STANDARDS FOR SCIENTIFIC DIVING AT DUTCH UNIVERSITIES AND RESEARCH INSTITUTIONS (DIVING SAFETY MANUAL)

Version 1.1

Written by the Expert Group of the Dutch National Scientific Diving Committee (DNSDC):
www.dutchscientificdiving.nl

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A. GENERAL PROCEDURES

A1. Introduction

Dutch Universities and other research institutions have been involved in diving research around the world since the early 1970's. The number of researchers that partakes in diving research has grown since and many courses taught at universities now include diving research as part of the curriculum. In the Dutch Working Conditions Act (Arbowet[1]) no reference is made to working under pressure or while working underwater. Regulations for work involving diving have however been included in the "Arbeidsomstandighedenbesluit"[2] starting at "Afdeling 5. Werken onder overdruk". These regulations foremost apply to commercial diving, typical in e.g., the offshore industry. Diving for research purposes, however, fundamentally differs from working as a commercial diver, and as such the regulations that apply for the latter are often irrelevant to diving for research purposes for Scientific Diving. As a consequence, specific regulations for Scientific Diving are currently largely lacking, which could result in unclear requirements, responsibilities, and protocols required to ensure safe working conditions for the growing number of scientific divers at Dutch universities and research institutes.

Dutch universities and research institutes, including Wageningen University & Research (WUR), Royal Netherlands Institute for Sea Research (NIOZ), Naturalis Biodiversity Center (NBC), University of Amsterdam (UvA), Van Hall Larenstein, University of Applied Sciences (VHL) and the University of Groningen (RUG), have therefore recently expressed a strong desire to develop transparent rules and regulations for Scientific diving in the Netherlands to remedy the current unclarities in this regard and have founded the Dutch National Scientific Diving Committee (DNSDC). The DNSDC strives towards defining a clear framework outlining obligations, requirements and procedures that allow responsible and safe Scientific Diving practices at Dutch universities and research institutes.

This document therefore represents the first draft to come to minimal safety standards developed by the DNSDC for Scientific Diving at the present day. This document should be continuously updated to include and reflect new developments relevant to Scientific Diving.

[1] https://wetten.overheid.nl/BWBR0010346/2020-12-01
[2] https://wetten.overheid.nl/BWBR0008498/2021-01-01

It is the DNSDC's intend to ensure that the standards presented in this document will eventually become part of the Dutch Labor Law (ARBO wetgeving) as is already the case in 11 other European countries[3].

The Scientific Diving Standards that are provided in this document have been compiled in collaboration with representatives of all aforementioned Dutch academic institutions (the DNSDC expert group), academics currently involved in diving research, dive safety, work safety-, legal and organizational experts. These Scientific Diving Standards also fulfill the minimum requirements for internationally recognized Scientific Diving certifications, namely those of a European Scientific Diver (ESD) and Advanced European Scientific Diver (AESD).

Institute regulations and guidelines specific to its own diving program can be provided in an institute-specific addendum[4].

A2. Purpose

The purpose of these Scientific Diving Standards is to ensure Scientific Diving takes place in a manner that will ensure safe working conditions and maximize the protection of scientific divers from accidental injury and/or illness. Secondly, they serve to define minimal standards for training and certification that will allow research collaborations among Dutch and international research institutes that adhere to the same or comparable standards. These standards are drafted, revised annually (when necessary), and approved by the Dutch National Scientific Diving Committee (DNSDC). These standards then serve as the foundation for an organization's diving program that is overseen and organized through an organization's Diving Control Board (DCB). Meeting the minimum standards defined in this manual is a requirement for organizations to become a member of the Dutch National Scientific Diving Committee (DNSDC) and take part in Scientific Diving activities in the Netherlands.

The Scientific Diving Standards provide (1) minimum standards for research organizations that want to establish a Scientific Diving program, (2) standards on how to conduct such Scientific Diving programs, and (3) the basic regulations and procedures to maximize persons' safety during Scientific Diving operations.

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[3] https://www.esdpanel.eu/

[4] The institute-specific addendum is provided by the employer or host organization and should be used together with the Standards for Scientific Diving manual (see A6).

The Dutch National Scientific Diving Committee (DNSDC) is always available for information or help to anyone involved in academic diving programs in the Netherlands.

A3. Definition of Scientific Diving

Scientific Diving is defined following the definition of the American Association of Underwater Scientists (AAUS) as:

“Diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks. Scientific Diving does not include performing any tasks usually associated with commercial diving, such as: Placing or removing heavy objects underwater, inspection of pipelines and similar objects, construction, demolition, cutting or welding, or the use of explosives.”

In other words, scientific divers are scientists or scientists-in-training that observe and gather scientific data while SCUBA-diving. They do not engage in construction and trouble-shooting tasks associated with commercial diving. Scientific Diving focusses on gathering data or collecting samples using recreational diving technology, tools and procedures (e.g., register observations, deploy sensors and sampling equipment with a maximum in-water weight of less than 20 kg, use of mechanical/electrical hand tools).

This Scientific Diving protocol is not applicable when commercial certificates are specifically required such as e.g., offshore wind farms and oil and gas platforms, even if only light underwater work is performed.

A4. Exemptions for certain persons and specific forms of diving

Students (MSc and BSc) are exempted from the rules and regulations in the “Arbeidsomstandighedenbesluit” (Art. 6.31. Duikarbeid leerlingen en studenten). Students from educational institutions are allowed to take part in diving activities when they (1) have obtained a recreational dive certification and when diving activities (2) are for the purpose of scientific research, (3) involve “light work”, and (4) are conducted as part of a buddy or a dive-team. Additional regulations can be implemented by Ministerial regulation (“ministeriële regeling”). While students are exempted, definitions are required to define what constitutes “light work” and what level of certification is required to avoid subjective interpretations of such terms. These definitions can be incorporated in a future version of these standards. The standards presented in this document hence apply to the staff of research institutes, PhD candidates (AiO’s, OiO’s) and postdoctoral fellows.

