DNV·GL

RULES FOR CLASSIFICATION

Offshore units

DNVGL-RU-OU-0375 Edition July 2017

Diving systems

DNV GL AS

FOREWORD

DNV GL rules for classification contain procedural and technical requirements related to obtaining and retaining a class certificate. The rules represent all requirements adopted by the Society as basis for classification.

Any comments may be sent by e-mail to *rules@dnvgl.com*

CHANGES – CURRENT

This is a new document.

This document replaces the December 2015 edition of DNV-DSS-105 and the April 20017 edition of DNV-RP-E401.

CONTENTS

CHAPTER 1 PRINCIPLES AND PROCEDURES FOR CLASSIFICATION

SECTION 1 GENERAL

1 Introduction

1.1 Objective

This publication presents DNV GL rules for classification: Diving systems, the terms and procedures for assigning and retaining classification, including listing of the applicable technical references to be applied for classification.

1.2 Scope

1.2.1 These rules give technical and procedural requirements for classification of complete diving systems, including the certification of components and materials to be used.

1.2.2 The scope of classification includes:

— certification of system components
— plan approval and survey of of the diving system.

1.2.3 These rules do not include vessel specific requirements relevant to diving support vessels, as covered by DNVGL-RU-SHIP.

Guidance note:

Notwithstanding the above, these rules do apply to the diving system as installed on vessels with the class notation **Diving support vessel** as described in DNVGL-RU-SHIP Pt.5 Ch.10

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1.2.4 The designer or builder may as an alternative to comply with the requirements given in these rules, submit evidence that the topics covered in these rules are accepted by the national authorities.

Guidance note:

National authorities may have requirements in addition to the requirements stipulated in these rules. Compliance with the requirements in these rules will not automatically result in compliance with requirements stipulated by the national authorities.

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1.3 Application

1.3.1 These rules apply to certification and classification during the design, construction and operation of diving systems.

1.3.2 These rules are intended for diving systems used in the petroleum and natural gas industries. For application in other industries, special considerations may need to be agreed by the parties to the contract and or involved statutory regulators.

Guidance note:

Additional requirements for the diving system may be applicable due to the statutory requirements given in certain geographic areas, or onboard ships flying certain flags (see also Sec.2 [2.2]) .

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1.3.3 These rules apply to both transferable and permanent installed diving systems as located on and operated from a ship, barge, mobile offshore platform, fixed offshore installation or an onshore site (in the latter case e.g. for training and research purposes).

1.3.4 These rules do not apply to submersibles or atmospheric diving systems (ADS such as JIM and NEWT suits) as these are covered by DNV GL rules for classification: Underwater technology (RU-UWT).

1.4 Organisation of this document

Following this introduction section, this document is structured as follows:

— Ch.1 Sec.2 describes the classification principles and procedures.
— Ch.2 describes the design, construction and certification provisions as required for classification of surface and saturation diving systems (in respectively Sec.1 and Sec.2).
— Ch.3 provides the procedural and inspection requirements as applicable for diving systems in operation.

The document is completed with three supportive appendixes:

— App.A is a list of sources to assist in obtaining reference documents.
— App.B outlines generic project sub-phases.
— App.C summarizes testing and inspection requirements on pressure containing equipment.

2 References

2.1 Normative references

The latest revisions of the following documents apply as normative references:

Table 1 Rules and standards for classification

Document code	*Title*
DNVGL-RU-OU	Rules for classification: Offshore units
DNVGL-RU-SHIP	Rules for classification: Ships
DNVGL-ST-0378	Standard for offshore and platform lifting appliances

Table 2 Offshore standards

Document code	*Title*
DNVGL-OS-A101	Safety principles and arrangements
DNVGL-OS-D201	Electrical installations
DNVGL-OS-D202	Instrumentation, safety and telecommunication systems
DNVGL-OS-D301	Fire protection
DNVGL-OS-E402	Diving systems

Table 3 Class programmes

Document code	*Title*
DNVGL-CP-0183	Flexible hoses - Non-metallic materials
DNVGL-CP-0184	Flexible hoses with permanently fitted couplings - Metallic materials

Table 4 Recommended practices

Document code	*Title*
DNV-RP-E403	Hyperbaric Evacuation Systems

Table 5 Other normative references

Document code	*Title*
ASME VIII div.1 or div.2	ASME boiler and pressure vessel code, rules for construction of pressure vessels
ASME PVHO-1	Safety standard for pressure vessels for human occupancy
ASME PVHO-2	Safety standard for pressure vessels for human occupancy: in service guidelines
ASTM G93-03	Standard practice for cleaning methods and cleanliness levels for materials and equipment used in oxygen-enriched environments
API 17E	Specification for subsea production control umbilicals
BS 4778	Quality vocabulary, part 2: quality concepts and related definitions, 1991, British Standards Institute, London
EN 13096	Transportable gas cylinders, condition for filling gases into receptacles, single component gases
EN 13099	Transportable gas cylinders, condition for filling gas mixtures into receptacles
EN 1708-1	Welding, basic weld joint details in steel, part 1: pressurized components
EN 837-1	Pressure gauges part 1: bourdon type pressure gauges Dimensions, metrology, requirements and testing
EN ISO 10297	Gas cylinders cylinder valves specification and type testing
EN ISO 15001	Anasthetic and respiratory equipment compatibility with oxygen
EN ISO 10524-1	Pressure regulators for use with medical gases
EN ISO 9809-1	Gas cylinders, refillable seamless steel gas cylinders - design, construction and testing, part 1: quenced and tempered steel cylinders with tensile strength less than 1100 MPa
EN ISO 9809-2	Gas cylinders, refillable seamless steel gas cylinders - design, construction and testing, part 2: quenced and tempered steel cylinders with tensile strength greater or equal to 1100 MPa
EN 10204	Metallic products, types of inspection documents
EN ISO 11120	Gas cylinders, refillable seamless steel tubes for compressed gas transport, of water capacity between 150 l and 3000 l, design construction and testing

Document code	*Title*
EN 16753	Gas cylinders, periodic inspection and testing, in situ (without dismantling) of refillable seamless steel tubes of water capacity between 150 l and 3000 l, used for compressed gases
EN 13445	Unfired pressure vessels
EN ISO 12021	Respiratory equipment compressed gases for breathing apparatus
IEC no.79-10	International Electro Technical Commission's publication no.79-10, and IMO MODU code Ch.6
IMO resolution A.831(19)	Code of safety for diving systems, 1995
IMO resolution A.692(17)	Guidelines and specifications for hyperbaric evacuation systems, 1991
IMO MSC/Circ.645 of 6 June 1994	Guidelines for vessels with dynamic positioning systems
IMO resolution MSC 149 (77)	See SOLAS regulations III/6.2.1
IMO resolution MSC 307 (88)	FTP code International Code for Application of Fire Test Procedures
IMO resolution MSC337 (91)	Code on noise levels on-board ships
ISO 6406	Gas cylinders, seamless steel gas cylinders, periodic inspection and testing
ISO 6385-2004	Ergonomic principles in the design of work systems
ISO 9000	Quality management
ISO 10013	Guidelines for quality management system documentation
ISO 10380, BS 6501	Pipework, corrugated metal hoses and hose assemblies
ISO 10474	Steel and steel products, inspection documents
ISO 13628-5	Petroleum and natural gas industries, design and operation of subsea production systems, part 5: subsea control umbilicals
ISO/IEC/17065:2012	Conformity assessment, requirements for bodies certifying products, processes and services
PD 5500:2009 + latest amendments	Specification for unfired fusion welded pressure vessels
Note: see App.A list of sources to assist in obtaining reference documents.	

2.2 Informative references

2.2.1 General

Table 6 Informative references

Document code	*Title*
ISO 10297	Gas cylinders - cylinder valves - specification and type testing
ISO 10524-1	Pressure regulators for use with medical gases - part 1: pressure regulators with flow-metering devices
ISO 11114-3	Gas cylinders - compatibility of cylinders and valve materials with gas contents - part 3: autogenous ignition test in oxygen atmosphere
NFPA codes	National Fire Protection Agency codes
NORSOK Standard U-100	Manned underwater operations
SOLAS 1974 Consolidated edition	International Convention for the Safety of Life at Sea

2.2.2 Survey related

The following references may be used as guidance for conducting surveys:

a) Diving Safety Memorandum issued by the Health and Safety Executive in the U.K.
b) International Marine Contractors Association, IMCA/AODC, guidance notes, especially D 018 and D 024
c) IMO code of safety for diving systems adopted by IMO resolution A.831(19) on 23. November 1995
d) IMO guidelines for hyperbaric evacuation (IMO resolution A.692(17))
e) Instructions to classification Societies by Maritime Authorities
f) Merchant shipping notices, issued by the Department of Transport in the U.K.
g) Canada-Newfoundland and Labrador Offshore Area Diving Operations Safety Transitional Regulations (SOR/2015-5)
h) NORSOK U-100 manned underwater operations
i) Norwegian Maritime Directorate regulation of 19 April 1984 No.940
j) Canada-Nova Scotia offshore area diving operations safety transitional regulations SOR/2015-6
k) Regulations pertaining to manned underwater operations in the petroleum activity, by NPD
l) SI 1997 no.2776 The diving at work regulations 1997.

