site shall be considered the overall electrical co-ordinator. In this function he is entitled to request documentation that all electrical equipment brought on board, is properly certified and maintained, and that all personnel working on electrical circuits are properly qualified.

8.1.2.2 Operation management

The diving/ADS superintendent shall carry out operation management. In operations with more than one shift per day, a dedicated superintendent other than the supervisors, shall manage the team.

The operation management shall be responsible for the implementation of the MUO, and may, in consultation with and with the consent of the shift management, commence an operation. All relevant parties have the right and the duty to halt operations in the event that the activities are not conducted in a safe manner.

If there is no operation management, the shift management shall assume the duties of the operation management.

The diving/ ADS superintendent has the overall responsibility to ensure that the activities are carried out in accordance with current laws, regulations and applicable procedures. It is the superintendent's responsibility to ensure that all personnel are qualified and familiar with current laws, regulations, procedures and equipment applicable to the operation.

8.1.2.3 Shift management

Shift management is carried out by the Diving Supervisor. The Diving Supervisor shall have the responsibility for the safe conduct of diving on his shift.

A MUO may only be commenced if the Diving Supervisor agrees. The Diving Supervisor is responsible to ensure that the necessary equipment is available and that laws, regulations and procedures are complied with.

8.1.2.4 Operation management of chamber complex

The life support supervisor shall be responsible for the safe and proper operation of the chamber complex.

8.1.2.5 Working environment committee

The contractor shall have a working environment committee system for the diving activity complying with relevant acts and regulations.

The working environment committee members shall receive the necessary training to perform their duties in a satisfactory manner. Time shall be allocated so that the members can perform their duties satisfactorily, preferably within their working period.

The working environment committee shall focus on items relating to safety and working environment. Reported accidents and near misses shall be evaluated. The working environment committee shall have an advisory function and shall recommend necessary preventive measures.

If the working environment committee members are unable to reach an agreement, the various views shall be recorded and resulting decisions taken at management level. The members shall sign the minutes of meetings, and a copy shall be supplied to the operator's representative.

8.1.2.6 Personnel subject to hyperbaric conditions or work under water

The divers and pilots of ADS shall keep a personal logbook and hold this in safekeeping for at least two years after the last entry. The line management shall verify the logbook.

Work under water and stay under pressure shall only be carried out if the diver feels fit to do so.

Operations shall be suspended if any person finds that safety has not been satisfactorily ensured.

8.1.2.7 Technical work

All technical personnel involved in maintenance of the diving plant and equipment shall be familiar with the applicable procedures. The operation and shift management shall at all times be familiar with the status of the plant and equipment in use. Technical personnel shall adhere to the procedures for approval of alterations of the plant and equipment.

8.1.3 Mobilisation / demobilisation

A mobilisation shall be carried out in accordance with a defined mobilisation plan. When the contractor considers mobilisation to be completed, notification shall be submitted to the operator for acceptance.

A demobilisation shall be carried out according to a defined demobilisation plan.

8.1.3.1 Mobilisation of personnel

The contractor's system for mobilisation of personnel shall ensure that all personnel employed by the contractor meet their job requirements, and are familiar with and trained in carrying out their regular assigned duties and any special procedures related to safe execution of the work.

The mobilisation plan must ensure that time is available for an effective familiarisation of all personnel.

8.1.3.2 Familiarisation training

Familiarisation training shall include all diving/ ADS personnel, and shall be conducted in accordance with a specified programme defining time schedules and content.

The programme shall be adapted to the level of previous knowledge of the work-site and work tasks of the individual participants. Familiarisation training shall be documented and verified.

8.1.3.3 Supervisory personnel

All offshore supervisory personnel shall be allowed adequate time for familiarising with contract specifications, job procedures and current regulations. They shall also be familiarised with, and in agreement with, the documented risk analyses performed and the resulting risk reducing measures.

8.1.3.4 New personnel

New personnel being mobilised during the operation shall receive a familiarisation of the same standard as those taking part in the initial familiarisation programme.

8.2 Diving procedures

The contractor shall use verified procedures that will prevent decompression sickness and any other harmful effects according to Ref. 2.23. Procedures shall be such as to avoid extraordinary strain and discomfort for the personnel. Treatment and -emergency tables shall be established.

Procedures shall be based on recognised standards. Contractors shall substantiate the efficiency and reliability of diving tables by maintaining track records for the procedures, and by systematically analysing these records as part of their system for experience feedback. The contractor shall prepare statistical material in order to evaluate the quality of the procedures.

Decompression procedures shall allow for therapeutic treatment to be carried out without increased risks for involved personnel.

8.2.1 Surface oriented diving

Diving tables in accordance with Ref. 2.24 shall be used. See also Ref. annex A. 34.

Diving that requires decompression stops shall not be planned when diving from small crafts (“flipper diving”). Further operational recommendations are given in Ref. annex A. 31 or equivalent.

8.2.2 Saturation diving

8.2.2.1 Compression

Compression rates issued in Ref. 2.23 shall be used. In this reference, the reference to (OD 1990); E. “Threshold values for gases” shall be ignored. Instead the text of 5.2.3 in this NORSOK-standard shall be applied. The stand-off periods shall not take place more than 1 msw shallower than the planned living depth. The ambient pressure and established diurnal rhythm shall be taken into account in the evaluation of when personnel are ready to start work.

8.2.2.2 Decompression

Decompression shall be performed in accordance with verified procedures aiming to avoid decompression sickness and other negative short or long term health effects on the divers. Decompression rates issued in Ref. 2.23 shall be used.

8.2.2.3 Excursions

The contractor shall prepare procedures for excursions. Procedures issued in Ref. 2.23 shall be used. As a minimum, the procedures shall define:

- living depth;
- working depth;
- limitations of excursion after change of living and/or working depth;
- maximum rates for compression and decompression during excursion;
- maximum pressure increase and decrease during the excursion.

It is of special importance to restrict the use and distance of upward excursions.

The maximum rate for decompressions during excursion: 10 msw/min.

8.2.2.4 Living depth

Dive planning shall be based on minimum change of living depth and excursion exposures.
The living depth shall be as close to the working depth as possible, based on a total evaluation of all safety aspects.

It is possible to carry out living depth changes, but it is not allowed to compress, decompress, and recompress.

8.2.3 Deep saturation diving

For diving at depths of more than 180 msw, special attention must be given to compression and decompression procedures. Compression shall be performed according to Ref. Annex A. 35 , and decompression shall be performed according to Ref. annex A. 36.

Tests for HPNS symptoms shall be performed, according to Ref. annex A. 37.

8.3 Monitoring

8.3.1 General

All diving systems shall have equipment allowing monitoring of important parameters and conditions. There shall be primary and secondary systems for monitoring of parameters, to verify that a correct atmosphere is maintained.