This protocol does not apply to or provides guidelines for the following types of diving:

- decompression diving
- NITROX diving
- diving deeper than 40 m
- mixed gas diving
- solo-diving
- blue water diving
- ice and polar diving
- diving at altitude (> 300 m)
- cave diving
- rebreather diving
- saturation diving
- surface supplied forms of diving (e.g., snuba)

A5. Consequences of Violation of Regulations

Failure to comply with the regulations of this diving safety protocol may be cause for the restriction or revocation of the diver's Scientific Diving authorization by the diver's employer or host organization.

A6. Operational Control

An institutional diving program is characterized by (1) a diving safety manual which includes at a minimum: procedures covering all diving operations specific to the program; procedures for emergency care, including recompression and evacuation; and criteria for diver training and certification, and (2) a Diving Control Board (DCB) that can approve and monitor diving projects, review and revise the diving safety manual, assure compliance with the manual, certify the depths to which a diver has been trained, take disciplinary action for unsafe practices and, assure adherence to the buddy system (a diver is accompanied by and is in continuous contact with another diver in the water) for SCUBA diving.

Each institute with a Scientific Diving Program shall ensure that its personnel adhere to the standards described in this document and fulfill the administrative obligations that result from it. The standards herein should be adhered to regardless of where diving research takes place. If an organization conducts specific diving activities that are not explicitly covered in this manual, the organization should add relevant regulations and guidelines specific to its own diving program to this manual (institute-specific addendum) so that these additional

specifications meet or exceed those in this manual. Additions need to be approved by the Dutch National Scientific Diving Committee (DNSDC).

An employer is ultimately responsible for all diving activities taking part under its auspices by its employees and students. An employer shall minimize the risks associated with diving activities (1) by endorsing the guidelines and procedures in this document, (2) pay for all costs associated with obtaining, maintaining, or servicing dive gear, (3) pay for medical exams to ensure employees are fit to dive, (4) provide accident and liability insurances for those conducting research diving under its auspices and (5) cover costs associated with all training that might be necessary to safely conducting Scientific Diving projects, including medical training.

A6.1 The Diving Control Board (DCB)

The Diving Control Board (DCB) oversees and approves all Scientific Diving activities conducted by employees of an organization (e.g., universities, research institutes). The DCB consists of (at minimum) one chairperson, i.e., the Diving Safety Officer (DSO), appointed by the responsible administrative officer, with the advice and counsel of the DCB, and two active scientific divers. A DSO should have at least 3 years of experience with all aspects of Scientific Diving (i.e., engaged in sustained or successive scientific diving activities during the past three years) and can also be an inactive researcher with previous experience. Alternative membership of the board (e.g., adding an organization's safety expert) can be defined by an organization's own procedures. Within an organization, the DCB has absolute authority over the Scientific Diving program's operations. The DCB can delegate aspects of an organization's diving program (e.g., record keeping) to other entities within an organization (e.g., HR department, an organization's own dive training program).

The DCB must:

- Establish operational procedures (when necessary) beyond those described in this manual to address an organization's specific needs and concerns.
- Approve Scientific Diving projects conducted by the organization's employees.
- Annually, and based on each year's experience, review and if necessary, recommend revisions of this manual to the Dutch National Scientific Diving Committee (DNSDC).
- Ensure compliance with the procedures outlined in this safety manual and investigate diving incidents or violations of an organizations diving related procedures.
- Approve the depth to which a diver is authorized to dive.
- Take disciplinary action when divers engage in unsafe practices.

- Act as the official representative of an organization when engaging with the Dutch National Scientific Diving Committee (DNSDC).
- Recommend the issue, reissue, or the revocation of diving authorizations (the DCB can, in special cases, waive specific requirements of training, examinations, depth authorizations, and minimum activity to maintain authorizations).
- Suspend diving operations that are considered unsafe or unwise.
- Recommend criteria for equipment selection and use.
- Establish and/or approve facilities for the inspection and maintenance of diving equipment.

A6.2 Dive group
A dive group (aka: Dive Team) consists of at least two divers that form a dive team/buddy pair and a dive leader. The Dive leader can be one of the divers if an Observer is present.

The specifics of each role within a dive team are described below.

A6.2 Diver
A person who stays underwater for a period of time by carrying a supply of compressed gas., A diver has to (1) be qualified to be a member of a Scientific Diving team following the standards described in **D1** of this manual and (2) show proof that no medical conditions exist that would disqualify a diver from taking part in Scientific Diving (see: section **D3**).

A6.3 Dive leader
One individual shall be designated as the Dive Leader (aka: Lead Diver) for each dive. The Dive Leader shall be at the dive location during the diving operation and will:

- Ensure that all diving activities occur in accordance with the procedures outlined in section **B** of this manual.
- Ensure that all members of a dive team are qualified for diving and possess a current authorization to do so.
- Ensure safety and emergency equipment (see section **C5**) is in working order and present at the dive site.
- Suspend diving operations if (in his/her opinion) conditions are not safe.
- Report to the DSO, all physical problems believed to have resulted from diving, especially symptoms of pressure-related injuries.

A6.4 Observer
One individual shall be designated as an Observer for each dive. The Observer shall be at or near the dive location physically or if conditions do not allow to leave a person alone onshore (due to e.g., personal safety issues) through e.g., radio or phone contact. The Observer

ensures that divers return from their dives at priorly agreed times. The Observer does not partake in diving activities and is foremost responsible for starting emergency procedures in cases divers do not return or surface and coordinate with others in case activities in the vicinity of diving operations unfold that are likely to interfere with diving operations. The observer possesses a current certification of having successfully followed a course in basic rescue techniques relevant to SCUBA diving emergencies (diving first aid, including cardio-pulmonary resuscitation (CPR) and oxygen administration).

Table 1: Overview of responsibilities within organizations.