2.3 Terminology and definitions

2.3.1 Verbal forms

Term	*Definition*
shall	verbal form used to indicate requirements strictly to be followed in order to conform to the document
should	verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required
may	verbal form used to indicate a course of action permissible within the limits of the document

2.3.2 Definitions

Term	*Definition*
administration	the government of the state whose flag a ship or floating structure which carries a diving system is entitled to fly or in which the ship or floating structure is registered (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.1)
as-built survey	survey of the installed and completed diving system, which is performed to verify that the completed installation work meets the specified requirements, and to document deviations from the original design, if any
basket	a divers basket (sometimes known as a stage) is a frame and mesh construction designed to accommodate divers whilst they are lifted in and out of the water
bottle	a pressure container for the storage and transport of gases under pressure (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.2)
builder	signifies the party contracted to build a diving system in compliance with the Society's rules
case by case	when the case by case approval procedure is used, documentation of the design shall be submitted for approval for each application as required in the applicable chapters of the rules. When the case by case survey procedure is used, the survey shall be performed on the basis of approved design documentation for the actual application and as required in the applicable sections of the rules. Compliance with the approved design documentation and applicable requirements will be documented by certificates as required in the applicable sections of the rules.
certificate	a document confirming compliance with the Society's rules or with other rules and regulations for which the Society has been authorized to act
certification	a service confirming compliance with applicable requirements on the date that the survey was completed. Materials and components in DNV GL classified diving systems shall be certified according to the level of certification given in this document.
chamber	surface decompression, pressure or compression chambers, (see DDC), hereafter called the chambers, and are pressure vessels for human occupancy
class	in the context of these rules, class is assigned to and will be retained by the diving system complying with applicable requirements of the Society's rules
classification	in the context of these rules, a service which comprises the development of independent technical standards for diving systems, and verifies compliance with the rules throughout the vessels' life
closed bell	a sealed submersible diving chamber (SDC) that locks on and off the chamber where the divers decompress (DDC). Pressure differentials are retained by way of a closed door sealing the divers in at pressures, elevated or lowered compared to the surrounding pressure.
closed circuit breathing system (CCBS)	a system for supply of breathing gas to the diver and saving of his exhaled gases for re-circulation after scrubbing and replenishing

Term	*Definition*
commissioning	in relation to diving systems, refers to activities which take place after installation and prior to operation, comprising the tests and trials
competent body/competent person	in this context defined as a company, organisation or person recognised as fit to carry out specified inspections or tests. The recognition may be by DNV GL or by a statutory agency.
compressor	a mechanical device that increases the pressure of a gas by reducing its volume. The increase of pressure may be carried out by pistons, screws or diaphragms. A compressor designed with inlet (suction) pressure above atmospheric shall be entitled as booster. Depending on the application medium, purification and/or filter systems may be provided downstream.
construction phase	all phases during construction, including fabrication, installation, testing and commissioning, up until the installation or system is safe and operable for intended use. In relation to diving systems, this includes procurements, manufacture assembly, rectification, installation, testing, commissioning and repair.
contractor	a party contractually appointed by the Purchaser to fulfil all, or any of, the activities associated with design, construction and operation
customer	signifies the party who has requested the Society's service
demobilised	diving system is stored on shore and requires a full maintenance regime for mobilisation
depth	the water depth or equivalent pressure to which the diver is exposed at any time during a dive or inside a surface compression chamber or a diving bell, (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.6)
design	all related engineering to design of the diving system
design temperature, minimum	the lowest possible temperature to which the equipment or system may be exposed to during installation and operation, irrespective of the pressure. Environmental as well as operational temperatures shall be considered. **Guidance note:** For LARS, the design temperature is defined in DNVGL-ST-0378 standard for offshore and platform lifting appliances. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
design temperature, maximum	the highest possible temperature to which the equipment or system may be exposed to during installation and operation. Environmental as well as operational temperatures shall be considered.
designer	signifies a party who creates documentation submitted to the Society for approval or information
divers	personnel subjected to higher ambient pressure than one atmosphere
diving bell	a submersible compression chamber, including its fitted equipment, for transfer of diving personnel under pressure between the work location and the surface compression chamber, (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.7)

Term	Definition
diving system	the whole plant and equipment necessary for the conduct of diving operations, (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.8). In DNVGL terms the whole plant and equipment necessary for safe conduct of diving operations where compression and decompression of divers are taking place
dmax	maximum operating depth of the surface diving system. This is the depth corresponding to the maximum pressure for pressurizing divers. (For classified systems this may be specified in the certificate and data sheet).
evacuation system	a system whereby divers under pressure can be safely evacuated from a ship or floating structure to a position where decompression can be carried out, (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.9)
fabrication	activities related to the assembly of objects with a defined purpose. In relation to diving systems, fabrication refers to e.g. deck decompression chambers, wet-bells, and pressure vessels for gas storage, environmental control systems, launch and recovery systems etc.
fabricator	the party performing the fabrication (in this context, normally of windows for PVHOs)
failure	an event affecting a component or system and causing one or both of the following effects: — loss of component or system function — deterioration of functional capability to such an extent that the safety of the installation, personnel or environment is significantly reduced.
flag administration	the maritime administration of a vessel's country of registry
gas	see breathing gas
gas containers	cylinders, bottles and pressure vessels for storage of pressurized gas
guidance notes	contain advice which is not mandatory for the assignment or retention of class, but with which the Society, in light of general experience, advises compliance
handling system	the plant and equipment necessary for raising, lowering and transporting the diving bell between the work location and the surface compression chamber (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.10), (see launch and recovery system (LARS))
hazard	a deviation (departure from the design and operating intention) which could cause damage, injury or other form of loss (Chemical Industries Association HAZOP guide)
hazardous areas	those locations in which an explosive gas-air mixture is continuously present, or present for long periods (zone O), in which an explosive gas-air mixture is likely to occur in normal operation (zone 1), in which an explosive gas-air mixture it not likely to occur, and if it does it will only exist for a short time (zone 2), (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.11)

Term	Definition
hazard and operability study (HAZOP)	the application of a formal systematic critical examination to the process and engineering intentions of new or existing facilities to assess the hazard potential of inadvertent operation or malfunction of individual items of equipment and their consequential effects on the facility as a whole (Chemical Industries Association HAZOP guide)
hydro-test or hydrostatic test	see pressure test
hyperbaric evacuation system (HES)	system for evacuating divers under pressure. This includes the hyperbaric evacuation unit (HEU), the launch and recovery and control systems.
hyperbaric rescue vessel (HRV)	IMO uses the term hyperbaric evacuation unit (HEU), see above
inner area	the areas which are inside the chambers. Interconnecting trunks are considered part of the inner area when the door is opened into the chamber.
inspection	activities such as measuring, examination, testing, gauging one or more characteristics of a product or service and comparing the results with specified requirements for determine conformity
installation (activity)	the operations related to installing the equipment, diving system or support structure, e.g. mounting chambers and handling systems etc., including final testing and preparation for operation
installation manual (IM)	a document prepared by the contractor to describe and demonstrate that the installation method and equipment used by the contractor will meet the specified requirements and that the results can be verified
launch and recovery system (LARS)	the system and equipment necessary to launch and recover the divers, the diver's basket or wet-bell to the chambers as well as transport the divers between the surface support unit and the underwater working site, including any guide rope systems and cursor systems
lay-up	a terminology used for diving systems that are out of commission. In this state the diving system may be installed on board or permanently stored on shore.
life support system	the gas supply, breathing gas system, decompression equipment, environmental control system and equipment required to provide a safe environment for the diving crew in the diving bell and the surface compression chamber under all ranges of pressure and conditions they may be exposed to during diving operations, (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.12)
life support systems (in DNV GL terms)	the systems comprising gas supply systems, breathing gas systems, pressure regulating systems, environmental control systems, and systems required to provide a safe habitat for the divers, in the basket, the wet-bell and the chamber compartments under normal conditions during diving operation
load	any action causing stress, strain, deformation, displacement, motion, etc. to the equipment or system
manufacture	making of articles or materials, sometimes in larger volumes. In relation to diving systems, refers to activities for the production of pressure vessels, distribution panels and other components, performed under contracts from one or more contractors.
manufacturer	signifies the entity that manufactures the material or product, or carries out part production that determines the quality of the material or product, or does the final assembly of the product

Term	Definition
maximum operating depth	maximum operating depth of the diving system is the depth in metres or feet of seawater equivalent to the maximum pressure for which the diving system is designed to operate, (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.16)
open bell (also known as wet bell)	a suspended canopy chamber, open at the bottom like a moon pool structure that is lowered underwater to operate as a stage for the divers with the advantage of providing an air pocket for refuge and a space for communication outside the mask/helmet
operations (phase)	the phase when the diving system is being used for the purpose for which it was designed
organization	the International Maritime Organization (IMO), (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.17)
owner	signifies the registered owner or manager of the diving system or any other organization or person who has assumed the responsibility for operation of the diving system and who on assuming such responsibility has agreed to take over all the duties and responsibilities, see DNVGL-RU-OU-0101 Ch.1 Sec.5 [1.2]
oxygen systems	systems intended for a gas with a higher oxygen percentage than 25
plan approval	signifies a systematic and independent examination of drawings, design documents or records in order to verify compliance with the rules or statutory requirements. Plan approval will be carried out at the discretion of the Society, which also decides the extent and method of examination.
planned maintenance system (PMS)	s system for planning and recording of maintenance activities
pressure control system	in relation to diving systems, this is the system for control of the pressure in the various systems, comprising the pressure regulating system, pressure safety system and associated instrument and alarm systems
pressure regulating system	in relation to diving systems, this is the system which ensures that, irrespective of the upstream pressure, a set pressure is maintained downstream (at a given reference point) for the component
pressure safety system	the system which, independent of the pressure regulating system, ensures that the allowable set pressure is not exceeded
pressure test	the hydrostatic pressure test initially performed at the manufacturer of the pressure vessel in accordance with requirements in the design code
pressure system test	in relation to diving systems, this is the internal pressure applied to the component or system during testing on completion of installation work to test the diving system for tightness
pressure vessel	a container capable of withstanding an internal maximum working pressure greater than or equal to 1 bar, (see IMO code of safety for diving systems Ch.2 design, construction and survey 1 3.18)
purchaser	the owner or another party acting on his behalf, who is responsible for procuring materials, components or services intended for the design, construction, installation or modification of a diving system
purification and filter systems	purification and filter systems are used to remove contaminants from breathing gases after compression has taken place