Location of monitoring equipment sensors shall be arranged so as to give time for corrective measures before any reduction of the safety of personnel is incurred. Monitoring equipment shall be designed to allow the setting of limit values and so that alarm signals are given when measured values exceed certain defined limits.

8.3.2 Monitoring of parameters

An on-line system shall be used for recording of diver, ADS, bell, habitat and chamber parameters. Sensors for depth monitoring shall be located on the bell and on the diver.

The following parameters shall be measured, displayed and logged on a continuous basis:

- Time;
- Divers/ADS depth;
- pO_2 and pCO_2 in the divers/ADS breathing gas;
- Hot water temperature and flow to the bell;
- Bell internal and external pressure;
- Bell internal pO_2, pCO_2 and temperature ;
- Chamber internal pressure, humidity, pO_2, pCO_2 and temperature;
- ADS O_2 supply bottle pressure;
- ADS suit temperature, pressure and humidity;
- Habitat internal and external pressure;
- Habitat internal pO_2, pCO_2 and temperature.

For diving deeper than 200 msw the following parameters shall in addition be measured, displayed and logged:

- Hot water temperature at the divers suit;
- Bell hot water temperature and flow to the diver at the bell.

The following substances shall be monitored and logged on a routine basis:

- Potentially toxic gases in the hyperbaric environment;
- In habitat when welding : CO, Ar, NOx, O_3, fumes, dust (not required on-line);
- Bacterial growth/content in all critical places.

8.3.3 Visual monitoring

All chamber compartments, bells and habitats shall be equipped with video monitoring equipment, enabling the surface support crew to visually monitor the occupants and relevant operations.

The ADS shall be equipped with a video-camera enabling the ADS supervisor to visually monitor the area in front of the suit. The suit shall be equipped with ample lighting for illuminating the work area and for relocating purposes. A battery operated strobe light shall be fitted to the suit. The pilot shall easily view all monitoring equipment in the suit.

Before deploying a bell near structures, inside another vessel’s anchor pattern, etc., the work-site shall be visually checked by an ROV.

When a diver is in the water, an ROV or diver carried camera shall be used to visually monitor the diver and the operation. Videotapes shall be kept for at least 24 hours.

8.3.4 Recordings during operations

Recordings of communication with diver in water/bell/ basket/ wet bell/ habitat shall be made during every MUO. Recordings from the last 12 hours shall be available and shall include the check of equipment and personnel prior to the commencement of the operation.

In case of accidents or serious near incidents, recordings of communication and video tapes shall be kept and made available for eventual later investigation.

8.4 Provisions regarding time

8.4.1 Stay at working depth

During saturation diving stay at working depth shall not exceed 14 days. For diving deeper than 250 msw this stay shall not exceed 10 days.

The planning shall take into consideration the strain that the divers will be exposed to during the operation when the time period for stay at working depth is determined. The strain on the divers shall be continuously considered during the operation with regard to whether a shorter period should be applied. It is a prerequisite that the total length of stay under pressure is the subject of discussions with the representatives of the personnel including safety delegates.

8.4.2 Time between saturation periods

The time between saturation periods shall at least be equal to the duration of the preceding saturation period. In the case of diving deeper than 250 msw the time between saturation periods shall be at least twice the duration of the last saturation period.

8.4.3 Bell run

Maximum time for a bell run is 8 hours for ordinary saturation diving, and 6 hours for diving deeper than 200 msw. Workloads shall be assessed during planning of the diving operations, and if applicable a shorter bell run may be chosen. If the divers request that the dive should be suspended before the maximum permissible time is up, this shall be decisive. Timing of bell run duration starts when the clamp is first taken off.

8.4.4 Time in water

Continuous time in water during a 12-hour period shall not exceed 4 hours. For diving deeper than 200 msw this shall not exceed 3 hours.

Reports from the divers with regard to work conditions, need for rest period and/or suspension of the dive will however normally determine the length of stay in the water, up to the maximum time stipulated.

During bell diving, the divers who have been in the water from the beginning of the dive will normally be assigned as standby divers for the one or ones to follow on for work outside the diving bell. The standby diver shall be ready to give immediate assistance to the diver in the water and therefore has to be physically capable of carrying out this task. This must be taken into account when deciding the time period the diver is to stay in the water.

During bell diving shallower than 200 msw, using 3 man bell-runs, the total time in water during a 12 hour period can be extended to 6 hours (see definition of time in water, bell diving) on the following conditions:

- Divers shall return to the bell and take off his mask for a minimum 20 minutes break after approximately 3 -4 hours to ensure fluid balance.
- The break in the bell to be logged;
- Each diver shall be given a dry day as bell-man every third day.

8.4.5 Time limit for diving/ ADS supervisor

The diving/ ADS supervisor shall have a rest period from the direct communication control after a period of 4 hours. The total time for this function shall be limited to 8 hours in the course of a 12-hour period. Such a rest period should normally not be less than half an hour. The workload should determine the length of the rest period. Inside a 24-hour period supervisory personnel should normally have a 12-hour period of continuous rest.

The direct communication control can be assigned to a trainee diving supervisor, provided the diving supervisor supervises the trainee.

8.4.6 Operational time for manned submersible craft

An ADS manned by one person shall have a maximum operation time in water of 6 hours. If manned by more than one person, the maximum operation time in water is 8 hours.

In the case of larger, autonomous ADS operating independently of support vessel on the surface, the time limits stipulated above will normally not be applicable.

8.4.7 Time in submerged habitat

The bell run shall not exceed 8 hours. When a breathing mask is used continuously, the personnel shall have a rest period after 4 hours in a safe atmosphere without using a breathing mask. This break shall normally not be less than half an hour.

8.4.8 Daily rest period

A continuous work free period of at least 12 hours shall be included in any 24 hours period for personnel working under water or under increased ambient pressure. Work and rest periods shall be specified in a shift programme and shall be planned at regular hours.

In the case of unforeseen and extended delays in diving operations, the need for minor changes in the original shift plan may be considered. If changes are to be made, the parties involved including representative of the personnel and safety delegate shall approve them.

Surface personnel carrying out support functions for the manned underwater operation, and whose work has an influence on safety during the operation, shall have at least 8 hours continuous rest period during the course of a 24 hours period.

8.4.9 Observation time following completed diving operation

After a completed saturation period, divers shall have immediate access to therapeutic re-compression for a minimum of 24 hours. In the case of surface oriented diving divers shall have immediate access to therapeutic re-compression for a minimum of 12 hours following a completed dive.

Limitation regarding flying after diving shall be regulated in relevant diving tables in accordance with Ref. 2.23 and 2.24.

8.5 Operational measures

8.5.1 Manning of control room

During operations at least two qualified persons shall be present in a control room attending to the safety related functions. For short periods (e.g. in connection with meal breaks) at least one competent person in addition to one qualified person shall be present in the control room. Ref. annex B.

8.5.2 Depth limitation

Surface oriented diving shall not be carried out at depths exceeding 50 msw.