	Diving Safety Manual	DNSDC 1 Dive plan	DNSDC 2 Diver registration	DNSDC 3 Dive logs
Dutch National Scientific Diving Committee (DNSDC)	**revise**			
Organization's management	**approve**			
Dive Safety Officer (DSO)	**evaluate**	**approve**	**approve/file***	
Diving Control Board (DCB)**	**evaluate**	**evaluate**	**check**	
Lead diver	**follow**	**formulate**		**formulate / file**
Diver	**follow**		**formulate**	

** Note that administrative aspects of this task could be outsourced to an organization's HR or administrative department*
*** An organization's safety expert could be added to the DCB if desired*

A7. Collaborative diving projects, reciprocity and associated divers

When two or more organizations are involved in one collaborative research project that involves diving activities, they must designate one of the participating DCBs to govern the joint dive project. A Scientific Diver from one organization must apply for permission to dive under the auspices of another by submitting form DNSDC -2 (Diver registration, Appendix 1) to the host's organization DSO. If denied, the host DCB will send the visiting Scientific Diver and their DCB an explanation of all reasons for the denial. Responsibility for individual divers ultimately resides with the home organization.

Associated divers are persons with similar or greater experience as Scientific Divers that are not employed through a Dutch research organization. Examples of associated divers include students, dive masters and -instructors of certified dive centers, diving staff of a research institute that is visited, etc. Given their qualification, associated divers can assist Scientific Divers with field work and if necessary, take over the responsibilities of a Dive leader or Observer. Associated divers have to be included on the dive plan (DNSDC -1, Appendix 1).

A8. Record Keeping Procedures and Requirements

Each organization must maintain consistent records for its diving program and for each participant. These records include but are not limited to:

(1) a manual Standards Scientific Diving (this document), (2) records showing equipment was inspected, tested and maintained (annually; DNSDC-2), (3) medical approval to dive for each diver (every 5 years or specified in institute-specific addendum; DNSDC-2), (4) diver training records (DNSDC-2), (5) diver authorization(s) (DNSDC-2), (6) dive plans (DNSDC-1), (7) individual dive logs (DNSDC-3), (8) dive incident reports and (9) reports of disciplinary actions. Records and documents must be retained by the organization following national regulations.

B. DIVING REGULATIONS

All Scientific Diving activities will take part by a Dive Team (aka: Dive group). All members of a Dive Team possess a current certification of having successfully followed a course in basic rescue techniques relevant to SCUBA diving emergencies (Diving first aid, including cardio-pulmonary resuscitation (CPR) and oxygen administration) and are familiar with the location and content of the Emergency Action Plan (form DNSDC-1, Appendix 1).

Scientific Diving is performed following the most recent ND88 and DCIEM tables, and the depth limit (not exceeding 40m) is determined by the conditions at the dive location and the qualifications of the dive team:

Scientific diving can take place with SCUBA to a depth of 30m when a person is certified as a European Scientific Diver (or equivalent) and the conditions at the dive locations have been evaluated as favorable by a Dive Safety Officer.

To SCUBA dive to a maximum depth of 40m divers need to be certified as Advanced European Scientific Diver (or equivalent) and the conditions at the dive locations have been evaluated as favorable by a Dive Safety Officer. The Dive Safety Officer also verifies that the divers have sufficient qualifications, training and experience for the pursued dive in the environment the dive is planned in.

This Scientific Diving manual applies anywhere in the world where underwater activities are carried out under responsibility of a Dutch research institutes. However, when local regulations demand to follow more stringent rules, these rules are applied on top of the rules listed in this document.

B1. Administrative procedures

No one shall engage in diving activities under an organization's diving program unless they have been authorized by their organization's DSO following the provisions outlined in this manual.

A Dive Plan (DP, see form DNSDC-1, Appendix 1) for each proposed project or dive must be submitted for approval by the DCB or designee before diving activities can begin. Dive Plans should be approved at least one week before diving activities commence. A DP should be formulated so that it considers the competency of the least experienced diver. The information included in a Dive Plan should include at least the following and the Dive Leader has briefed the Dive Team and relevant other persons (e.g., the captain of a boat) at least on all aspects in the overview below marked with an *:

- Names of all members of the Dive Team
- Name of Dive leader(s) and Observer(s)
- Dive Buddy assignments and tasks *
- Each Diver's authorizations
- Entry, exit, descent and ascent procedures *
- Diving Mode(s) and Gas(es)
- Turn around pressure and required surfacing pressure (Gas management) *
- Approximate number of proposed dives
- Location(s) of proposed dives
- Estimated depth(s) and bottom time(s) anticipated
- Maximum depth(s) and bottom time *
- Repetitive dive plans, if required
- Goals and objectives of the proposed work *
- Equipment and boats (if relevant) to be employed
- Perceived environmental and operational hazards anticipated and mitigations *
- Emergency and diver recall procedures*
- Emergency Action Plan

B2. Dive procedures

Before each dive, a Dive Team ensures that all members are fit, willing and sufficiently trained for the planned diving activities. It is a diver's responsibility and duty to refuse to dive, without fear of penalty, if in his/her judgment, conditions are unsafe or unfavorable. A Dive Team will suspend all diving activities if one member suspects that the proposed diving

activities could negatively affect the safety or wellbeing of another. All diving activities adhere to the buddy system, whereby divers can assist one another in case of emergencies.

Before each dive, each member of a Dive Team conducts a functional check of their diving equipment (especially regulators and gauges) in the presence of their dive buddy and ensures that he or she has the capacity to achieve and maintain positive buoyancy. Environmental conditions at the dive site are assessed directly prior to entering the water to evaluate if last minute changes in e.g., currents or the weather require suspending or delaying planned diving activities.

Divers in a buddy pair follow the most conservative dive profile (e.g., in case different dive computers are used). On ascend, a safety stop (at least 3 minutes) is made at a depth of 3 meters for every dive exceeding 10 meters. A dive must be planned and executed so that each diver carries enough gas according to the “minimum gas principle”. Minimum gas represents the minimum amount of gas carried by each diver that will allow the diver to get themselves, and another diver, to the surface or next available gas source. When the minimum gas limit is reached by one diver in the team, the team ascents to the surface together. Other gas management procedures can be used after prior approval of one’s DSO. It is the responsibility of each diver to terminate a dive that he/she considers unsafe in a way that does not harm or endanger others in a Dive Team. A diver can deviate from the procedures outlined in this manual to prevent death or serious harm to oneself or another member of the Dive Team.