Term	Definition
quality assurance (QA)	planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality
quality plan (QP)	the document setting out the specific quality practices, resources and sequence of activities relevant to a particular product, project or contract. A quality plan usually makes reference to the part of the quality manual applicable to the specific case.
quality system	signifies both the quality management system and established production and control procedures
rules	all requirements adopted by the appropriate approval body as the basis for classification
safety objectives	the safety goals for the construction, operation and decommissioning of the diving system including acceptance criteria for the level of risk acceptable to the owner
saturation diving	once a diver becomes saturated with the gases that make decompression necessary, the diver does not need additional decompression. When the blood and tissues have absorbed all the gas they can hold at that depth, the time required for decompression becomes constant. As long as the depth is not increased, additional time on the bottom is free of any additional decompression.
self-propelled hyperbaric lifeboat (SPHL)	see hyperbaric evacuation system (HES)
shipyard	signifies the party contracted to build a vessel in compliance with the Society's rules
significant wave height	when selecting the third of the number of waves with the highest wave height, the significant wave height is calculated as the mean of the selection.
society	the Society signifies DNV GL
surface compression chamber	a pressure vessel for human occupancy with means of controlling the pressure inside the chamber (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.5)
survey	signifies a systematic and independent examination of a diving system, materials, components or systems in order to verify compliance with the rules and/or statutory requirements. Surveys will be carried out on the vessel, at the construction or repair site as well as at sub-suppliers and other locations at the discretion of the Society, which also decides the extent and method of control
survey planning document	as described in Ch.3 Sec.1 [3.1] document describing the diving system and the requirements to survey and testing throughout the lifetime of the diving system
T_{op}	maximum operation time, i.e. the time from start of pressurization of the diver, until the diver is back to atmospheric conditions
transferable diving system	a diving system designed to be easily transferable in one or more units and which may be installed on-board a ship, barge or offshore platform for a short period of time not exceeding one year. A transferable diving system may be assembled from different units into a particular configuration suitable for a specific working operation

Term	Definition
umbilical	the link between the diving support unit and the diving bell and may contain surveillance, communication and power supply cables, breathing gas and hot water hoses. The hoisting and lowering strength member may be part of the umbilical, (see IMO code of safety for diving systems Ch.2 design, construction and survey 1.3.19). In DNV GL terms a link between support vessel and the divers, or the diving wet-bell, which may contain gas hoses, hot water hose, power supply cables and communication cables
verification	a service that signifies a confirmation through the provision of objective evidence (analysis, observation, measurement, test, records or other evidence) that specified requirements have been met
wet bell	see open bell
witnessing	signifies attending tests or measurements where the surveyor verifies compliance with agreed test or measurement procedures

2.4 Abbreviations and symbols

2.4.1 Abbreviations

Abbreviation	Description
AE	acoustic emission testing
ADS	atmospheric diving systems
AoM	approval of manufacturers
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AUT	automatic ultrasonic testing
BS*	British standard
CC	condition of class
CCBS	closed circuit breathing system
C-Mn	carbon manganese
CE	Conformité Européene (European Conformity)
CRA	corrosion resistant alloy
DDC	divers decompress chamber
DP	dynamic positioning
EBW	electronic beam welded
ET	eddy current testing
FMEA	failure mode effect analysis

Abbreviation	*Description*
HAZ	heat affected zone
HAZOP	hazard and operability study
HES	hyperbaric evacuation system
HFW	high frequency welding
HPIC	hydrogen pressure induced cracking
HRV	hyperbaric rescue vessel
IACS	International Association of Class Societies
IM	installation manual
IMO	International Maritime Organisation
ISO	International Organisation for Standardisation
ITP	inspection and test plan
JIM	trade name for a 1 bar armored diving suit
KV	charpy value
LARS	launch and recovery system
LBW	laser beam welded
MAWP	maximum allowable working pressure
MO	memo to owners
MPQT	manufacturing procedure qualification test
MPS	manufacturing procedure specification
MS	memo to owners
MSA	manufacturing survey arrangement
NACE	National Association of Corrosion Engineers
NEWT	trade name for a 1 bar armored diving suit
NDT	non-destructive testing alternatively NDE is used with the same meaning
NPD	Norwegian Petroleum Directorate
P	production
PC	product certificate
PD	public document
PMS	planned maintenance
PVHO	pressure vessel for human occupancy
Q	qualification
QA	quality assurance
QC	quality control

Abbreviation	*Description*
QP	quality plan
QRA	quantitative risk analysis
SDC	submersible diving chamber
SPD	survey planning document
SPHL	self-propelled hyperbaric lifeboat
TA	type approval
TR	test report
TP	test pressure
SF	safety factor
ROV	remotely operated vehicle
PV	pressure vessels
UTS	ultimate tensile strength
WPS	welding procedure specification
YS	yield stress
*Note: now PD – public document	

2.4.2 Symbols

A = cross section area

D = nominal outside diameter

D_{max} = greatest measured inside or outside diameter

D_{min} = smallest measured inside or outside diameter

D_i = D-2t_{nom} = nominal internal diameter

E = oung's modulus

f_0 = ovality, $\frac{D_{\max} - D_{\min}}{D}$

H = wave height

H_s = significant wave height

ID = nominal inside diameter

O = out of roundness, D_{max} - D_{min}

OD = nominal outside diameter

T = operating temperature

T_{max} = maximum design temperature

T_{min} = minimum design temperature

T_{nom} = nominal thickness

SECTION 2 PRINCIPLES AND PROCEDURES FOR CLASSIFICATION

1 Introduction

General principles and procedures applicable for classification are described in DNVGL-RU-OU-0101 Ch.1. This section provides specific requirements applicable for classification of diving systems and shall be read as a supplement to the above referred rules.

2 Classification principles

2.1 The classification concept

2.1.1 Introduction

The classification concept consists of the development and application of rules and offshore standards with regard to design, construction and survey of vessels, installations and systems.

2.1.2 In general, these rules and the referred standards cover requirements for the availability and the safety of the diving system.

2.1.3 For the assignment of class see [4], for the retention of class see [5].

2.1.4 Applicable rules

These rules and the referred standards lay down technical and procedural requirements related to obtaining and retaining a class certificate.

2.1.5 Where other standards and external criteria are used, the exact terms of reference and documents to be issued shall be agreed at the beginning of the project and formally defined in the contract. The use of other standards does not allow for a reduction of the quality management requirements as described in the safety philosophy of DNVGL-OS-E402.

2.1.6 DNV GL reserves the right to call for additional requirements to cover issues essential to the certification and classification process if not covered by the standards in question.

2.1.7 It is normally not acceptable to mix standards due to the possible differences in safety philosophies.

2.2 Statutory certification

2.2.1 The Society undertakes statutory certification on behalf of flag administrations when and to the extent the Society has been authorised to do so by the individual flag administration, in accordance with requirements given in the IMO code of safety for diving systems adopted by IMO resolution A.831(19). A corresponding diving system safety certificate may be issued upon proof of compliance when and to the extent the Society has been authorised to do so by the individual Flag Administration.

Guidance note:

If not authorized or if the flag has not adapted the IMO code, DNV GL may issue a statement of compliance.

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3 Classification scope and notations

3.1 Scope

3.1.1 The following parts and systems are covered by classification of a diving system:

a) chambers
b) bell
c) permanent gas storage containers
d) other pressure vessels
e) life support systems
f) divers heating systems
g) electrical systems and installations
h) fire protection, detection and extinction
i) launch and recovery systems
j) main umbilical
k) pipes, valves and fittings
l) booster pumps and compressors
m) helium reclaim plant (if installed)
n) gas analysers
o) gas mixing units
p) gas absorbers
q) breathing systems
r) depth gauges
s) sanitary system
t) communication system.

Guidance note:

As lifesaving appliances are covered by statutory regulations, there may be overriding requirements for hyperbaric evacuation systems (HES). Consequently, it is important to inform DNV GL at an early stage what flag state is intended for the vessel and what geographical areas of operation the diving system should be approved for.

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3.1.2 The classification of the diving system will cover assembly of the components into a system and include the following:

a) launching and recovery system for bell
b) the arrangement of the diving system assembly
c) the complete diving system assembly with respect to safety.

3.2 Class notations

3.2.1 A diving system class notation **Diving system(Surface)** or **Diving system(SAT)** for surface and saturation diving systems respectively, will be issued in the diving system's classification certificate as a formal statement confirming that the diving system has been assembled, tested and commissioned in accordance with specified requirements.

3.2.2 The operational restrictions as listed in Table 1 apply.

Table 1 Class notations

Class	*Design and certification requirements*	*Restrictions*	*Provisions*
Diving system(Surface)	Ch.2 Sec.1	d_{max}< 60 msw T_{op}< 8 hours	open bell or basket deployment allowed No HES required
Diving system(SAT)	Ch.2 Sec.2	as stated in the requirements and assumptions in the certificate, appendix to classification certificate and data sheet (20.201a)	closed bell Dedicated HES required
msw = metres sea water. d_{max} = maximum operating depth.			

Guidance note:

The major differences between **Diving system(Surface)** and **Diving system(SAT)** are requirements for the:

a) physical size of the chambers
b) life support system
c) control stand
d) communication system
e) capacity of emergency power supply.

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3.2.3 Requirements which do not specifically refer to **Diving system(Surface)** or **Diving system(SAT)**, or which are called minimum requirements in these rules and the referred standards, apply to all systems.

4 Assignment of class

4.1 Assignment of class - new systems

4.1.1 General

A request for classification of a new diving system shall be submitted in writing by the customer. The Society reserves the right to decline a request for classification. Assignment of class shall follow the requirements given in DNVGL-RU-OU-0101 Ch.1 Sec.4. The scope of attendance shall be agreed between the manufacturer and the Society before manufacturing commences.