When deeper than 20 msw a wet bell/diving basket shall normally be used. If a wet bell or a diving basket is not used, efficient measures shall be implemented to ensure the safe recovery of the diver from the water.

When diving deeper than 50 msw a diving bell shall be used.

8.5.3 Surface decompression chamber

For all surface oriented diving operations a compression chamber shall be ready for use. It shall be possible for the diver to reach maximum depth in the chamber within time limits as specified in diving tables.

8.5.4 Tendering the diver’s umbilical

Diver’s umbilical shall at all times be under supervision of a tender. The height from the water surface to the tender’s surface work position shall not exceed 5 meters.

8.5.5 Standby diver/contingency diver

At depths shallower than 20 msw the standby diver may be located at the surface, provided the location is less than 5 meters above the water level.

At depths deeper than 20 msw the standby diver shall be located below surface in suitable position in water/bell/wet-bell/basket.

During every diving operation a contingency diver shall be appointed and located at surface. Necessary equipment shall be ready for use. For diving from small crafts, the contingency diver can be located on board the mother vessel.

8.5.6 Length of diver's umbilical

The length of the diver's umbilical shall not exceed the length considered necessary at any given time, normally limited upwards to 45 meters.

Dispensation for longer umbilical has to be granted by the parties involved including representatives of the personnel, safety delegates and authorities where required. A risk analysis shall be performed.

When determining maximum umbilical length, the following hazard points should be taken into consideration:

- The distance from the diver to the nearest hazard point (thrusters, sea water intake etc.) should be at least 5 meters;
- Duration of bail-out equipment;
- Breathing resistance;
- Thermal conditions;
- Umbilical storage, deployment, handling and recovery;
- Wet tendering;
- ROV survey with mapping of debris/ obstructions;
- Positioning and stability of the work-site;

The stand-by diver's umbilical shall be at least 3 meters longer than the diver's umbilical, and any use of an extended umbilical shall be logged.

8.5.7 Operation from a dynamically positioned vessel

Specific safety measures shall be taken in the planning and implementation of MUO carried out from dynamically positioned vessels according to Ref. 2.2, 2.3, 2.25 and Ref. annex A. 6 or equivalent.

The operational manual for the DP vessel shall include an up-to-date description of the diving system(s) and guidance on the conduct of diving operations as they may be affected by the DP vessel itself. Procedures shall comprise:

- actions to be taken in case of changes in alert level status;
- operations of divers in enclosed spaces and free flooding;
- precautions to guard against thruster wash or suction effect;
- surface support and down-line handling;
- preparations and use of emergency plans;
- moving vessel.

Communications between the dive control position and the DP console shall be regular and frequent. Each watch-keeper shall inform the other about any change in operational circumstances that occurs or that is planned. The operation manual shall give guidance and procedures concerning the transfer of information, along with a description of the communication systems and alarm systems available, and shall define the meaning of commonly used terms, particularly where they refer to emergency situations.

If surface oriented diving is performed from a DP vessel, very great care is needed in the planning and execution to minimise the effect of thrusters on the divers. The effects shall be carefully considered and precautions taken to guard against them, especially when the bell or divers pass through the splash zone. Diver umbilical lengths, and the manner of deploying them, shall be chosen so that divers and their equipment are restrained from contact with thrusters and from being affected by their wash.

A DP audio-visual slave alarm shall be installed in the diving control rooms.

8.5.8 Operation with manned submersible craft

ADS shall be equipped according to the planned operation time. Necessary measures in order to bring the personnel to safety in emergency situations shall be taken.

8.5.9 Welding process

During the welding process the divers shall use effective respiratory protective equipment.

If a diver must breathe the atmosphere in the habitat for shorter or longer periods after welding has started, it shall be verified that the atmosphere is within required limits prior to the diver removing his breathing equipment.

8.5.10 Radioactive sources

National authority (according to Ref. 2.10) shall accept procedures for use of radioactive sources. Activation of radioactive sources when a diver is inside the habitat shall not be possible.

9 CONTINGENCY REQUIREMENTS

9.1 Contingency plan

Prior to the commencement of MUO a contingency plan shall be drawn up specifying the intended measures to limit the effects of accidents or hazardous situations in accordance with regulations (Ref. 2.26).

Risk analyses and a study of previous operations and accidents will normally constitute the basis for definition and scope of a contingency preparedness plan. Prior experience is an important element in these analyses.

Based on these processes of analysis, the measures intended to be implemented in the event of specific accidents or hazard situations shall be described. This will include the use of equipment, of personnel and of other resources.

The contingency plan for the specific project or operation shall be interfaced with the operator’s contingency plan for the relevant location and with the overall contingency plan applicable to the operator’s activities.

This contingency plan shall include an organisation plan showing the lines of communication, responsibility and reporting, as well as a description of equipment and procedures. Authority and responsibilities shall be clearly defined.

9.1.1 Emergency preparedness training

At the planning stage of a MUO the requirements for contingency training shall be assessed.

Prior to the start of the operations, all relevant personnel shall undergo training to ensure that they are conversant with and drilled in their tasks in connection with potential emergencies (Ref. annex A 17).

A programme for routine, repetitive training and drills in this respect, to ensure a high level of emergency preparedness shall be set up. This programme and its implementation shall be documented.

Personnel with medical duties in an emergency situation shall be trained according to Ref. 2.14.

9.1.2 Emergency preparedness equipment

Diving bell, submerged habitat and ADS shall be equipped to ensure that personnel can maintain vital functions in emergency situations, until it may be assumed that the personnel have been brought to safety.

When undertaking a manned underwater operation, means to effectively locate, assist and recover the bell/habitat/ADS shall always be available. Such means shall be an additional diving bell for depths exceeding 200 msw, or, for shallower depths, a large ROV capable of assisting units in distress, or additional ADS.

Diving bell, submerged habitat and ADS shall be equipped with a transponder, permanently fixed to the unit in question operating at a frequency of 37.5 kHz.

All units for manned underwater operations that may be called on to render assistance to units in distress shall have equipment to relocate a distressed unit.

An ROV may, for instance, provide connections for necessary supplies to emergency panels on diving bells and submerged habitats, or attach emergency lifting gear on to units that are unable to make use of ordinary facilities for recovery to the surface.

Emergency equipment shall have sufficient capacity to ensure that personnel may be brought to safety in the event of unforeseen emergency situations.

For ADS operations, the recovery systems ability to recover the ADS in a ‘worst case’ situation shall be demonstrated and documented. Personnel shall be available, in immediate readiness, to operate the back-up system.

Operations shall not be performed in sea - states exceeding 90% of the system’s capacity.

9.2 Contractor’s contingency centre

While in operation, the contractor shall maintain, in immediate readiness, a contingency room with adequate communication facilities, all relevant documentation and other necessary facilities for the contingency team.