B3. Post-dive procedures

After each dive, divers will report any physical problems, symptoms of decompression sickness or gear malfunctioning to the Dive Leader, DSO or DNSDC. Each organization will develop its own emergency procedures, including criteria for emergency care, for evacuations, recompression and incident reporting. Divers cannot fly (> 300 m) for 12 hrs after making one dive within decompression limits or for 18 hrs after making multiple dives within decompression limits on one or more multiple days. Per 7 days of diving a diver has to have a break of one day without diving.

B4. Record keeping

Divers will log every dive made (including recreational dives if one wants) in a format of one’s organization’s choosing (e.g., in logbooks or online). The diver is responsible for maintaining these records and submit these annually to the DSO (DNSDC-3, Appendix 1). Dive logs should at minimum contain the following information for each dive:

- Name of diver and buddy
- Date, time, and location
- Diving modes used
- General nature of diving activities
- Maximum depth and dive time
- Diving tables or computers used
- Detailed report of any near or actual incidents

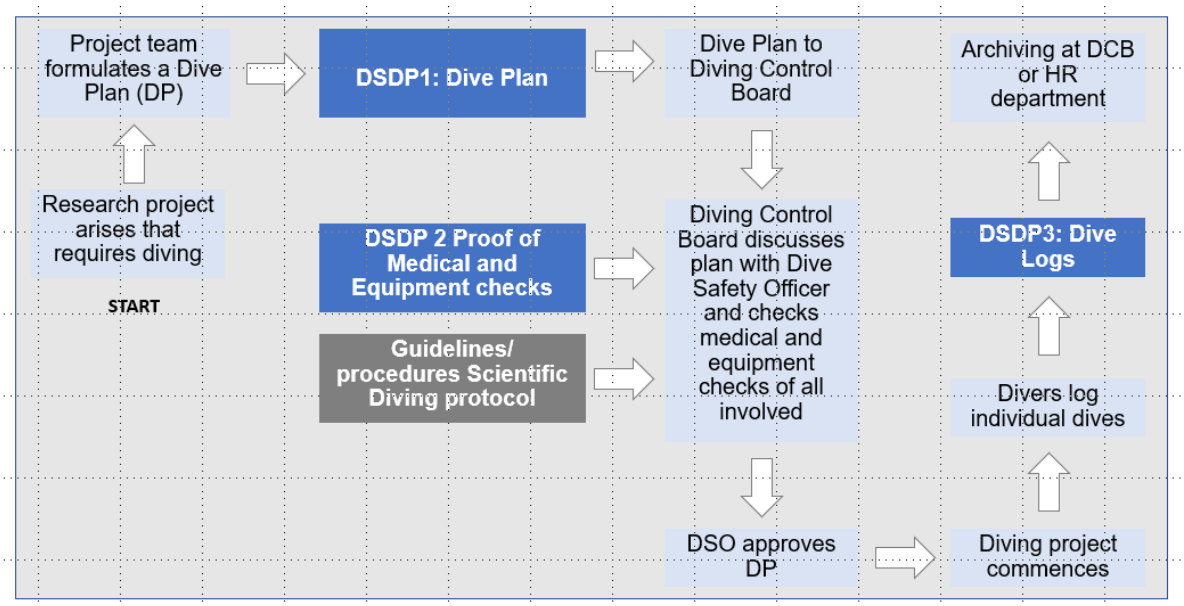

Figure 1: Overview of the different steps within a project which includes diving activities. DP: Dive Plan (DNSDC-1); DSO: Diving Control Board.

In case a diver requires hyperbaric treatment or sustains moderate or serious injury, the Dive Leader immediately sends a report to the organization's DSO, DCB and DNSDC including details of those involved (including contact information), the circumstances under which an accident took place, a description of the injuries or illnesses (including treatment(s) given) and recommendations to avoid similar incidents in the future. Dive accidents resulting in permanent injuries, hospitalization, or death, should be reported to the proper authorities (Arbeidsinspectie; article 9 Arbowet).

C. EQUIPMENT

C.1 General

In addition to the equipment below, each diver possesses basic dive gear, including, at least a diving mask and snorkel, a releasable weight belt (or similar), a dive knife or scissors and a wet or dry suit suitable for local environmental conditions.

All equipment (including rental equipment) needs to meet the standards set by the DNSDC and important items (regulators, gauges and BCDs) require at least annual inspection following the manufacturer's specifications and authorized service points. Each maintenance service must be logged, (date and nature of work performed), serial number of the item (if possible), and the name of the person or company that performed the work for the following equipment: (1) regulators, (2) gauges (SPG, Depth Gauges, Timers, and Dive Computers), (3) BCDs, (4) dry-suits and (5) full face masks. The diver is responsible for maintaining these records and submit these annually to the DSO. All (rented) equipment must be used and services following the manufacturer's specifications.

C.2 Regulators and Gauges

The standard configuration for open-circuit diving consists of a first stage, a primary and back up 2nd stage, a submersible pressure gauge (SPG) and the inflator hose for a Buoyancy Compensator Device (BCD). A full-face mask can be used instead of the primary 2nd stage. Regulators should meet or exceed the European CE open circuit standard EN 250.

C.3 Dive tanks

Scuba cylinders must be designed, constructed, maintained and hydrostatically tested in accordance with the applicable European provisions (e.g. NEN-EN). Scuba cylinders and valves must have an internal and external inspection at intervals following national regulations of the country where the dives are performed (e.g., 5 years in the Netherlands).

C.4 Other diving equipment

Each diver has at least:

- a functional underwater timing device and depth indicator, or dive computer. If divers make multiple dives, the same dive computer must be used.
- a means (e.g., a BCD) to achieve and maintain neutral buoyancy underwater and positive buoyancy at the surface (not be used to lift items underwater instead of lift bags)

C.5 Support equipment

A first aid kit and emergency oxygen appropriate for the diving being conducted must be available at the dive site. Oxygen should last so all injured divers can be transported to a decompression chamber or other necessary medical services. A diver's flag (or Surface Marker) must be displayed prominently where required or where water traffic is probable. Communication equipment (including spare batteries or chargers) must be present on shore near the dive site (or on a boat) to contact local emergency services.