4.1.2 Upon class request, the Society's surveyor will inspect the manufacture and assembly of the diving system and attend the necessary tests.

4.1.3 The degree of technical innovation in the diving system shall be considered.

Guidance note:

Risks to the diving operation are likely to be greater for a diving system with a high degree of technical innovation than with a diving system designed, manufactured and installed to well-known criteria in well-known vessels. Similarly, the degree of risk to the diving system should be considered where contractors are inexperienced or the work schedule is tight. Factors to be considered include:

a) degree of difficulty in achieving technical requirements

b) knowledge of similar diving systems

c) knowledge of contractors' general system experience

d) knowledge of contractors' experience in similar work.

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4.1.4 Plan approval

Documents required in each section of DNVGL-OS-E402 shall be submitted for review and or approval by DNV GL.

Guidance note:

Plan approval includes:

a) reviewing specifications for design

b) reviewing design reports and drawings

c) performing independent parallel calculations for certain systems and components

d) reviewing specifications for manufacture and operation, resulting from design.

Definition of scope of work for plan approval of design will follow Table 2.

Table 2 Scope of work for plan approval of design

Plan approval activity
Review of the design process by
a) review of design quality management documentation
b) audit of design quality management system
Review of specifications for design by
c) review of the design basis with emphasis on the typical location on and interface with the support vessel. Evaluation of the design criteria, specifically or in general depending on the installation
Review of design reports and drawings by
d) review of the main documentation to ensure that the main conditions have been accounted for in design, that the governing conditions are identified, and that the chosen design philosophies are in accordance with specified codes and standards
e) evaluation of the main methods used and spot checks of the input data and the calculation results
f) detail review of main design reports
Performing independent parallel calculations by
g) simplified independent analysis and calculation(s) performed by spot checks
h) advanced independent analysis and calculation(s) performed by spot checks
Review of specifications for manufacture and operation by
i) spot check of critical aspects
j) review of main specifications
k) review of underlying specifications

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4.2 Survey during construction

4.2.1 General

Where DNVGL-OS-E402 refers to certification, survey, acceptance, agreement or qualification this shall be done by DNV GL. Inspections and test executed as part of the construction surveys shall be included in the inspection and test plan (ITP) in accordance with DNVGL-OS-E402 Ch.2 Sec.1[3.5].

4.2.2 Survey during manufacture, assembly and installation

Survey during manufacture is either carried out by means of full time attendance, audits, inspection or spot checks of the work, as appropriate, in sufficient detail to verify that the specified requirements of the diving system are complied with.

4.2.3 Verification of these activities relates not only to the contractor's work but also to the monitoring of work carried out by others.

4.2.4 Verification shall consist of one, or more, of the following:

a) reviewing the manufacture process
b) reviewing manufacture procedures
c) reviewing qualification process
d) surveillance during manufacture activities
e) reviewing final documentation.

4.2.5 Definition of scope of work for manufacturing shall follow Table 3.

Table 3 Scope of work for attendance during manufacturing and fabrication of components

Survey activity
Review of the manufacturing and fabrication process
a) review of manufacturing management systems
b) audit of the quality management system
Review of manufacturing and fabrication procedures
c) review manufacturing, fabrication, method and inspection procedures for confirmation of compliance with the manufacturing specification
Review of qualification process
d) review the manufacturing procedure specification, (MPS), manufacturing procedure qualification test (MPQT), if applicable
e) full time attendance during MPQT, if applicable, or first day production
Surveillance during manufacturing and fabrication activities
f) attendance during testing, to ensure, based on spot checks, that the delivered products have been produced in accordance with the manufacturing specification
Review of final documentation

4.2.6 Definition of scope of work for installation shall follow Table 4.

Table 4 Scope of work for attendance during installation

Verification activity
Review of the installation process
a) review of installation management systems
b) audit of the quality management system
Review of installation procedures
c) spot check of installation manual (IM)

Verification activity
d) for critical operations (identified from the systematic review) review the IM
Review of qualification process
e) for critical operations, review the qualification of the IM
f) full time attendance during tests, if applicable, or at start-up
Surveillance during installation activities
g) attendance during start-up of each sub-system installation
h) full time attendance during trials and associated visit- based attendance during testing
Review of final documentation

4.2.7 Testing and commissioning

After completed installation, the diving system shall be tested in compliance with an approved test program in presence of the surveyor according to Table 5. The required tests are stated in DNVGL-OS-E402.

Table 5 Scope of work for attendance during final testing for operation, including as-built survey and project completion

Verification activity
Review of procedures
a) review of the procedures for system tests to ensure that the test procedure will test the diving system in accordance with the design requirements
Surveillance during testing and completion activities
b) attendance during pressure testing
c) full time attendance during pipe testing and audit based attendance during cleaning, and drying
d) full time attendance during as-built surveying and system testing
Review of final documentation
e) check of as-built documentation
f) review of as-built documentation

4.2.8 For environmental control systems a copy of the approved test program completed with the final set points will be endorsed by the surveyor, and shall eventually be kept available on-board.

4.3 Assignment of class - existing systems

4.3.1 A request for class entry of an existing diving system shall be submitted in writing by the customer. The Society reserves the right to accept or decline an application for class entry. The assignment of class shall follow the requirements given in DNVGL-RU-OU-0101 Ch.1 Sec.4 [2.4].

4.3.2 When a diving system, or part of a diving system, has been certified by another recognised classification society, evidence of previous design approval will be required. Such evidence shall include drawings of the arrangement and details bearing the approval stamp, or specifically covered by an approval

letter. In addition, for components requiring certification, the corresponding certificates shall be available along with maintenance records.

4.3.3 After review of the evidence and examination and testing in accordance with relevant parts of DNVGL-OS-E402, the system or components may be registered under the class notation with DNV GL.

4.4 Classification certificate

4.4.1 When all the applicable classification requirements have been met.

4.4.2 A data sheet for diving systems will be issued to support the class notation by giving a description of the diving system, operational limitations and conditions of use for which the diving system is intended, codes and standards with which the diving system has been found to comply, its item number (when relevant) and referencing certificates and reports of components in the diving system.

4.4.3 When a diving system has been assigned class, its main particulars and details of the class assigned will be entered in the Society's register according to requirements given in DNVGL-RU-OU-0101 Ch.1 Sec.4 [4].

Guidance note:

Table 6 provides an overview of the different documents as issued by DNV GL throughout the building project phases. The purpose of these documents is to:

a) provide documentation that design approval, monitoring of fabrication and testing of final product has been presented

b) confirm the diving system's components conformity with the requirements

c) document the work performed by DNV GL.

Table 6 Diving system certification – documents provided by DNV GL

Reference standard for certification								
Project phases	Design		Construction					Operation
	Conceptual design	Detail design	Manufacturing of materials	Manufacturing of components	Manufacturing of sub-systems and assemblies	Installation	Project completion	Operation, maintenance and repair
Certification phase	Pre-certification	Certification				Classification		Maintenance of classification
Types of certification documents provided	Letter	Approval letter	Documents for individual phase or natural part thereof: certificates of materials and components, survey reports and data sheet			Class certificate with data sheet		Retention of class certificate

Applicable certificates include:

a) request for certification/classification of diving systems and parts of diving systems (form no.14.30a)

b) classification certificate for diving system (form no.CDSV)

c) installation report diving system (form no.51.71a)

d) certificate for diving system (form no.14.39a)

e) data sheet for diving system (form no.20.201a)

f) certificate for chambers for diving systems (form no.14.31a)

g) certificate for diving bells (form no.14.32a)

h) test report of test and thorough examination of lifting appliances (onboard testing, non-ILO152) (form no. OLA201)

i) survey report (form no.40.9a)

j) plan approval letter

k) IMO diving system safety certificate (form no.DSV 101 or DSV 301)

l) certificate of conformity diving systems (form no.DSV.CON).

Product and material certificates are, in principle, documents confirming that an examination has been carried out, and are valid only at the date of issue. However, for some certificates a specified period of validity, and maintenance conditions for ensuring this validity, may be given in the certificate e.g. statutory and class certificates.

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5 Retention of class

5.1 Conditions of retention of class

5.1.1 Classification is based on the assumption that:

a) the diving system is properly maintained and operated by competent personnel
b) that a pre-check procedure is followed to ensure that all systems and components function properly before start of each operation
c) that the current, wave and wind conditions are within the design limits for the various systems.

5.1.2 Diving systems in operation will retain class provided that:

a) The diving system is operated within the specified limitations.
b) Periodical surveys are carried out in accordance with Ch.3 based on an approved survey planning document (SPD) covering the diving system.
c) The owner provides adequate documentation from inspection and maintenance activities.
d) The owner maintains any installed systems for condition monitoring and carries out condition evaluations as applicable.
e) Information about damage, repairs and modifications, which may affect the certification, is promptly reported to the Society.
f) Conditions of class (CC) issued by the Society are acted upon within the specified time.

5.1.3 Diving systems that are temporarily out of service shall be subject to periodical inspections for retention of class. The inspection requirements will be agreed upon between the owner and the Society.

5.2 Damage and repairs

For repair and replacement of significant components of the diving system, re-testing and/or certification shall be in accordance with these rules. See Ch.3 Sec.1 [4].

5.3 Withdrawal of class

5.3.1 The class notation can be withdrawn if the owner fails to:

a) comply with the operational procedures for the diving system accepted by the Society
b) carry out the regular in-service inspection and maintenance programme according to the procedures accepted by the Society
c) comply with any conditions of class issued by the Society.