9.3 Hyperbaric evacuation

9.3.1 General

In the event of an emergency it shall be possible to evacuate all divers under pressure to a safe place. This requires efficiency in the total evacuation procedure.

The contingency plan shall include a description of the procedure of hyperbaric evacuation, and of how to bring the persons to surface pressure.

The contractor's plan for hyperbaric evacuation shall be based on risk analyses covering the launch, stabilisation, recovery and normalisation phases of an evacuation.

9.3.2 Saturation diving

Saturation divers shall be evacuated to an evacuation unit and transported to a suitable place for decompression as quickly as possible.

The following phases shall be described in the contingency plan:

I. Transfer of divers to the evacuation unit, and launching of the unit;
II. The evacuation unit in the water, including a description of how the life support functions are planned to be maintained, where and how the rescue unit is to be moved and, if applicable, taken out of the water;
III. Evacuation unit taken under control and decompression of divers.

If there may be more than 18 bar (1800 kPa) difference in pressure between persons who are to be evacuated, it should be possible to maintain a difference in pressure during evacuation.

The time from the moment the last diver enters the evacuation unit until the unit is 100 meters away from the diving work-site, shall not exceed 15 minutes. The total period between notification of evacuation, with divers in the chamber complex, and until the time when the evacuation unit is 100 meters away from the diving platform, should not exceed 30 minutes. This includes the time required to bring the system to a pressure enabling transfer of all divers into the evacuation unit using emergency procedures as in Ref. annex A 38. or equivalent. This recommendation must be seen with reference to the time required to bring the divers to the same pressure using emergency procedures as in Ref. annex A. 38 or equivalent.

The selection of the HRV reception centre shall be based on an evaluation of the time it will take, under the prevailing weather conditions, to transport the HRV to the centre from the operational location, and the centre's proven capability to receive the HRV. Documentation of a successful HRV integration test for the type of HRV in question shall be available.

ANNEX A - REFERENCES (INFORMATIVE)

The references listed below gives recommendations for diving related equipment and procedures.

A.1 DMAC guidance notes and codes.

A.2 Elliott DH. Medical assessment of fitness to dive. Biomedical Seminars, Ewell England.

A.3 NUTEC report no. 20-94: Medical examination of deep divers.

A.4 STF-78 A99123: ”Cleaning and disinfection in operational systems – Recommended industrial standard”.

A.5 SINTEF report no. STF-23 A92015: FUDT - Bacteriology 1991. Disinfecting in hyperbaric environments.

A.6 NORSOK standard S-002 Design principles - Working Environment.

A.7 NPD report ISBN 82-7257-386-5 mars 1993: Menneske- maskin forhold i kontrollrom for bemannede undervannsopperasjoner i petroleumsvirksomheten.

A.8 NUTEC report no. 45-93: Procedure for testing for off-gassing from flexible hoses used for breathing gas.

A.9 NUTEC report no. 46-93: Procedure for general testing for off-gassing from materials used in diving systems.

A.10 American conference of governmental industrial hygienic (ACGIH) threshold limit values for chemical substances and physical agents and biological limits, ISBN 0-936712-92-9.

A.11 NPD report, OD-92-05: Report regarding hyperbaric threshold values for contaminants.

A.12 NUTEC report no. 27-95: Routine surveillance of chemical contamination of breathing gas in diving systems.

A.13 Diving at Work Regulations 1997. Approved code of practice. Commercial diving projects offshore. Issued by Health and Safety Commission, England.

A.14 HSE safety notes made in pursuance of the regulations.

A.15 Norges Standardiseringsforbund (NSF) NS 5814 Requirements for risk analysis including Sintef report STF 75 A91021 (ISBN 82-519-0970-8) -Guidance to NS 5814.

A.16 Guidelines for safety and emergency training, issued by OLF.

A.17 NPD report ISBN 82-72757-385-7 : Nød- og beredskapstrening for dykkepersonell.

A.18 SINTEF report no. STF-23 F95019: Handbook for testing of diving equipment.

A.19 IMCA DO18

A.20 DNV rules for certification of lifting appliances.

A.21 IMO Resolution A.649(16) Code for the Construction and Equipment of Mobile Offshore Drilling Units.

A.22 SINTEF report no. STF-23 A92011: Functional requirements for diving bell.

A.23 NPD report Januar 1993: Nødbatterier til dykkerklokke.

A.24 SINTEF report no. STF-23 F92027: Evaluation of theoretical calculations for thermal insulation of diving bells based on practical measurements.

A.25 NPD report YA-541: Luftklokkedykking (Air bell diving).

A.26 IMO A.692(17) Guidelines and Specifications for Hyperbaric Evacuation Systems.

A.27 IMCA guidance notes and codes

A.28 ISO 32 colour coding of gas system.

A.19 SINTEF report no. STF-23A91024: Specification of diver emergency system.

A.30 NUTEC report no. 11-95: Test programmes for diver’s breathing systems.

A.31 NPD report YA-545: Dykking fra lettbåt ("Flipper diving").

A.32 Nordisk Båt Standard for yrkesbåter mindre enn 15 m (Nordic Boat Standard for professional vessels shorter than 15 m).

A.33 OLF guidelines for ROV services.

A.34 NPD report YA-776 Standard dekompresjonstabeller for overflateorientert dykking.

A.35 NUTEC report no. 20-93: Compression procedures.

A.36 NUTEC report 36-92: Dekompresjonsprosedyrer for heliox metningsdykk dypere enn 180 msw

A.37 NUTEC report no. 21-93: HPNS screening.

A.38 NUTEC report no. 34-84: Time margins during hyperbaric evacuation.

ANNEX B - SELECTION CRITERIA FOR PERSONNEL ENGAGED IN MANNED UNDERWATER OPERATIONS (NORMATIVE)

All trainees undergoing diver training shall hold a valid certificate of medical fitness for diving issued by a medical practitioner approved for the examination of divers. Further, the recommended standard for participants of a bell diving course is that they are qualified as surface oriented divers with at least 12 months experience from commercial diving, including at least 50 hours bottom time (out of these at least 10 hours at depths exceeding 20 meters, including 6 hours at depths greater than 30 meters).

B.1 Surface Oriented Diver - training requirements (NORMATIVE)

B.1.1 Aim

The aim of the training shall be to enable the divers to carry out their work safely to a depth of (a) 30 meters using self-contained diving equipment, and (b) 50 meters with surface oriented diving equipment. Furthermore the aim is to provide the diver with the understanding and knowledge of basic skills required in order to complete various underwater tasks safely and efficiently.

B.1.2 Course syllabus

The following training is required for the issuing of certificates:

B.1.2.1 Hours theory:

1.	Diving physics	12
2.	Use of equipment	20
3.	Seamanship	8
4.	Diver communication systems	4
5.	Underwater tasks	10
6.	Underwater hazards	2
7.	Diving plant and equipment	7
8.	Compression chamber operations	
9.	Decompression	12
10.	Legislation, statutory instruments	4
11.	First Aid and Diving Medicine	16

Number of hours for theoretical training is intended as a guideline. The number of hours for item 8 is comprised in the number given for item 2.