C.6 Gas standards

Every effort should be made to verify breathing gas meets the requirements of the NEN-EN 12021 standard (or similar). If this is not verifiable, the DCB must develop a protocol to mitigate risk to the diver.

NEN-EN 12021 standard

- Water vapor (H_2O): <25mg/m^3 (measured from compressor. Fill pressure: 225/330 bar)
- Water vapor (H_2O): <35mg/m^3 (measured from dive cylinder. Fill pressure: 330 bar)
- Water vapor (H_2O): <50mg/m3 (measured from dive cylinder. Fill pressure: 225 bar)
- Carbon monoxide (CO): <15ppm
- Carbon dioxide (CO_2): <500ppm
- Oils: <0,5mg/m^3 (no smell/ taste)

D. SCIENTIFIC DIVER CERTIFICATIONS

D.1 Diver

A person can start Scientific Diving activities within a dive team if he/she has a European Scientific Diving (ESD) qualification[5] or:

- 50 logged dives (show proof by personal logbook or dive computer records).
- “Rescue diver” certification from a recognized SCUBA diving training agency showing proof of basic rescue techniques relevant to SCUBA diving emergencies.
- Diving first aid, including cardio-pulmonary resuscitation (CPR) and oxygen administration.
- When the last dive before the start of fieldwork was logged longer than a 18 months ago, the employee has to log a minimum of 5 new dives without a scientific task before commencing any Scientific Diving.

While joining a dive group is possible with the above-mentioned pre-requisites, the employee can be asked to work towards securing the European Scientific Diver certification by his/her employer. Requirements to apply for an ESD qualification can be found in Appendix 3.

[5] https://www.esdpanel.eu/sd-european-standards/

D.2 Dive leader

An employee can lead a dive team if he/she has an Advanced European Scientific Diver certification[6] (AESD; www.esdpanel.eu). A Dive leader is a diver capable of organizing and supervising a Scientific Diving team (see: A6.2 Dive leader). A person can function as a dive leader having an Advanced European Scientific Diving (AESD) qualification or:

- (1) European Scientific Diving (ESD) qualification or (2) a “Rescue diver” certification from a recognized SCUBA diving training agency and proof of having followed a course in basic rescue techniques relevant to SCUBA diving emergencies (Diving first aid, including cardio-pulmonary resuscitation (CPR) and oxygen administration).
- 100 logged dives (show proof by personal logbook or dive computer records).
- When the last dive before the start of fieldwork was logged longer than 18 months ago, the employee has to log a minimum of 5 new dives without a scientific task before commencing any Scientific Diving.
- Show proof of having experience leading a dive group[7].

While joining a dive group is possible with the above-mentioned pre-requisites, the employee can be asked to work towards securing the European Scientific Diver certification by his/her employer. Requirements to apply for an AESD qualification can be found in Appendix 3.

D.3 Medical examinations

All scientific divers must pass a medical examination by a certified Dive physician (Keuringsarts B) at least every 5 years or more frequent if required in the institute-specific addendum. A medically cleared diver experiencing any conditions which may disqualify candidates from diving (Appendix 4) must receive clearance to return to diving from a physician before resuming diving activities. The medical examination requirement cannot be waived for any diver.

[6] https://www.esdpanel.eu/sd-european-standards/
[7] Provide a written overview (CV) of projects and experiences in which you fulfilled the role of dive leader or gained other relevant experience e.g. having supervised dive groups in the field during a project/field course, proof of divemaster training.

APPENDIX 1: DNSDC FORMS

Important: The information below provides a guideline for the forms DNSDC-1, DNSDC-2 & DNSDC-3. National forms will be formulated and evaluated in later versions of the Standards for Scientific Diving. Institute-specific adjustments and requirements apply (please consult your institute-specific-addendum).

DNSDC-1: SCIENTIFIC DIVE PLAN + EMERGENCY PLAN

Date Submitted:
Institute/Department:

Project Title:
Short project name:

Start of Project:
End of Project:

Responsible Project Leader/PI:
E-mail:
Phone number:

Scientific dive plan submitted by:
Role in plan:
E-mail:
Phone number:

Dive Location(s):

Additional regulations: *Do additional national or regional regulations apply for diving and field work in the country/region where the project will be performed?*

Project

Project goal/objectives:

Detailed description of Activities and Location: *include a map with the planned dive area*

Types of work performed during dives:

multiple answers possible:

☐ *underwater survey (free-swimming or transect based)*

☐ *underwater photography/ underwater videography*

☐ *specimen collection*

☐ *in-situ measurement (e.g. physiological experiments)*

☐ *benthic coring*

☐ *research equipment/material deployment and maintenance.*

☐ *Other....*

Planned Max./Average Depth(s):

***** *maximum diving depth is 30 or 40 meter (see section B of the Standards Scientific Diving). The only exception could be in an emergency event to prevent fatalities in the team, under the condition that this will not endanger the other divers of the team.*

Dives Per Day: *How many dives per day, scheduled rest days per team member*

Approximate number of proposed dives

Total Daily Bottom Time:

Diving Mode:

Breathing Gas: *gas management*

Source of Breathing Gas: *organized via a dive center? Or where will tanks be filled? Etc.*

Recent Air Test: *air quality test*

Dive Planning Mechanism:

Environment:

Platform: *shore/boat/etc*

Entry, exit, descent and ascent procedures:

Specialized Sampling Equipment/Tool Considerations:

List of Dive Team Members:
It is the responsibility of the PI and Lead Diver to ensure that all divers have experience and current authorizations for the proposed activities. Include the roles in the Dive Team. Continue on a separate sheet if needed.

Name	*Certification*	*Max Depth*	*Cleared to dive (DSO)*	*Insurance status*	*Emergency contact information (including name, relation and telephone number)*

Risk assessment and mitigation measures:

List identified risks associated with proposed activities or environment (e.g. thermal issues, lost/wayward diver, high currents, deep depths, low visibility, vessel traffic, hazardous marine organisms, etc.) and measures for eliminating or reducing risks to acceptable levels.