5.3.2 Additionally, the class notation can be withdrawn if the diving system:

a) is damaged, or is suspected of having been damaged, in a manner likely to impair its safety or integrity
b) demonstrates signs of deterioration likely to impair its safety or integrity
c) is subjected to any modifications or repairs, which can impair its safety or integrity
d) is considered demobilised or taken out of use.

5.3.3 If the situation leading to withdrawal of the class notation no longer exists, the notation may be reinstated. However, the diving system will be subject to special assessment or monitoring prior to and or following the reinstating of the class notation.

6 Certification of materials, components and systems

6.1 Introduction

6.1.1 The scope of classification requires that specified materials and components intended for the diving system are certified. The objective of this certification is to ensure that applied materials and components comply with the technical requirements. Certification normally includes both plan approval and survey during production and/or of the final product, (see DNVGL-RU-OU-0101 Ch.1 Sec.6 [2]).

6.1.2 Ch.2 defines the extent of the required certification.

Guidance note:

Certification should be planned in close co-operation with the owner and each of its contractors, to provide a scope of work that is tailor-made to the schedule of each production process or activity, i.e. to make the verification activities, surveillance and hold points, an integrated activity.

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6.2 Type approval

Type approval is a procedure for approval of standard designs and/or routinely manufactured, identical components, systems or assemblies to be used in DNV GL classed diving systems. Type approval is detailed further in DNVGL-RU-OU-0101 Ch.1 Sec.6 [2.3].

7 Legal provisions

Legal provisions are given in DNVGL-RU-OU-0101 App.A.

CHAPTER 2 DESIGN, CONSTRUCTION AND CERTIFICATION PROVISIONS

SECTION 1 SURFACE DIVING SYSTEMS

1 Introduction

This chapter provides the procedural and technical requirements as applicable for the classification of surface diving systems. Systems complying with these requirements will be assigned a class notation **Diving system(Surface)**.

2 Technical requirements

The technical requirements of DNVGL-OS-E402 Ch.2 shall ne applied.

3 Documentation requirements

Documentation requirements are described in DNVGL-OS-E402 Ch.2 Sec.1 [2] and the component specific requirements are listed in DNVGL-OS-E402 Ch.2 Sec.2 to DNVGL-OS-E402 Ch.2 Sec.8.

4 Survey and testing requirements

4.1 General

4.1.1 The tests carried shall follow the test descriptions of DNVGL-OS-E402 Ch.2 Sec.2 to DNVGL-OS-E402 Ch.2 Sec.8. The Society may increase the extent of tests when deemed necessary.

4.1.2 Testing shall be in compliance with approved programmes.

4.2 During and after manufacturing and assembly

The inspection shall be carried out at the manufacturers and/or builder, during or after the manufacture/ assembly. The extent and method of examination shall be agreed in the terms of delivery and the specifications.

4.3 Survey and testing requirements during and after installation

4.3.1 The diving system shall be tested at sea trials on-board according to an approved programme.

4.3.2 During the sea trials the normal launch and recovery system shall be tested to the maximum depth. For surface diving systems employing a wet-bell the bell shall be checked for leakage at depth, including gas cylinders, piping and hoses.

4.3.3 Drills shall be held to assure adequate access for the divers, and the ability to transfer an injured diver, to the chamber, and to compress the chamber, within the time frame stipulated by the applied decompression tables.

5 Certification requirements

5.1 General

5.1.1 For general principles to certification see Ch.1 Sec.2 [6], for definitions of the different certificate types see DNVGL-RU-SHIP Pt.1 Ch.3 Sec.4.

5.1.2 The Table 1 to Table 2 provide an overview of certification requirements, divided into:

— design and manufacture
— assembly.

Guidance note:

Table 1 list requirements for single certificates, combination of certificates or different alternatives. Examples:

Table 1 Examples supporting the understanding of the tables

Description	*Certificate type*	*Issued by*	*Explanation*
Component example 1	PC+TR	manufacturer	A product certificate and a test report issued by the manufacturer
Component example 2	PC+TR	Society +manufacturer	A product certificate issued by the society and a test report issued by the manufacturer
Component example 3	TA/PC+TR	Society/ manufacturer	A type approval certificate issued by the society or a product certificate and a test report issued by the manufacturer

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5.2 Launch and recovery systems

Launch and recovery systems shall normally be certified by a competent person as lifting appliances in accordance with the procedures applicable for the system and compliant with ILO convention no.152. Operational limitations shall be stated in the data sheet. For DNV GL classed diving systems a DNV GL product certificate type CG2 will be issued for the LARS.

5.3 Design and manufacture

Table 2 Certification requirements during design and manufacturing (see DNVGL-OS-E402 Ch.2)

Description	*Certificate type*	*Issued by*
Pressure vessels for human occupancy (PVHO)	PC	Society
Windows in PVHO	PC	Society
Manufacturers of, and certification of, gas cylinders, approved manufacturer and (3.2) certificate according to EN 10204	AoM+PC	Society+manufacturer
Smaller gas cylinders considered essential	PC	Society
Production tests of gas cylinders	TR	manufacturer
Tolerance checks	TR	manufacturer

Description	*Certificate type*	*Issued by*
Testing after heat treatment	TR	manufacturer
Materials	TR/PC	manufacturer/Society[1]
Stainless steel parts welded to non-stainless pressure vessel	TR	manufacturer
Manufacturers of pressure vessels, approved manufacturer	AoM	Society
Materials for gas cylinders	PC	manufacturer
Approval and testing of acrylic material in accordance with ASME PVHO-1	TR	manufacturer
Shock testing of hoses for use in oxygen systems with	TR	manufacturer
Tested for noxious, toxic or flammable properties, test report (TR)	TR	manufacturer
Materials and components in oxygen systems	PC+TR	manufacturer
Overpressure alarm	PC+TR	manufacturer
BIBS masks	PC	manufacturer
Control, alarm and safety systems in gas mixers	PC+TR	Society+manufacturer
Heaters for chambers	PC+TR	manufacturer
Temperature controls	PC	manufacturer
Noise reduction	TR	manufacturer
Carbon dioxide removal	PC+TR	manufacturer
Hydrostatic testing of piping	TR	manufacturer
Piping	MC+PC[2]	Society/manufacturer
Flexible hose assemblies (with couplings) including umbilical hoses	TA+TR	Society+manufacturer
Mechanical testing of umbilical	TR	manufacturer
Completion testing of umbilical	TR	manufacturer
Safety valves and overpressure alarm	PC+TR	manufacturer
Pressure relief devices and shut-off valves	PC	manufacturer
Chamber mounted valves for water	PC+TR	manufacturer
Valves and pressure regulators	PC	manufacturer
Fittings and pipe connections	PC	manufacturer
Manifolds	PC+TR	manufacturer
Pressure regulators	PC	manufacturer
Compressors	PC	Society
Umbilical	PC	Society

Description	*Certificate type*	*Issued by*
Lights	PC	manufacturer
Electrical penetrators for pressure vessels	PC+TR	Society+manufacturer
Electrical motors	PC	Society/manufacturer[3]
Testing pressure resistant enclosures	TR	manufacturer
Cables	TA/PC+TR	Society/manufacturer
Fire proof cables	TA+ PC[6]	manufacturer
Non-hazardous materials	TR	manufacturer
Fire detection and alarm system	TA/PC+TR	Society/manufacturer
Manually operated fire fighting device for inner area	TA/PC+TR	Society/manufacturer
Fire fighters outfit	TA/PC+TR	Society/manufacturer
Portable fire extinguishers	TA/PC+TR	Society/manufacturer
Winches and power packs	PC	Society
LARS control and monitoring	PC	Society
Stops and brakes	TR	manufacturer
Power tests[5]	TR	manufacturer
Ropes	PC	Society/manufacturer[4]
Blocks and shackles	TR or ILO FORM 3	manufacturer
Sheaves, product certificate	PC	Society
Materials for structural members in launch and recovery systems	PC	manufacturer
Temperature indicator	PC+TR	manufacturer
Monitors in wet bell	TR	manufacturer
Pressure indicators and gas analysers	TA/PC+TR	Society/manufacturer
Oxygen analyser	PC	manufacturer

[1] PC for materials for main pressure retaining parts, otherwise TR.

[2] See DNVGL-RU-SHIP Pt.4 Ch.6.

[3] Issued by manufacturer under 100 kW, by the Society over 100 kW, see DNVGL-OS-D201 Ch.3.

[4] See DNVGL-ST-0378.

[5] Including hydraulic, electric, load test, high voltage/pressure, insulation/leak.

[6] Including fire resistant cables (IEC 60331) or flame retardant for not critical cabling.

5.4 Assembly

Table 3 Certification requirements during assembly (see DNVGL-OS-E402 Ch.2)

Description	*Certificate type*	*Issued by*
Mixing system	PC+TR	Society+manufacturer
Hydrostatic testing of piping	TR	manufacturer
Piping	MC/PC[5]	Society/manufacturer
Lights	PC	manufacturer
Cables	TA/PC+TR	Society/manufacturer
Fire proof cables[1]	TA+PC	society+manufacturer
Fire detection and alarm system	TA/PC+TR	Society/manufacturer
Launch and recovery system certified as lifting appliance	PC	Society
Winches and power packs	PC	Society
LARS control and monitoring	PC	Society
Stops and brakes	TR	manufacturer
Power tests	TR[2]	manufacturer
Ropes	PC+TR[3]+TR	Society+manufacturer
Blocks and shackles	TR or ILO FORM 3	manufacturer
Sheaves	PC	Society
Materials for structural members in launch and recovery systems	PC	manufacturer
Oxygen alarm	PC	manufacturer
Hyperbaric evacuation system and hyperbaric evacuation unit	TR[4]	manufacturer
Test of hyperbaric evacuation system	TR[4]	manufacturer
Chamber for hyperbaric evacuation unit	TR[4]	manufacturer
Launch and recovery system (LARS)	TA+TR[4]	Society+manufacturer
Hyperbaric evacuation system tests and drills	TR[4]	manufacturer

[1] Including fire resistant cables (IEC60331) or flame retardant for not critical cabling.