B.1.2.2 Diving physics

B.1.2.2.1 Properties of liquids and gases.

1. The relationship between pressure and volume (Boyle’s Law)
2. The relationship between volume and temperature (Charles’ Law)
3. Partial pressure of gases (Dalton’s Law)
4. Solubility of gases (Henry’s Law)
5. Buoyancy (Archimedes’ Principle)

B.1.2.2.2 Practical application of diving physics (item 1.1) in diving operations

B.1.3 Equipment theory, use of equipment

B.1.3.1 Theory

1. Diving equipment
2. Chamber theory
3. Hot water plant
4. Wet bell plant

B.1.3.2 Use of equipment

1. Diving in open sea
2. Diving with self-contained breathing equipment
3. Diving with surface oriented diving equipment This practice should be carried out in connection with dive in open sea to a depth of at least 20 meters.
4. Practice of emergency procedures
5. Pre- and post-dive procedures
6. Maintenance and repairs
7. Diving suits
8. Closed and semi - closed circuit breathing apparatus
9. Wet bell
10. Practice time in water The following minimum time periods shall be achieved during controlled practice in water. Time in water should include decompression stops. Time in compression chamber shall not be included.

0- 19 meters 1600 minutes (including at least 400 minutes at depth range 10-19 meters)

20- 39 meters 250 minutes (divided into at least 8 dives with a minimum bottom time of 10 minutes, including at least 100 minutes at depth range 30-39 meters)

40- 50 meters 150 minutes (including at least 3 dives in open sea with a total bottom time no less than 75 minutes).

A significant proportion of the practical diving exercises should be completed using surface oriented equipment, and during at least one dive to a depth exceeding 35 meters, an exercise with a hydraulically/pneumatically/electrically powered tool should be carried out. The exercise should have a duration of at least 20 minutes.

B.1.4 Seamanship

B.1.4.1 Seamanship, theory

1. Tides
2. Charts and navigation
3. Safety equipment

B.1.4.2 Seamanship, practice

1. Small boat handling
2. Safety equipment practice
3. Act as crew-member

B.1.5 Communication systems

B.1.5.1 Theory

1. Hand and line signals
2. Underwater oral communication

B.1.5.2 Practice

1. Practice hand and line signals
2. Practice use of underwater communication

B.1.6 Underwater tasks

B.1.6.1 Theory

1. Explosives theory
2. Rigging and light construction and repair work
3. Pneumatically/hydraulically powered tools
4. Other relevant underwater tools

B.1.6.2 Practice

1. The practice of underwater tasks is intended to provide the trainees with a general appreciation of the techniques, problems and safety aspects related to work under water. For certain operations such as cutting, welding, use of explosives and non-destructive testing (NDT) further practice will be required before the diver may be considered to be qualified.

2. For all work involving use of special equipment, the trainee shall be familiar with statutory testing and examination requirements, and their frequency.
   - Underwater search, inspection and survey
   - Rigging
   - Tools
   - Water jetting, airlifts and lifting bags
   - Bolt guns
   - Cutting equipment
   - Welding equipment
   - Explosives
   - Construction techniques

B.1.7 Underwater hazards

B.1.7.1 Theory

1. Underwater structures
2. Dynamically positioned vessels
3. Stages, baskets and wet bells

B.1.8 Diving plant and equipment

B.1.8.1 Theory

1. Air compressors and cylinders
2. Winches, air motors etc.
3. Fire fighting equipment

B.1.8.2 Practice

B.1.9 Chamber operation

B.1.9.1 Theory, covered under item 6.1

B.1.9.2 Practice

1. Practical chamber operation
2. Chamber diving

B.1.10 Decompression

B.1.10.1 Theory

1. Decompression tables
2. Decompression stops in water
3. Surface decompression

B.1.10.2 Practice

B.1.11 Legislation, statutory instruments

The diver is required to be familiar with and understand relevant legislation, regulations, guidelines, safety notices, etc. He shall further be able to assess problems and situations in connection with relevant diving operations subjected to the above mentioned legislation etc.

B.1.12 First Aid and Diving Medicine

B.1.12.1 Structure and function of the human body- structure and function of:

1. musculo/skeletal systems
2. nervous system
3. heart, blood vessels, blood circulation
4. lungs
5. ears, sinuses and vestibular organs

B.1.12.2 First aid Causes, prevention, symptoms and management under normal and hyperbaric conditions of*:*

1. bleeding
2. fractures, sprains and muscle trauma
3. shock
4. burns
5. electrocution
6. asphyxia,
7. pulmonary oedema
8. respiratory arrest
9. cardiac arrest
10. hypothermia

11. hyperthermia
12. underwater blast injury
13. Importance of personal hygiene in the management of injuries. Measures at the casualty site and during transportation of injured person. First aid equipment and its use during a manned underwater operation.

B.1.12.3 Diving related injuries and side effects - cause, effect, symptoms and treatment of:

1. decompression sickness
2. pressure related injuries
3. pressure equalisation - ear and sinuses
4. drowning
5. vomiting under water
6. gas embolism and pulmonary barotrauma
7. carbon dioxide poisoning
8. carbon monoxide poisoning
9. oxygen toxicity
10. anoxia and hypoxia
11. nitrogen narcosis

B.2 Bell diver - training requirements (NORMATIVE)

B.2.1 Aim

The aim of the training shall be to enable experienced surface oriented divers to carry out work safely as bell divers and standby divers in a diving bell.

B.2.2 Course syllabus

The following training is required for the issuing of certificates:

B.2.2.1 Hours theory :

1.	Diving physics	20
2.	Chamber operation	10
3.	Bell diving operations	12
4.	Legislation, statutory instruments	6
5.	Physiology and first aid	36

Number of hours for theoretical training is intended as a guideline.

B.2.2.2 Diving physics

B.2.2.2.1 Properties of liquids and gases

1. The relationship between pressure and volume (Boyle’s Law)
2. The relationship between volume and temperature (Charles’ Law)
3. Partial pressure of gases (Dalton’s Law)
4. Solubility of gases (Henry’s Law)
5. Buoyancy (Archimedes’ Principle)

B.2.2.2.2 Practical application of diving physics in diving operations

B.2.2.3 Chamber operations

1. Built-in breathing system (BIBS) - functioning and operation
2. Gas distribution system
3. Gas monitoring and recording
4. Carbon dioxide absorption system
5. Impurities in gas distribution systems
6. Gas purity
7. Cleaning of gas distribution systems
8. Monitoring and recording of parameters during chamber operation
9. Fire fighting equipment
10. Checks and maintenance
11. Sanitary arrangements
12. Medical and equipment locks
13. Communications
14. Emergency procedures
15. Compression and decompression
16. Dive log
17. Surface team
18. Diving operation

B.2.2.4 Bell diving operations

B.2.2.4.1 Practical experience - minimum requirements

The practical experience shall comprise work both as diver and as standby diver in a diving bell.