RISK	**MITIGATION MEASURES**
Example: *Hypothermia/hyperthermia*	*Example:* *Minimize by wearing appropriate dive gear and appropriate wind breakers / water bottles/ sun hats and sunscreen and constant monitoring, dive hood optional.*

Emergency procedures
Communication procedure: *How is communication organised to start the chain of survival.*

Oxygen at Site: *Yes/No*

First Aid at Site: *Yes/No*

Volume of Oxygen available: Tank size: **Fill pressure:**

O_2 delivery system: *Demand or free flow?*

Time of O_2 supply: *How long can two divers be supplied with oxygen on location?**

**Enough oxygen has to be available to supply two persons with 100% oxygen for the amount of time it takes to transport the persons to the next hospital/recompression chamber or for professional paramedics to arrive at the site.*

Dive Accident Management Plan
#Project name # Dive Accident Management Plan

I. FIRST RESPONSE
- A. Evaluate Airway, Breathing, and Circulation (ABC's) and initiate CPR if necessary. Contact emergency medical personnel on island that an emergency has occurred.
- B. Immediately provide the victim with oxygen at the highest partial pressure possible.
  - a. if conscious, use demand valve to deliver 100% oxygen
  - b. if unconscious and breathing, use non-rebreather mask at 15 liters per minute (lpm).
  - c. If not breathing, use pocket mask with supplemental oxygen at 15 lpm.
- C. Maintain the victim on oxygen during the transport to emergency medical facilities or until assistance arrives. Keep the victim comfortable and supine. If able, and not experiencing an altered level of consciousness, have the victim sip water. Guard against environmental exposure, Monitor for shock and treat if present.
- D. Secure affected diver's equipment if possible. Isolate affected gear from other equipment and leave equipment in the condition it was found. Tag equipment, "Do Not Handle".

II. COMMUNICATION
- A. **Divers Alert Network for medical and evacuation advice:**
  To be filled in for region project is diving in (Europe, North America, Asia, etc.)
- B. If necessary, begin transport to the nearest evacuation location or medical center.
- C. The dive leader will notify the Diving Safety Expert of the institute that work is performed for

III. TREATMENT

A victim of a pressure-related injury should be transported to a recompression chamber as soon as possible, by the most expedient means available. The victim should remain on oxygen at the highest partial pressure deliverable until arriving at the chamber or medical facility.

For relatively short transport times (a few hours), the victim may remain on oxygen without interruption. For longer transport times (many hours to days), the victim should be kept on an intermittent oxygen/air schedule to delay the onset of pulmonary oxygen toxicity. A recommended schedule is 50 minutes on oxygen, 10 minutes off. This schedule may be modified at the physician's (initial contact: MSOS or DAN) discretion. It may be necessary to keep the victim on oxygen continuously for the first couple of hours, then initiate an intermittent schedule.

For any long-term administration of oxygen at high partial pressure (greater than 0.5 ATA), the oxygen exposure must be carefully monitored and recorded. Generally, if

the expected time of oxygen administration will be several days, a patient should not receive more than 10000 minutes of 100% oxygen in and single 24-hours period. Longer periods of pulmonary recovery time must be scheduled into the treatment regime.

Pulmonary oxygen toxicity is measured in Unit Pulmonary Toxic Dose (UPTD), where one minute of oxygen at 1.0 ATA (760 mmHg), is 1 UPTD. Except in the extreme life-threatening circumstances the maximum allowable dosage of oxygen is 1440 UPTD's per 24-hour period. This amount of oxygen will result in a 10% loss of vital capacity. Any patient receiving this dose must be given a 10-12 hour recovery period before the administration of additional oxygen. When the patient arrives at a recompression chamber, the hyperbaric physician must be advised of the total amount oxygen the patient has received, as this will affect the timing and length of chamber treatment.

IV. HYPERBARIC FACILITES AND EVACUATION OPTIONS

Nearest Medical Treatment Facility to Dive Site(s):
To be filled in for region project is diving in

Where is the nearest operational recompression chamber located?
To be filled in for region project is diving in. Is it functional: Can diving incidents be treated there?

Evacuation/transportation considerations: *Transportation options to nearby facility?*

General Dive Plan Considerations:

- Any diver has the right to refuse to dive without fear of penalty if s/he feels the conditions are unsafe or unfavorable OR the dive violates the precepts of their training
- All Dive plans MUST be based on the competency of the least experienced diver.
- An ascent rate of *9/min* to 50% of the maximum depth, a slower ascent speed of 3m/min from 50% of the maximum depth to the surface and a precautionary stop at *3m for 3-5min* should be made for each dive.
- For all diving conducted under hazardous conditions a plan should be formulated to deal with such conditions.
- All divers using dive computers to plan dives and indicate or determine decompression status should follow the AAUS recommended dive computer guidelines.
- Plan dives conservatively and maximize surface intervals.
- A diver should wait at least **18-24 hrs** before flying or traveling to altitude (1000+ft) after any dive.
- An Emergency Plan should be reviewed for each project including the following: emergency contact information (including name, relation and telephone number) for each diver, nearest recompression chamber, nearest accessible hospital and anticipated means of transportation.

Diving Accident Emergency Management Plan

A diving accident victim is any person who has been breathing compressed gas underwater regardless of depth. It is essential that emergency procedures are pre-planned and medical treatment is initiated as soon as possible. It is the responsibility of the “Lead Diver” to develop procedures for such emergencies including evacuation and medical treatment for each dive location.

General Procedures:

Explain the circumstances of the dive incident to the evacuation team, medics and physicians. Do NOT assume that they understand why 100% Oxygen may be required for the diving accident victim or that recompression treatment may be necessary.

1. Rescue victim and/or position so the proper procedures may be initiated.
2. Establish (A)irway, (B)reathing and (C)irculation as required.
3. Administer 100% oxygen, if appropriate (in cases of Decompression Illness or Near Drowning).
4. Activate the local EMS for transport to the nearest appropriate medical facility. (the local EMS will vary from site to site – it must be stated in dive plan)
5. Contact the Diver’s Alert Network, Coast Guard, EMS or UC Travel Assistance Program.
6. Contact Diving Safety Officer (DSO) and Emergency Contact Person.