[2] Including hydraulic, electric, load test, high voltage/pressure, insulation/leak.

[3] See DNVGL-ST-0378 wire ropes to be delivered with DNV GL product certificate type CG4 or ILO FORM 4 certificate.

[4] If applicable through statutory requirement.

[5] See DNVGL-RU-SHIP Pt.4 Ch.6.

SECTION 2 SATURATION DIVING SYSTEMS

1 Introduction

This section provides the procedural and technical requirements as applicable for the classification of saturation diving systems. Systems complying with these requirements will be assigned a class notation **Diving system(SAT)** .

2 Technical requirements

The technical requirements of DNVGL-OS-E402 Ch.3 shall be applied.

3 Documentation requirements

Documentation as submitted for classification shall follow the component specific items as listed in DNVGL-OS-E402 Ch.3 Sec.2 to DNVGL-OS-E402 Ch.3 Sec.8.

4 Survey and testing requirements

4.1 General

4.1.1 The tests carried shall follow the test descriptions of DNVGL-OS-E402 Ch.3 Sec.2 to DNVGL-OS-E402 Ch.3 Sec.8.

4.1.2 Testing shall be in compliance with approved programmes.

5 Certification requirements

5.1 General

5.1.1 For general principles to certification see Ch.1 Sec.2 [6], for definitions of the different certificate types see DNVGL-RU-SHIP Pt.1 Ch.3 Sec.4.

5.1.2 The Tables 1 to Table 2 provide an overview of certification requirements, divided into:

— design and manufacture
— assembly.

Guidance note:

The tables list requirements for single certificates, combination of certificates or different alternatives. Examples:

Table 1 Examples supporting the understanding of the tables

Description	*Certificate type*	*Issued by*	*Explanation*
Component example 1	PC+TR	manufacturer	A product certificate and a test report issued by the manufacturer
Component example 2	PC+TR	Society +manufacturer	A product certificate issued by the society and a test report issued by the manufacturer
Component example 3	TA/PC+TR	Society/ manufacturer	A type approval certificate issued by the society or a product certificate and a test report issued by the manufacturer

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5.2 Launch and recovery systems

Launch and recovery systems shall normally be certified by a competent person as lifting appliances in accordance with the procedures applicable for the system and compliant with ILO convention no.152. Operational limitations shall be stated in the data sheet (see Ch.1 Sec.2 [4.4]), a DNV GL product certificate type CG2 will be issued by DNV GL for the LARS.

5.3 Design and manufacture

Table 2 Certification requirements during design and manufacturing (see DNVGL-OS-E402 Ch.3)

Description	*Certificate type*	*Issued by*
Certification of pressure vessels for human occupancy (PVHO)	PC	Society
Windows in PVHO	PC	manufacturer
Material grade sand additional testing of materials	TR	manufacturer
Materials for main pressure retaining parts	PC	manufacturer
Stainless steel parts welded to non-stainless pressure vessel	TR	manufacturer
Manufacturers of pressure vessels, approved manufacturer	AoM	Society
NDT of piping	TR	manufacturer
Testing after heat treatment	TR	manufacturer
Tolerance checks	TR	manufacturer
Smaller gas cylinders considered essential	TR	Society
Certification of gas bags for helium reclaim systems	PC	manufacturer
Manufacturers of, and certification of, gas cylinders	AoM	Society+manufacturer
Materials as defined by EN 10204 for gas cylinders	PC	manufacturer
Acceptance of other standard and design evaluation. Testing EN 10204 to applied standard	TR	manufacturer

Description	*Certificate type*	*Issued by*
Production tests of gas cylinders	TR	manufacturer
Pressure relief devices and shut-off valves	PC	manufacturer
BIBS masks	PC	manufacturer
Manifolds	PC+TR	manufacturer
Oxygen analyser	PC	manufacturer
Overpressure alarm	PC+TR	manufacturer
Safety valves and overpressure alarm	PC+TR	manufacturer
Chamber mounted valves for water	PC+TR	manufacturer
Heaters for bells and chambers	PC+TR	manufacturer
Temperature controls	PC	manufacturer
Temperature indicator	PC+TR	manufacturer
Noise reduction	TR	manufacturer
Carbon dioxide removal	PC+TR	manufacturer
Helium regeneration	PC+TR	manufacturer
Control, alarm and safety systems in gas mixers	PC+TR	Society+manufacturer
Lights	PC	manufacturer
Monitors in wet bell	TR	manufacturer
Electrical motors	PC	Society/manufacturer[1]
Fire proof cables	TA+PC	Society+manufacturer
Electrical motors in inner area	PC	manufacturer
Electrical switchboards 1 (superscript)	PC+TR	manufacturer
Testing pressure resistant enclosures	TR	manufacturer
Cables	TA+PC	Society+manufacturer
Electrical penetrators for pressure vessels	PC+TR	Society+manufacturer
Pressure indicators and gas analysers	TA/PC+TR	Society/manufacturer
Non-hazardous materials	TR	manufacturer
Manually operated fire fighting device for inner area	TA or PC	manufacturer
Winches and power packs	PC	Society
Stops and brakes	TR	manufacturer
Winches and power packs	PC	Society
LARS control and monitoring	PC	Society
Release mechanisms for hoists and guides	TA/PC+TR	Society/manufacturer

Description	*Certificate type*	*Issued by*
Power tests[2]	TR	manufacturer
Ropes[3]	PC+TR	manufacturer
Blocks and shackles DNV GL product certificate type CG3 or ILO FORM 3	TR/ILO FORM 3	manufacturer/Society
Sheaves	PC	Society
Materials for structural members in launch and recovery systems	PC	manufacturer
Tested for noxious, toxic or flammable properties	TR	
Materials and components in oxygen systems	PC+TR	manufacturer
Piping	PC	Society/manufacturer[4]
Hydrostatic testing of piping	TR	manufacturer
Flexible hose assemblies (with couplings) including umbilical hoses	TA+PC	Society+manufacturer
Shock testing of hoses for use in oxygen systems	TR	manufacturer
Valves and pressure regulators	PC	manufacturer
Fittings and pipe connections	PC	manufacturer
Compressors	PC	Society
Purification and filter systems	PC	Society
Umbilical	PC	Society
Mechanical testing of umbilical	TR	manufacturer
Completion testing of umbilical	TR	manufacturer

[1] Issued by manufacturer under 100 kW, by the Society over 100 kW, see DNVGL-OS-D201 Ch.3.

[2] Including hydraulic, electric, load test, high voltage/pressure, insulation/leak.

[3] See DNVGL-ST-0378 wire ropes to be delivered with DNV GL product certificate type CG4 or ILO FORM 4 certificate.

[4] See DNVGL-OS-D101 Ch.3.

5.4 Assembly

Table 3 Certification requirements during assembly (see DNVGL-OS-E402 Ch.3)

Description	*Certificate type*	*Issued by*
Oxygen alarm	PC	manufacturer
Components for oxygen systems	TR	manufacturer
Pressure relief valves	PC+TR	manufacturer
Filters	PC	manufacturer
Shut-off valves	PC	manufacturer

Description	*Certificate type*	*Issued by*
Non-return valves, flow-fuses and valves	PC+TR	manufacturer
Closed circuit breathing system (CCBS)	PC+TR	Society+manufacturer
Communications systems	TA/PC+TR	society/Society +manufacturer
Launch and recovery system certified as lifting appliance	PC	Society
Tested for noxious, toxic or flammable properties	TR	manufacturer
Materials and components in oxygen systems	PC+TR	manufacturer
Piping	PC	Society/manufacturer[1]
Hydrostatic testing of piping	TR	manufacturer
Hydrostatic testing of piping	TR	manufacturer
Flexible hose assemblies (with couplings) including umbilical hoses	TA+PC	manufacturer
Shock testing of hoses for use in oxygen systems	TR	manufacturer
Valves and pressure regulators	PC	manufacturer
Fittings and pipe connections	PC	manufacturer
Mechanical testing of umbilical	TR	manufacturer
Completion testing of umbilical	TR	manufacturer

[1] See DNVGL-OS-D101 Ch.3.

CHAPTER 3 CLASSIFICATION IN OPERATION

SECTION 1 PRINCIPLES FOR SURVEYS

1 Introduction

1.1 General

This chapter list requirements and criteria on the survey of diving systems. These shall be applied to the survey planning document as described [3.1].

1.2 Other codes

This chapter is intended to comply with the inspection requirements given in:

— IMO code of safety for diving systems, 1995 resolution A.831(19).
— IMO guidelines and specifications for hyperbaric evacuation systems, 1991 resolution A.692(17).

2 Survey execution

2.1 General

2.1.1 Surveys may be carried out with the vessel on location or in port as long as the diving system is not under pressure at the time. Pressure vessels requiring internal inspection should be depressurised, opened up, cleaned and made ready for survey.

2.1.2 Internal inspections of gas storage bottles should be carried out in accordance with an approved procedure by an approved service supplier. Consult the register of approved service suppliers.

2.1.3 The diving system status as accessible through MyDNVGL.com list the planned surveys.

2.1.4 The following report forms should be completed:

— semi-annual reports to the planned maintenance system (PMS), every 6 months
— annual survey checklist, yearly
— intermediate survey checklist, every 2 or 3 years
— renewal survey checklist, every 5 years
— narrative reports, at each survey
— damage reports if applicable
— upgrades/modifications history, incl. approvals.

Additional checklists may apply.

3 Documentation

3.1 Survey planning document

3.1.1 A survey planning document shall be part of the documentation on board for the lifetime of the diving system. The survey planning document shall be written by the owners representatives in accordance with the principles laid out in Ch.3 of these rules, but shall be suited to their particular diving system. For transferable

diving systems, the survey planning document shall specify scopes for surveys when the system is installed and for surveys when the system is in storage (laid-up).