Familiarisation

1. An instructor shall be present in the bell until satisfied that the trainee has the necessary knowledge of the functions of diver and of standby diver. The following number of dives shall be completed at the depth range of 5-10 meters:
   - 24 bell lockouts as diver
   - 24 bell lockouts acting as bell-man (standby diver)
   - 5 simulated rescues of unconscious diver
   - 12 complete bell-runs including transfer under pressure
2. As a minimum, the first three bell lockouts should be completed with the instructor in the bell, if desirable without transfer under pressure. All subsequent bell runs should be made according to the procedures for transfer under pressure. The trainee diver may only make one lockout from the bell at any one depth during each bell run. However, the diver and the bell-man (standby diver) may change around so that each carries out one lockout at a particular depth. Further lockouts may be made during the same bell-run provided the depth of the bell is changed and operation of the bottom door is included.
3. Of each trainee is required:
   - At least 4 chamber pressurisation's including check of transfer chamber;
   - At least 4 pre-dive bell checks;
   - As a diver, to have experienced simulated gas loss and communication failure, simultaneously;

4. Bell bounce dives
   Each trainee must complete three bell bounce dives to depths of 55, 75 and 100 meters respectively. A simulated rescue of an unconscious diver should be made during one of these dives.
5. Saturation
   From a living depth greater than 50 meters the trainee must complete two bell runs in open water to a depth greater than 50 meters. The lockout time for each bell run should be at least 15 minutes for each diver. The saturation period should have duration of minimum 60 hours.

B.2.2.4.2 Monitoring and recording

B.2.2.4.3 Bell gas distribution system

B.2.2.4.4 Carbon dioxide absorption system

B.2.2.4.5 Heating systems

B.2.2.4.6 Communications

B.2.2.4.7 Emergency recovery system for diving bell

B.2.2.4.8 Handling system for diving bell

B.2.2.4.9 Checks, pre- and post-dive procedures

B.2.2.4.10 Emergency measures

B.2.2.4.11 Breathing gas recovery systems

B.2.2.4.12 Survival equipment

B.2.2.4.13 Dynamically positioned vessels

B.2.2.4.14 Surface team

B.2.2.5 Legislation, statutory instruments

The diver is required to be familiar with and understand relevant legislation, regulations, guidelines, safety notices, etc. He shall further be able to assess problems and situations in connection with relevant diving operations subjected to the above mentioned legislation.

B.2.2.6 Physiology and first aid

A bell diver needs to have a broader understanding of diving medicine and first aid than that required for a surface oriented diver. He must be able to assess vital symptoms and to apply first aid in a diving bell.

B.2.2.6.1 Structure and function of the human body. Structure and function of:

1. musculo/skeletal systems,
2. nervous system,
3. heart, blood vessels, blood circulation,
4. lungs,
5. ears, sinuses and vestibular organs.

B.2.2.6.2 O_2 toxicity cause, effects, symptoms and management of O_2 toxicity. Calculation of O_2 partial pressure and the significance of this pressure to the safety of the divers.

B.2.2.6.3 First aid causes, prevention, symptoms and management under normal and hyperbaric conditions, including a diving bell, of:

1. bleeding,
2. fractures, sprains and muscle trauma,
3. shock,
4. burns,
5. injuries caused by electricity,
6. asphyxia,
7. pulmonary oedema,
8. respiratory arrest,
9. cardiac arrest,
10. hypothermia,
11. hyperthermia,
12. underwater blast injury.

Importance of personal hygiene in the management of injuries. Patient examination. Checking pulse, respiratory rate and temperature. Measures to be taken during transfer of injured person from diving bell to chamber. Measures to be taken in the bell or chamber and during transportation of injured person. First aid equipment and its use during a manned underwater operation.

B.2.2.6.4 Diving related injuries and side effects cause, effect, symptoms and management of:

1. pressure related injuries,
2. ear related injuries and illnesses,
3. drowning (both primary and secondary),
4. vomiting under water,
5. carbon dioxide poisoning,
6. carbon monoxide poisoning,
7. high pressure nervous syndrome (HPNS),
8. nitrogen narcosis,
9. anoxia and hypoxia.

B.2.2.6.5 Decompression related illness

Causes, effects, symptoms, diagnosis and management of illnesses requiring recompression, e.g. decompression sickness, gas embolism, pulmonary barotrauma and related conditions.

B.3 Trainee Air Diving Supervisor - training requirements (NORMATIVE)

B.3.1 Aim

The aim of the training shall be to enable the trainee to carry out work safely as trainee air diving supervisor during manned underwater operations.

B.3.2 Course syllabus

The following training should be required for the issuing of certificates:

B.3.2.1 Hours theory:

1.	Diving physics	8
2.	First Aid and Diving Medicine	10
3.	Diving plant and equipment	4
4.	Support equipment, tools and remotely controlled submersible craft	4
5.	Legislation and safety notices	6
6.	Advisory bodies and classification societies	3
7.	Procedures, emergency procedures, tables	6
8.	Labour legislation	4
9.	Management systems, quality assurance	6
10.	Dynamic positioning	3

Number of hours for theoretical training is intended as a guideline.

B.3.2.2 Diving physics

B.3.2.2.1 Revision

1. Boyle’s law
2. Charles’ law
3. Dalton’s law
4. Henry’s law
5. Archimedes’ principle

B.3.2.2.2 Heat conduction, heat loss

B.3.3 Physiology and first Aid

B.3.3.1 Revision

1. diving medicine
2. treatment tables
3. first aid

B.3.4 Diving plant and equipment

1. Symbols, schematics
2. Wet bell, diving basket
3. Decompression chamber
4. Analysis equipment
5. Pipes, valves, fittings

B.3.5 Support equipment, tools and remotely controlled submersible craft

1. Compressors, filters
2. Hot water machines
3. Electrical equipment
4. Lifting and handling gear
5. Hydraulic equipment
6. Inspection equipment
7. High pressure water jet
8. Liaison with remotely controlled vehicle

B.3.6 Statutory instruments and safety notices

1. Relevant labour legislation
2. Relevant diving regulations
3. Relevant safety notices
4. Breathing gas purity requirements
5. Casualty register, casualties during air diving

B.3.7 Advisory bodies and classification societies

1. Recommendations by:
   - DMAC
   - AODC/IMCA
   - DNV

B.3.8 Procedures, emergency procedures

B.3.8.1 Procedures for air diving

1. Operational procedures
2. Length of umbilical when diving from dynamically positioned vessels
3. Log keeping

B.3.8.2 Emergency procedures for air diving

1. emergency situation in sea
2. emergency situation in chamber
3. emergency situation on diving work-sites

B.3.8.3 Decompression tables

B.3.9 Internal control, quality assurance

1. Regulations relating to management systems for compliance with statutory requirements in relation to safety, working environment and protection of the external environment in the petroleum activities.
2. Principles for management systems and quality assurance

B.3.10 Dynamic positioning

1. Relevant standards
2. IMCA’s recommendations

B.4 Trainee bell diving supervisor - training requirements (NORMATIVE)

B.4.1 Aim

The aim of the training shall be to enable the trainee to function as trainee bell diving supervisor during manned underwater operations.