Divers Alert Network:

24/7 Diving Emergency:

To be filled in for region project is diving in (Europe, North America, Asia, etc.)

DAN Non-Emergency Diving Questions and all other DAN services:

To be filled in for region project is diving in (Europe, North America, Asia, etc.)

Signatures

Lead Diver Affidavit:

X

_____ xxxxx _____

Signature of Lead Diver **Date**

Supervisor or Advisor Approval:

I verify the need for this project and the student or employment status of listed divers for this project is as indicated.
I hereby approve the contents of this protocol as well as diving activities for which it is implemented.

X

_____ _____

Signature of PI, Advisor, or Supervisor **Date**

Receipt Date: xxxxx **DSO Review Date:** xxxxxx

Remarks, Conditions, Restrictions:

X **xxxxxx**

_____ _____

Signature of DSO **Date**

DNSDC-2: DIVER REGISTRATION: CERTIFICATION, MEDICAL FILE & EQUIPMENT

Important: The information below provides a guideline for what the form DNSDC-2 should include. National forms will be formulated and evaluated in later versions of the Standards for Scientific Diving. Institute specific adjustments and requirements apply (please consult your institute-specific-addendum).

Certification:

Personal information:

Institute/Department:

Dive certification (s): *Provide copies of Certification to DSO.*

- *Level*
- *Additions*
- *Issue date*
- *Validity*
- *Optional: Show proof of having experience leading a dive group: Provide a written overview (CV) of projects and experiences in which you fulfilled the role of dive leader or gained other relevant experience e.g. having supervised dive groups in the field during a project/field course, proof of divemaster training.*

Medical File

All scientific divers must pass a medical examination by a certified Dive physician (Keuringsarts B). The proof of medical clearance to dive should be filed in the DNSDC-2. The diver is responsible for maintaining these records and submit these to the DSO.

Equipment:

Status of equipment:

Details on brand/series/specification:

Overview maintenance status:

Provide inspection and service details, including details on authorization service points*. E.g. Scuba cylinders and valves must have an internal and external inspection at intervals.

*Each maintenance service must be logged, (date and nature of work performed), serial number of the item (if possible), and the name of the person or company that performed the work. The diver is responsible for maintaining these records and submit these annually to the DSO. All (rented) equipment must be used and services following the manufacturer's specifications.

DNSDC-3: DIVE LOG

Important: *The information below provides a guideline for the form DNSDC-3. National forms will be formulated and evaluated in later versions of the Standards for Scientific Diving. Institute specific adjustments and requirements apply (please consult your institute-specific-addendum).*

The dive logs:

The diver is responsible for maintaining these records and submit these annually to the DSO
Dive logs should at minimum contain the following information for each dive:

- Name of diver and buddy
- Date, time, and location
- Diving modes used
- General nature of diving activities
- Maximum depth and dive time
- Diving tables or computers used
- Detailed report of any near or actual incidents
- *Additional information:*
  Conditions
  Visibility & current
  Temperature of the water
  Salt/Fresh Water
  Cylinders used
  Weight
  Exposure Wear
  Role in Dive Team
  Purpose of the Dive: e.g. Details on Scientific Task, Project

APPENDIX 2: DEFINITION OF TERMS

AESD	Advanced European Scientific Diver
Commercial Diver:	An employee involved in tasks beyond light underwater work that are **not** part of the exemption for scientific diving. These tasks can be placing or removing heavy objects (>20 kg) underwater, using high pressure tools, inspection of pipelines and similar objects, construction, demolition, cutting or welding, or the use of explosives. In some environments, commercial certificates are specifically required such as e.g., offshore wind farms and oil and gas platforms, even if only light underwater work is performed.
Buddy pair:	Two comparably equipped scuba divers in the water in constant communication.
Dive computer:	A microprocessor based device which computes a diver's theoretical decompression status, in real time, by using pressure (depth) and time as input to a decompression model, or set of decompression tables, programmed into the device.
Dive group:	A dive group (aka: Dive Team) consists of at least two divers that are forming a dive team/buddy pair and a dive leader who can be one of the divers if an Observer is present on shore.
Dive leader:	Certified scientific diver with experience and training to conduct the diving operation
Dive site:	Physical location of a diver during a dive.
Dive team:	see: Dive Group
Diver:	A person who stays underwater for long periods by carrying a supply of compressed gas.
Diving Control Board (DCB):	Group of individuals who act as the official representative of the membership organization in matters concerning the Scientific Diving program.
Diving Safety Officer (DSO):	Individual responsible for the safe conduct of the Scientific Diving program of the membership organization
Dive insurance	Additional insurance complementing standard accident and liability insurances provided by the employer. This Dive insurance specifically covers emergency support related to scientific diving, e.g. Dive Alert Network (DAN) insurance.
ESD:	European Scientific Diver. An ESD certificate can be issued by a representative of an ESDP member state. Requirements for applying for the ESD qualification can be found in Appendix 3.
Observer:	The Observer ensures that divers return from their dives at priorly agreed times. The Observer does not partake in diving activities and is foremost responsible for starting emergency procedures in cases

	divers do not return or surface and coordinate with others in case activities in the vicinity of diving operations unfold that are likely to interfere with diving operations. The observer possesses a current certification of having successfully followed a course in basic rescue techniques relevant to SCUBA diving emergencies (diving first aid, including cardio-pulmonary resuscitation (CPR) and oxygen administration).
Nitrox:	Any gas mixture comprised predominately of nitrogen and oxygen, most frequently containing between 22% and 40% oxygen. Also be referred to as Enriched Air Nitrox, abbreviated EAN.
Scientific Diver:	Scientific divers are scientists or scientists-in-training that observe and gather scientific data while SCUBA-diving.
SCUBA diving:	SCUBA Self Contained Underwater Breathing Apparatus. Type of diving whereby divers use breathing equipment that is completely independent of a surface gas supply.
Employer:	An employer is ultimately responsible for all diving activities taking part under its auspices by its employees and students. An employer shall minimize the risks associated with diving activities (1) by endorsing the guidelines and procedures in this document, (2) pay for all costs associated with obtaining, maintaining, or servicing dive gear, (3) pay for medical exams to ensure employees are fit to dive, (4) provide accident and liability insurances for those conducting research diving under its auspices and (5) cover costs associated with all training that might be necessary to safely conducting Scientific Diving projects, including medical training.