Guidance note:

A survey planning document gives owners and surveyors a chance to tailor the instructions to fit each individual system or component and thereby avoid misunderstandings often encountered with respect to the application of generic requirements. This may also streamline the surveys in consideration of the operational situations in each case.

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3.1.2 The survey planning document shall be written in English, or translated into English, and approved by DNV GL prior to the survey taking place. Checklists shall be included as attachments. It shall have the following information printed on the front page:

— DSV survey planning document
— name of support vessel or installation given in the classification register
— DNV GL ID number given in the classification register
— IMO number (for statutory surveys)
— name of company
— revision number and date.

3.2 Checklists

Checklists shall be made available for the surveyor to fill out and endorse at each survey. The checklists shall include the following information at the top of each page:

— name of support vessel or installation given in the classification register
— DNV GL ID number given in the classification register (for units in class with DNV GL)
— IMO number (for statutory surveys)
— page number
— name of company
— scope of survey (annual, intermediate, renewal or otherwise)
— in columns: survey item, condition, action, comment
— place, date, surveyor, signature, and stamp.

3.3 General documentation

The following general documentation shall be available on board:

— emergency procedures for each work site to cover all foreseeable situations
— diving operations log
— valve shut-off checklists
— operational procedures
— emergency procedures
— dive log, duly signed off
— data sheet for diving system form 20.201a
— layout drawing for diving system
— PMS records.

3.4 Documentation in dive control

3.4.1 Diagram of the thruster configuration shall be provided showing the bell and thrusters locations at 10m depth intervals, with relative distances marked between the two. The diagram may be referenced to indicate umbilical lengths used relative to working depth.

3.4.2 A copy of relevant parts of the emergency procedures (preferably plasticized/sealed) should be kept in the bell for diver guidance. A duplicate copy should be kept in dive control.

4 Out of service

Diving systems that are temporarily out of service shall be subject to periodical inspections. The inspection requirements will be agreed upon between the owner and DNV GL on a case by case basis.

SECTION 2 PERIODICAL SURVEYS

1 Annual survey

The survey shall normally include:

— calibration of essential instrumentation (depth gauges, gas analysers etc.)
— switching from main to emergency electrical power supply
— emergency systems including bell emergencies (buoyancy if applicable)
— function test of the handling system
— partly dismounting of heat protection and penetrators on the bell may be required
— hyperbaric evacuation system tests and drills.

Detailed specification of test requirements are given in the relevant sections of the DVNGL-OS-E402 Ch.2 and Ch.3.

2 Intermediate survey

The requirements given in [1] apply with the addition of the following tests:

— gas leak tests
— testing of safety valves
— functional test of fire detection-, alarm- and extinctionsystems
— functional tests of life support systems
— functional tests of alarm systems
— functional tests of mechanical and electrical systems
— hyperbaric evacuation system tests and drills.

Detailed specification of test requirements are given in the relevant sections of the DVNGL-OS-E402 Ch.2 and DVNGL-OS-E402 Ch.3.

3 Renewal survey

The requirements given in [1] and [2] apply with the addition of the following tests:

— Bell buoyancy materials, heat protection, penetrators, windows and attached members shall be dismounted for inspection for possible corrosion and deterioration.
— Pressure tests and inspections shall be carried out according to App.C.
— The working mass of the bell of pressure containing equipment shall be checked.
— Diving bell handling systems shall be subject to static load testing.
— If applicable, the bell's releasable ballast system with attachments shall be structurally tested with a static load of 1.5 times the mass of the ballast in air.
— hyperbaric evacuation system tests and drills.
— Viewports, 10 years old or more, shall be replaced.

APPENDIX A LIST OF SOURCES TO ASSIST IN OBTAINING REFERENCE DOCUMENTS (INFORMATIVE)

1 General

Table 1

Reference document	*Source*
DNV GL standards and offshore standards	DNV GL Veritasveien 1 N-1322 Høvik, Norway http://www.dnvgl.com
A guide to hazard and operability studies, 1979, Chemical Industries Association Limited, London.	http://www.cia.org.uk/
AS/NZS ISO 8402 quality, vocabulary: 1994	International Organization for Standardization, Geneva http://www.iso.ch/
ISO 6385:2004 ergonomic principles of the design of work systems	
ISO 9000 quality management	
ISO/TR 10013:2001 guidelines for quality management system documentation	
ISO 10 380, BS 6501-1:2004 pipework, corrugated metal hoses and hose assemblies	
ISO 10474 steel and steel products: inspection documents	
ISO 13628-5 subsea umbilicals	
BS 4778-2:1991 quality vocabulary, quality concepts and related definitions, British Standards Institute, London.	British Standards Institute http://www.bsi-global.com/
ISO/IEC 1706:2012 conformity assessment, requirements for bodies certifying products, processes and services	International Organization for Standardization, Geneva. http://www.iso.ch/
ISO 2503 gas welding equipment, pressure regulators and pressure regulators with flow-metering devices for gas cylinders used in welding, cutting and allied processes up to 300 bar (30 MPa)	
EN 10204 metallic products, types of inspection documents.	
ASME VIII div.1	American Society of Mechanical Engineers http://www.asme.org/
ASME PVHO-1 safety standard for pressure vessels for human occupancy	
API codes for hoses	American Petroleum Institute http://api-ec.api.org/
API 17E specification for subsea production control umbilicals.	
IMO code of safety for diving systems, 1995 resolution A.831(19)	International Maritime Organization http://www.imo.org/
IMO guidelines and specifications for hyperbaric evacuation systems, 1991 resolution A.692(17)	

Reference document	*Source*
IMO MSC/Circ.645 of 6 June 1994 guidelines for vessels with dynamic positioning systems	
IMO resolution A.809(19) see SOLAS regulations III/6.2.1	
IMO resolution MSC.61(67) FTP code: international code for application of fire test procedures: resolution MSC.61(67): including fire test procedures referred to in and relevant to the FTP code	
IMO resolution A.468 (XII) code on noise levels on-board ships.	
IMO MODU code Ch.6	
International Convention for the Safety of Life at Sea (SOLAS) 1974	
AODC and IMCA documents	http://www.imca-int.com/
International Electro Technical Commission's publication No.79-10	http://www.iec.ch/
NORSOK standard U-100 manned underwater operations	http://www.nts.no/norsok/
PD 5500:2009 specification for unfired fusion welded pressure vessels	British Standards Institute http://www.bsi-global.com/
SAE J 517 hydraulic hose	Society of Automotive Engineers http://www.sae.org/
EN 853 rubber hoses and hose assemblies, wire braid reinforced hydraulic type, specification, 856 rubber hoses and hose assemblies, rubber-covered spiral wire reinforced hydraulic type, specification, 857 rubber hoses and hose assemblies, wire braid reinforced compact type for hydraulic applications, specification	
National Fire Protection Agency codes	National Fire Protection Association (NFPA) 1 Batterymarch Park P.O. Box 9101 Quincy, MA 02269-9101 USA Telephone: +1 617 770-3000 Fax: +1 617 770-0700 www.nfpa.org

APPENDIX B GENERIC DESCRIPTION OF PROJECT SUB-PHASES

1 Introduction

1.1 General

Some examples of descriptions of project sub-phases or milestones are given below. These descriptions are not intended to be precise definitions but are given as suggestions as to how particular project-specific definitions can look.

2 Initial studies

2.1 Feasibility study

2.1.1 A feasibility study is a study directed at evaluation of the feasibility of one or more concepts.

2.1.2 The feasibility study is an evaluation of one or more proposed technical concepts against project cost and schedule. It should identify special technical problems and indicate the solution or solve these to the degree necessary to confirm the feasibility of the project cost and schedule.

2.1.3 The feasibility study shall address all essential cost and schedule aspects, and should conclude on what the most uncertain factors are and how they should be approached. It should preferably address aspects such as support vessel design, special legislation etc. that are peripheral to diving system integrity.

2.2 Concept study

2.2.1 A concept study is a design made to establish the main dimensions and data of the diving system.

2.2.2 These include, for example, diameter, wall thickness, material type etc. Other aspects include placement on the support vessel and identification of possible needs for major conversion works (existing vessels and designs) and or (additional) surveys. In short, the study has to establish the basic parameters for the work to be performed in the next stages of design and a means for more detailed cost estimation and possibly comparison of a number of concepts detailed to the same level.

2.2.3 It is expected only to indicate the preferred or possible methods or solutions of how to solve design issues, configurations, installation practices, etc. On this basis it is expected that the concept study documentation identifies how far the design has reached, what needs to be further detailed or investigated and how the designer foresees the use of the given information as part of the subsequent design.

3 Design

3.1 Basic design

3.1.1 Basic design is a design made to establish the main dimensions and data of the diving system to a level where it is possible to make a detailed cost estimate and to place fabrication orders without taking any significant economic risk.

3.1.2 The following should be defined:

a) The maximum significant wave height in which the bell shall be launched, the diving system group (**Diving support vessel(Surface)** or **Diving support vessel(SAT)**), the range of ambient temperatures, maximum operating depth(s), maximum operating time(s).
b) Number of chambers and their dimensions, number of bells and their dimensions, other pressure vessels and their particulars, gas storage with particulars.
c) Number of compressors with their particulars, umbilical with particulars.
d) Basic information on electrical supply and distribution with estimated consumers and capacity.
e) Proposed fire protection.
f) Particulars of the handling system(s).
g) Proposed hyperbaric evacuation system.
h) A draft to the data sheet for diving system (DNV GL form 20.201a) should be made to give an overview of the system. This data sheet may be updated as the project progresses.

In short, to establish a design for which only local details remain to be defined.