B.4.2 Course syllabus

The following training should be required for the issuing of certificates:

B.4.2.1 Hours theory:

1.	Diving physics, gas mixture, gas consumption	10
2.	First Aid and Diving Medicine	13
3.	Diving plant and equipment	7
4.	Support equipment, tools and remotely controlled vehicles	5
5.	Legislation and safety reports	2
6.	Advisory bodies and classification societies	4
7.	Procedures, emergency procedures, tables	7
8.	Management systems, quality assurance	6
9.	Dynamic positioning	2

Number of hours for theoretical training is intended as a guideline.

B.4.2.2 Diving physics, gas mixture, gas consumption

B.4.2.2.1 Revision

1. Gas laws

B.4.2.2.2 Gas mixture and compression

B.4.2.2.3 Consumption of gas and chemicals

B.4.3 First Aid and Diving Medicine

1. Diving medical conditions
2. Hypothermia and hyperthermia
3. Medical equipment and first aid equipment
4. Examination of patient
5. Treatment tables
6. Bacteriology

B.4.4 Diving plant and equipment

1. Chamber and regeneration plant
2. Recovery plant
3. Panels, regulators, pipes and fittings
4. Analysis equipment, gas purity, cleaning for O_2 use

B.4.5 Support equipment, tools and remotely controlled submersible craft

1. Electronic equipment, electricity in water
2. Hyperbaric welding
3. Radioactivity - hazards and hazard limit values
4. Liaison with remotely controlled submersible craft

B.4.6 Statutory instruments and safety notices

1. Relevant labour legislation
2. Relevant Diving regulations
3. Relevant Safety notices
4. Breathing gas purity requirements
5. Casualty register, casualties during bell diving

B.4.7 Advisory bodies and classification societies

1. Recommendations by:

- DMAC
- AODC/IMCA
- DNV

B.4.8 Procedures, emergency procedures, tables

B.4.8.1 Procedures for bell diving with emphasis on:

1. operation planning
2. equipment requirements
3. log keeping

B.4.9 Management systems, quality control

1. Quality assurance systems
2. Management systems
3. Planned maintenance

B.4.10 Dynamic positioning

1. Relevant standards
2. IMCA’s recommendations

B.5 Trainee LST - training requirements (NORMATIVE)

B.5.1 Aim

The aim of the training shall be to enable the trainee to function as trainee LST during manned underwater operations.

B.5.2 Course syllabus

The following training should be required for the issuing of certificates:

B.5.2.1 Hours theory:

1.	Diving physics	13
2.	Diving medicine	20
3.	First aid	19
4.	Decompression and treatment tables	6
5.	Diving plant and equipment	10
6.	Emergency procedures	4
7.	Legislation and safety notices	4
8.	Practical training	40

Number of hours for theoretical training is intended as a guideline.

B.5.2.2 Diving physics

B.5.2.2.1 Properties of gases

1. the relationship between pressure and volume (Boyle's Law)
2. the relationship between volume and temperature (Charles' Law)
3. partial pressure of gases (Dalton's Law)
4. solubility of gases (Henry's Law)

B.5.2.2.2 Gases used in diving

B.5.2.2.3 Gas mixture, compression

B.5.2.2.4 Physiology

B.5.2.2.5 Structure and function of the human body. Knowledge of the structure and function of :

1. musculo/skeletal systems,
2. nervous system,
3. heart, blood vessels, blood circulation,
4. lungs,
5. ears, sinuses and vestibular organs.

B.5.2.2.6 Diving related injuries and side effects. Knowledge of the cause, effects, symptoms and treatment of:

1. gas embolism and barotrauma,
2. decompression sickness,
3. nitrogen narcosis,
4. high pressure nervous syndrome (HPNS),
5. O_2 toxicity,
6. anoxia and hypoxia,
7. carbon dioxide poisoning,
8. carbon monoxide poisoning,
9. hyperthermia and hypothermia.

B.5.2.2.7 Hygiene, bacteria growth, control, treatment

B.5.2.2.8 Medical life-saving equipment for diving operations

B.5.3 First aid

B.5.3.1 Knowledge of cause, prevention, symptoms and treatment under normal and hyperbaric conditions of:

1. circulation failure,
2. bleeding,
3. fractures, sprains and muscle trauma,
4. burns,
5. shock.

B.5.3.2 First-aid equipment for diving operations

B.5.4 Tables for compression, decompression and treatment

1. Compression profile
2. Decompression tables
3. Treatment tables

B.5.5 Diving plant and equipment

B.5.5.1 Chamber complex:

1. system design
2. locks and locking mechanism
3. regeneration plant
4. sanitary plant

B.5.5.2 Gas distribution system

1. gas containers
2. pipelines and hoses
3. valves, pressure reduction valves and fittings
4. pressure gauges
5. compressors and booster pumps
6. built-in breathing system (“BIBS”)
7. thread forms
8. cleaning

B.5.5.3 Equipment for monitoring and recording

1. equipment for analysis of O_2 and CO_2
2. equipment for monitoring and recording of depth, temperature and humidity
3. equipment for monitoring and communication

B.5.5.4 Fire fighting equipment

B.5.6 Emergency procedures

1. Measures for fire prevention
2. Chamber evacuation, isolation of chamber
3. Measures in the event of pressure drop
4. Contamination - precautions and corrective action

B.5.7 Legislation

1. Relevant legislation, regulations, rules, guidelines, safety notices

B.5.8 Practical training

1. analysis of stored gas and chamber atmosphere
2. calibration of analysis equipment
3. gas supply to control panels and chambers
4. monitoring and recording of depth, temperature and humidity
5. calibration of monitoring and recording equipment
6. operation of communication equipment
7. compression and decompression of chamber complex
8. operation of sanitary arrangements and locks
9. transfer of personnel under pressure
10. practice of emergency procedures
11. use of treatment tables
12. cleaning

B.6 Leadership training (NORMATIVE)

B.6.1 Leadership and communication

B.6.1.1 Role of leader

1. definition of leadership
2. what is expected of a leader
3. definition of the leader function
4. ways of co-operation
5. attitudes
6. leadership over time

B.6.1.2 Communication

1. one-way/two-way communication
2. types of communication, language and body language
3. making people conscious of the matter in hand/the evolving process
4. information
5. instruction techniques

B.6.1.3 Conflicts

1. symptoms
2. causes
3. solutions
4. preventive measures

B.6.2 Planning and organising work

1. resource assessment
2. organising and assigning work tasks
3. definition of work.
4. ways of co-operation
5. team building
6. transfer of experience

B.6.3 Organisation and administration

1. mutual expectations
2. duties and responsibilities, framework/requirements
3. organisational structure
4. communication lines
5. administration

B.6.4 Leadership in emergency and stress situations

1. symptom recognition
2. behaviour and reactions
3. expectations to leaders in time of crisis
4. leadership styles, ad hoc leadership
5. awareness, preventive measures, training/crisis preparation
6. course of action
7. debriefing
8. transfer of experience

Guideline for theoretical training in leadership training is 16 hours.