APPENDIX 3: EUROPEAN PANEL FOR OCCUPATIONAL SCIENTIFIC DIVING STANDARDS

ESD – European Scientific Diver level of competency

The ESD must show proof of basic theoretical knowledge and a basic understanding of:

- Diving physics and physiology, the causes and effects of diving related illnesses and disorders and their management.
- The specific problems associated with diving to and beyond 20m, calculations of air requirements, correct use of decompression tables.
- Equipment, including personal dive computers and guidelines as to their safe use.
- Emergency procedures and diving casualty management.
- Principles of dive planning.
- Legal aspects and responsibilities relevant to Scientific Diving in Europe and elsewhere.

Be fully competent with/in:

- Diving first aid, including cardio-pulmonary resuscitation (CPR) and oxygen administration to diving casualties.
- SCUBA rescue techniques and management of casualties.
- The use and user maintenance of appropriate SCUBA diving equipment.

Be fully competent with:

- Search methods.
- Survey methods, both surface and sub-surface, capable of accurately locating and marking objects and sites.
- The basic use of airbags and airlifts for controlled lifts, excavations and sampling.
- Basic rigging and rope work, including the construction and deployment of transacts and search grids.
- Underwater navigation methods using suitable techniques.
- Recording techniques.
- Acting as surface tender for a roped diver.
- Sampling techniques appropriate to the scientific discipline being pursued.
- Show proof of having undertaken 70 open water dives, to include a minimum of:
- 20 dives with a scientific task of work supervised by a recognized research institution, such as listed above.
- 15 dives deeper than 15m of which of 5 dives deeper than 25m

- 12 dives in the last 12 months, including at least 6 with a scientific task of work.

All evidence must be recorded in nationally acceptable logs, countersigned by suitably qualified persons. None of the above precludes the possible requirement for a practical or theoretical demonstration of any or all of the points shown.

AESD – Advanced European Scientific Diver level of competency.

The AESD must show proof of basic theoretical knowledge and a basic understanding of:

- Diving physics and physiology, the causes and effects of diving related illnesses and disorders and their management.
- The specific problems associated with diving to and beyond 20m, calculations of air requirements, correct use of decompression tables.
- Equipment, including personal dive computers and guidelines as to their safe use.
- Emergency procedures and diving casualty management.
- Principles of dive planning.
- Legal aspects and responsibilities relevant to Scientific Diving in Europe and elsewhere.
- Dive project planning.

Be fully competent with/in:

- Diving first aid, including cardio-pulmonary resuscitation (CPR) and oxygen administration to diving casualties.
- SCUBA rescue techniques and management of casualties.
- The use and user maintenance of appropriate SCUBA diving equipment including dry suits and full-face masks.

Be fully competent with:

- Search methods.
- Survey methods, both surface and sub-surface, capable of accurately locating and marking objects and sites.
- The basic use of airbags and airlifts for controlled lifts, excavations and sampling.
- Basic rigging and rope work, including the construction and deployment of transacts and search grids.
- Underwater navigation methods using suitable techniques.
- Recording techniques.
- Acting as surface tender for a roped diver.
- Sampling techniques appropriate to the scientific discipline being pursued.

- Show proof of having undertaken 100 open water dives, to include a minimum of:
- 50 dives with a scientific task of work supervised by a recognized research institution, such as listed above.
- 10 dives between 20m and 29m.
- 10 dives between 29m and the national limit.
- 12 dives in the last 12 months, including at least 6 with a scientific task of work.
- 20 dives in adverse conditions, such as currents, cold water, or moving water.
- 20 dives as an in-water dive leader.

All evidence must be recorded in nationally acceptable logs, countersigned by suitably qualified persons. None of the above precludes the possible requirement for a practical or theoretical demonstration of any or all of the points shown.

APPENDIX 4: CONDITIONS WHICH MAY DISQUALIFY CANDIDATES FROM DIVING

1. Please consult the following list of conditions that usually restrict candidates from diving (Adapted from Bove, 1998[8]: bracketed numbers are pages in Bove; AAUS[9] Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to autoinflate the middle ears. [5 ,7, 8, 9]
2. Vertigo, including Meniere's Disease. [13]
3. Stapedectomy or middle ear reconstructive surgery. [11]
4. Recent ocular surgery. [15, 18, 19]
5. Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, untreated depression. [20 - 23]
6. Substance abuse, including alcohol. [24 - 25]
7. Episodic loss of consciousness. [1, 26, 27]
8. History of seizure. [27, 28]
9. History of stroke or a fixed neurological deficit. [29, 30]
10. Recurring neurologic disorders, including transient ischemic attacks. [29, 30]
11. History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage. [31]
12. History of neurological decompression illness with residual deficit. [29, 30]
13. Head injury with sequelae. [26, 27]
14. Hematologic disorders including coagulopathies. [41, 42]
15. Evidence of coronary artery disease or high risk for coronary artery disease. [33 - 35]
16. Atrial septal defects. [39]
17. Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying. [38]
18. Significant cardiac rhythm or conduction abnormalities. [36 - 37]
19. Implanted cardiac pacemakers and cardiac defibrillators (ICD). [39, 40]
20. Inadequate exercise tolerance. [34]
21. Severe hypertension. [35]
22. History of spontaneous or traumatic pneumothorax. [45]
23. Asthma. [42 - 44]
24. Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae, or cysts. [45,46]
25. Diabetes mellitus. [46 - 47]
26. Pregnancy. [56]

[8] Bove, A.A. 2011. The cardiovascular system and diving risk. Undersea and Hyperbaric Medicine 38(4): 261-269

[9] AAUS Standards For Scientific Diving: https://aaus.org/AAUS/About/Diving_Standards/AAUS/Diving_Standards.aspx?hkey=25acfc9a-aea5-4e7f-86c6-9c514c1e764c