3.1.3 On this basis, it is expected that a large part of the basic design documentation will be the final design documentation and that it identifies what needs to be further detailed or investigated and how this shall be done by the designer.

3.2 Detail design

Detail design means the finalisation of design. It can entail all stages of design, as it does not necessarily have to be preceded by another distinct phase. It shall address all design issues for all items of the diving system and finalise all the specifications for the subsequent production phases.

4 Other phases

4.1 General

Descriptions of other project phases, such as construction (manufacturing, installation, and commissioning) or operations are not given, as there is rarely any confusion of their meaning or extent. (See DNVGL-OS-E402).

APPENDIX C PRESSURE CONTAINING EQUIPMENT SUMMARY

1 General

1.1 Pressure testing

1.1.1 Pressure testing shall be carried out in accordance with an approved procedure on the relevant pressure vessels. Both Norwegian and British authorities require this testing. When modifications to the pressure boundaries have been carried out, the test requirements apply as given for new pressure vessels. Procedures for testing along with qualifications etc. should be submitted well in advance for review.

1.1.2 Pressure testing shall be carried out in accordance with the procedure, and to the test pressure (TP), required by the design code of the pressure vessel. The maximum allowable working pressure (MAWP) is determined by dividing the test pressure (TP) by a safety factor (SF). The minimum safety factors on DNV GL classed support vessels shall be 1.3. More stringent safety factors may be required by statutory regulations or by operators.

1.1.3 All pressure tests should be witnessed by a DNV GL surveyor. Internal visual inspections may be undertaken by a competent company in accordance with a prior agreement.

1.1.4 Prior to hydro testing, a thorough visual inspection internally and externally shall be conducted.

1.1.5 Acoustic emission testing in lieu of hydrostatic testing of gas storage tubes is accepted provided the testing is carried out in line with EN 16735.

1.2 Downgrading of pressure vessels

1.2.1 In lieu of hydraulic pressure testing, it may be acceptable to carry out a pneumatic pressure test to the maximum allowable working pressure (MAWP) and to downgrade the existing working pressure by the applicable safety factor (minimum 1.3). Pneumatic pressure tests shall adopt the safety precautions in Pt.5 5.8.4 of PD 5500:2000 unfired fusion welded pressure vessels.

1.2.2 For downgrading of pressure vessels in DNV GL classified diving systems, refer to the design code of the pressure vessel when determining test and maximum allowable working pressures (TP and MAWP). Determine the new shell thickness if there is corrosion and apply the new shell thickness to the original design so you arrive at the new TP and a new MAWP.

Note:

The test pressure TP is an engineering concept that relates to a certain factor compared to yield (normally 90% of yield). The maximum working pressure MAWP is a policy concept relating to a safety factor determined by standards, codes or statutory regulations. In one case, it may be 1.3 whereas in another it might be 1.5. It may also differ between the design codes and the materials applied in the manufacture of the pressure vessel.

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1.2.3 Downgrading procedure

a) Start with the design code for the PV.
b) Map thicknesses of the shell.
c) Apply the thicknesses to the calculations in the code and calculate the new TP.
d) Divide the new TP with the safety factor in the code to arrive at the new MAWP (or apply the safety factor given by regional regulations if this is greater).

e) Submit test procedure for approval.
f) For hydrostatic testing, test to the new TP and use to the new MAWP.
g) For pneumatic testing, test pneumatically to the new MAWP. Divide the new MAWP by the safety factor used in d. to arrive at the downgraded MAWP. Use at the downgraded MAWP.

Note:

Most codes give you safety procedures to follow when pneumatic testing is carried out. The codes should also stipulate visual inspection with acceptance criteria. If not, contact DNV GL for guidance. Proper visual inspection is essential.

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1.2.4 Downgrading of chambers may be requested either:

— to carry out periodical pressure testing after ten years pneumatically at a reduced pressure
— after installation of windows with a lower design pressure than the chamber
— after any other causes which may or may not imply a reduction of strength of the pressure vessel.

1.2.5 The procedure necessitates the following alterations and recordings:

a) The pressure vessel shall be marked at a location close to the original marking and the original marking shall be covered.
b) The filed copies of the certificates shall be marked.
c) Issue of an MO (memo to owners).
d) Issue of an MS (memo to surveyor).
e) Memos shall include the necessary information as to:
   — the new maximum operating pressure of the diving system
   — the reasons behind the downgrading.

This is done in order to simplify the procedure when the owner might, at a later stage, want to recertify the pressure vessel to its original operating pressure.

1.3 NDT of predefined pressure vessel welds

Applies to systems entering service after January 2003.

1.3.1 As a 3rd alternative, eddy current inspection of predefined welds may be chosen.

1.3.2 Upon completion of a successful leak test carried out to MAWP, eddy current testing (ET) shall be carried out on the weld surface of all external welds of windows, locks and interconnecting trunks.

Note:

The ET procedure shall be based on ISO 16753. Acceptance criteria shall be EN ISO 23278, acceptance level 2X (MT testing criteria). The ET testing procedure shall be sent in for approval prior to commencement of inspection.

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1.4 Seamless gas cylinders

1.4.1 As an alternative to hydro-testingof the seamless gas cylinders, testing using acoustic emission (AE) in accordance with EN 16753 gas cylinders, periodic inspection and testing, in situ (without dismantling) of refillable seamless steel tubes of water capacity between 150 l and 3000 l used for compressed gases may be chosen

1.4.2 The decision to base the testing on AE is irreversible and the procedure to rendering a gas cylinder unserviceable shall be followed as outlined in EN 16753.

1.5 First year periodic survey

All pressure vessels and piping shall be visually examined externally on an annual basis. Chambers and diving bells shall be visually examined internally also.

1.6 Second year periodic survey

1.6.1 All pressure vessels shall be visually examined internally as well as externally at two yearly intervals, excepting gas storage tubes and piping. The latter are examined externally only.

1.6.2 Gas cylinders used in or under water shall be hydrostatically tested at intervals of 2 years.

1.7 Fifth year periodic survey

1.7.1 At five year intervals chambers and bells are hydro-tested with an internal pressure equivalent to the test pressures given by the design code. If diving bells are to be used for observation diving (internal pressure at one atmosphere), they shall be hydrostatically tested to the external test pressure determined by the design code.

1.7.2 At first complete survey the interval for hydraulic pressure testing of gas containers may be extended to ten years if the following principles are applied:

— external and internal survey by intra-scope
— if internal survey is not possible or if corrosion or other items of concern are found, hydraulic test shall be carried out to the test pressure determined by the design code.

At the subsequent complete periodical surveys:

— external and internal survey by intra-scope
— hydraulic test to the test pressure determined by the design code.

1.7.3 At five year intervals gas cylinders and gas storage tubes, shall be hydrostatically tested to the test pressure and procedure (permanent set evaluation) as determined by the design code. At the first complete periodical survey the interval for hydraulic pressure testing of gas containers may be extended to 10 years if the following principles are applied:

— external and internal survey by intra-scope
— if internal survey is not possible or if corrosion or other items of concern are found, hydraulic test shall be carried out to the test pressure determined by the design code.

At the subsequent complete periodical surveys:

— external and internal survey by intra-scope
— hydraulic test to the test pressure determined by the design code.

1.7.4 At first complete survey the interval for hydraulic pressure testing of bell and chambers may be extended to ten years if the following principles are applied:

— external and internal survey
— if internal survey is not entirely possible or if corrosion or other items of concern are found, hydraulic test shall be carried out to the test pressure determined by the design code
— alternatively, pneumatic test to the working pressure may be carried out and the pressure vessel down graded, see [9.4.4].

At all subsequent complete periodical surveys:

— external and internal survey
— hydraulic test to the test pressure determined by the design code
— alternatively, pneumatic test to the working pressure may be carried out and the pressure vessel down graded, see [1.2] or NDT, see [1.3].

1.7.5 At five year intervals air and gas volume tanks, and sewage tanks, shall be hydrostatically tested to the test pressure determined by the design code.

1.7.6 At five year intervals hot water tanks shall be hydrostatically tested to the test pressure determined by the design code.

Table 1 Summary

Item	*New*	*1st year*	*2nd year*	*5th year*
Chambers	Visual (internal and external)	Visual (internal and external)	Visual (internal and external)	Visual (internal and external)
	Hydro-test		Leak test	Hydro-test or NDTl
	Leak test			Leak test
Diving bells	Visual (internal and external)	Visual (internal and external)	Visual (internal and external)	Visual (internal and external)
	Hydro-test (external)		Leak test	Hydro-test or NDT
	Leak test			Leak test
Gas bottles underwater	Visual (internal and external)	Visual (external)	Visual (internal and external)	Visual (internal and external)
	Hydro-test			
	Leak test		Hydro-test every 2nd year	
Gas storage tubes and HES bottles	Visual (internal and external)	Visual (external)	Visual (external)	Visual (internal and external)
	Hydro-test		Leak test	Hydro-test or AE testing
	Leak test			Leak test
Air and gas volume tanks and sewage tanks	Visual (internal and external)	Visual (external)	Visual (internal and external)	Visual (internal and external)
	Hydro-test		Leak test	Hydro-test or NDT
	Leak test			Leak test
Hot water and other tanks	Visual (internal and external)	Visual (external)	Visual (internal and external)	Visual (internal and external)
	Hydro-tes		Leak test	Leak test
	Leak test			

Item	*New*	*1st year*	*2nd year*	*5th year*
Pipework	Visual (internal and external) Hydro-test Safety factor 1.5	Visual (external)	Visual (external) Leak test	Visual (external) Leak test

CHANGES – HISTORIC

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification, technical assurance, software and independent expert advisory services to the maritime, oil & gas and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our experts are dedicated to helping our customers make the world safer, smarter and greener.

SAFER, SMARTER, GREENER