ANNEX C - ACCIDENT/ NEAR ACCIDENT REPORTING IN ACTIVITY UNDER NORWEGIAN PETROLEUM LAW (INFORMATIVE)

C.1 Requirements under the petroleum law in general

In the petroleum activity under the NPD petroleum law
- the *notification* of accidents having resulted in loss of life or serious personal injury and particularly serious accidents of this kind;
- *reporting* of accident resulting in personal injury;

are regulated by «Regulations relating to systematic follow-up of the working environment in the petroleum activities §7 and §8».

The National Insurance Administration (RTV) form 11.01. E shall be used for this type of reports.

C.2 Additional requirements for manned underwater operations

In conjunction with manned underwater operations in the petroleum activity there are additional requirements to reporting of incidents. A specialised form (enclosed) shall be used for this kind of reporting.

The information reported is used by NPD for input to the database DSYS.

If related to a manned underwater operation:
- every incident requiring first aid;
- every incident requiring medical- or hyperbaric -treatment;
- near accident, including situations when no person is present in the system used for the manned underwater operations;

shall by the contractor, be reported to NPD on the enclosed form.

A copy of this report shall be given to the operator's representative.

C.3 Reporting

C.3.1 First-aid/ medical treatment/ personal injury

In case of accident resulting in personal injury in conjunction with manned underwater operations both RTV and the enclosed form should be sent to NPD.

C.3.2 Near accident

If no personal injury, first-aid, or medical treatment is involved, the enclosed form only should be used.

C.3.3 Guidance to enclosed form

NOTE: If it is required to tick off more than one item in the same column, the most significant item should be marked with a circle.

C.3.3.1 Information related to the incident

Operator:	Name of operator
Field/ area:	Name of oil-field and location where incident took place
Contractor:	Name of manned underwater contractor
Work-site:	Name of vessel/ platform/ barge from where the MUO took place
Date:	Date of incident
Reported by:	Name of person reporting incident
Date reported:	Date of issuing report of incident
Incident category:	Tick off in correct box
Depth:	The depth in chamber/ water when incident took place
Breathing gas:	Air/ Nitrox/ Heliox/ Trimix/ etc.
Dive type:	Tick off in correct box or state method in use
Purpose of dive:	Tick off correct box or state purpose
Injured body part:	Tick off correct box or state other body parts
Type of injury:	Tick off correct box or state other types of injury
Treatment and follow up:	State briefly the first symptom, type of first aid, who administered the first aid, further treatment and follow up.

C.3.3.2 Analysis for cause

Phase of the diving operation:	Tick off correct phase in the operation when incident took place
Activity:	Activity of involved personnel when incident took place
Place of occurrence:	Tick off for correct place where incident took place. In arena means areas on the work-site outside the diving facility, but in close conjunction with the diving operation e.g. chamber control room, dive control, DP-control, gas-bag room, gas-storage room, compressor room, external life support room and rooms where equipment in conjunction with MUO is tested and/ or stored. All other areas on the work site
System fault:	Tick of correct system directly involved in the cause of incident
Cause of incident	
Equipment:	Tick of correct cause of incident with regards to equipment
Personnel:	Tick of correct cause of incident with regards to personnel
Other contributing factors:	Tick off other contributing factors or state type

C.3.3.3 Comments/ Follow up/ Signature

Corrective actions on long and short term:	List both implemented and planned corrective actions
Comments from safety delegate:	Safety delegate states his comments to the incident as relevant
Signature:	Signature of person reporting incident

ACCIDENTS/ NEAR ACCIDENTS DURING MANNED UNDERWATER OPERATIONS UNDER THE NORWEGIAN PETROLEUM LAW.
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OPERATOR:	FIELD/AREA:	CONTRACTOR(S)::	
WORK-SITE:	DATE OF INCIDENT:	REPORTED BY/ DATE REPORTED:	
INCIDENT CATEGORY: Near accident Accident with personal injury		DEPTH:	BREATHING GAS:

INFORMATION RELATED TO THE INCIDENT

PURPOSE OF DIVE	TYPE OF DIVE	PHASE OF THE DIVING OPERATION	ACTIVITY
Inspection Construction Repair Welding Maintenance Other (describe):	Saturation dive Bounce diving Surface oriented diving Monobaric diving Other (describe):	Pre dive Compression Bottom phase Decompression Post dive	Preparations During transport At work Post work At rest

PLACE OF OCCURRANCE	INJURED PART OF BODY	TYPE OF INJURY
In chamber In diving bell/ basket In water In habitat In rescue unit In other hyperbar unit In monobar unit In arena Outside arena	Head/ Neck Eye Ear Sinuses Shoulder/ Arm Hand/ Finger Chest/ Stomach Back Hip/ Knee/ Thigh/ Leg Ankle/Foot/ Toe Skin Other (describe):	Decompression sickness Barotraume during compression Barotraume during decompression Outer ear infection Other infection Wounds Fracture Heat injury Cold injury Unconsciousness Death Other (describe):

TREATMENT (describe):

ANALYSIS FOR CAUSE

SYSTEM FAULT

Chamber complex system	Bell system	Control rooms	Handling system	Gas supply
Environmental control plant	Hot water system	Tools	Personal diving equipment	
DP system	Vessel/ Installation outside diving plant (describe):			
Others (describe):				

EQUIPMENT	PERSONNEL	OTHER CONTRIBUTING CAUSES
Construction/ Design/ Ergonomics Mechanical failure Poor maintenance	Poor organisation Lack of or poor procedures Lack of training/ skills Unawareness Incorrect use of equipment Illness/ Personal injury	Pollution/ contamination Weather conditions Fire Other subsea operations (describe): Others (describe):

ACCIDENTS/ NEAR ACCIDENTS DURING MANNED UNDERWATER OPERATIONS UNDER THE NORWEGIAN PETROLEUM LAW.
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CORRECTIVE ACTIONS	
SHORT TERM (describe):	LONG TERM (describe):

COMMENTS FROM SAFETY DELEGATE:	
SIGNATURE SAFETY DELEGATE:	

SIGNATURE:	