

GUV-R 2112

Rules for Safety and Health Protection

GUV-Rule Operation of Scientific Divers

Edition January 2006, Vers. 0.9

Translated from German language by the German Commission for Scientific Diving (without any warranty for correctness)

Kommission
Forschungstauchen
Deutschland

KFT



The German Commission
for Scientific Diving



**Statutory Accident
Insurance Association**

Rules for Safety and Health Protection (*GUV-Regeln*) are summaries respectively specifications of contents of

- Governmental Health and Safety Legislations
and/or
- Regulations of the Statutory Accident Insurance Associations
and/or
- Technical specifications
and/or
- The experience of prevention against accidents of the Statutory Accident Insurance Associations

Editors (of the original German GUV Rule 2112)

Deutsche Gesetzliche Unfallversicherung (formerly: Bundesverband der Unfallkassen)
Fockensteinstr. 1, 81539 München
www.dguv.de (formerly: www.unfallkassen.de)

Edition January 2006

Developed by the expert committee for underground engineering, Board of Examiners for Scientific Divers with cooperation of the German Commission for Scientific Diving (*Kommission Forschungstauchen, KFT*)

English translation by the German Commission for Scientific Diving (Frank Donat, Martin Mainberger, Philipp Fischer) in cooperation with the German Board of Examiners for Scientific Divers (Frank Werner).

Index

Preliminary remark

1 Application

2 Definitions

3 General Requirements

4 Equipment

- 4.1 Underwater breathing apparatus
- 4.2 Additional diving equipment
- 4.3 Buoyancy devices
- 4.4 Lines
- 4.5 Breathing-air compressors
- 4.6 Air supply system
- 4.7 Hyperbaric chambers
- 4.8 Electrical systems and operating devices

5 Operation

- 5.1 Direction and supervision
- 5.2 Risk assessment and preparation of the diving operation
- 5.3 Instruction
- 5.4 Dive teams
- 5.5 Requirements for scientific divers
- 5.6 Tasks and requirements of the signal person
- 5.7 Provision of equipment and devices
- 5.8 Requirements for operating diving apparatuses
- 5.9 Written documentation
- 5.10 Communication
- 5.11 Preparation of a dive
- 5.12 Descent of divers
- 5.13 Dives
- 5.14 Abandoning dives
- 5.15 Operation of surface-supplied Underwater Breathing Apparatuses
- 5.16 Post-dive measures

6 Inspection of equipment

7 Code of Practice during diving accidents

Appendix 1: Decompression tables for surfacing

Appendix 2: Calculations of reserve air volume (presently under review)

Appendix 3: Requirements for admission of Scientific Diving Training Institutions

Appendix 4: **Training schedule**

Preliminary Remark

GUV-Rules are primarily for employers and are designed as a guideline to the implementation of the employers' duties according to the statutory health and safety regulations. Additionally, these rules should help to prevent accidents at work as well as work related health risks and illnesses.

When observing the GUV-Rules, the contractor may proceed on the assumption that he will meet the safety targets as set out in the GUV-Regulations. Alternative solutions are possible providing they warrant identical health and safety standards. If, in further specification of the statutory health and safety regulations, technical rules have been established by appointed committees, then these take priority.

DRAFT

1. Application

1.1 These regulations, designed to protect health and enhance safety, apply to all diving operations with scientific purpose, i.e. scientific diving operations

1.2 These regulations do not apply

- To commercial diving operations
- In the context of emergency and first aid institutions, fire departments and police departments.

DRAFT

2. Definitions

- 2.1 Employer** means a member of a Statutory Accident Insurance Association. Employers include directors of institutes or heads of research institutions who assign scientific underwater work to scientific divers.
- 2.2 Diver** means a certified scientific diver or certified commercial diver.
- 2.3 Stand-by diver** means a diver who is ready at the dive site to immediately assist a diver in the water during an emergency.
- 2.4 Underwater Breathing Apparatus** means a diving apparatus in which the diver's breathing-gas supply is regulated on demand.
- 2.5 Pressure at diving depth** means the pressure at any given diving depth.
- 2.6 Signal line** means a rope that provides a connection between signal person (tender) and diver, for the purpose of communicating signals to, and securing, the diver. Signal lines may have strain-relieving telephone cables woven into them (telephone lines).
- 2.7 Telephone line** means a signal line which has a strain-relieving telephone cable woven into it.
- 2.8 Orientation line** means a rope assisting in the diver's orientation, used primarily during search operations.
- 2.9 Drop rope** means a rope serving in the diver's orientation between the surface and underwater workplace.
- 2.10 Buddy line** means a rope connection between two divers (a diving pair).
- 2.11 Signal buoy** means a cylindrical signalling device floating on the surface, connected to the diver by a line.
- 2.12 Dive** means a distinct and limited period of time spent under water.
- 2.13 Diving operation** means all dives of one or more dive teams, pursuing a specific objective under similar conditions at the same underwater location.
- 2.14 Dive team** means a group of divers consisting of at least one diver, one stand-by diver and one signal person.
- 2.15 Repetitive dive** means a dive within less than 12 hours after the end of the previous dive by the same diver.
- 2.16 No-decompression-limit** means the maximum permissible bottom time, measured from the moment of leaving the surface until the beginning of surfacing, which does not require decompression stops.
- 2.17 Ascent** means the relocation to a shallower water depth.

- 2.18 Surfacing** means an ascent to the surface.
- 2.19 Hyperbaric chamber** means a pressure chamber used for the treatment of divers.
- 2.20 Hyperbaric medical centres for diving related diseases** means stationary institutions.
- 2.21 Emergency decompression** means the decompression of a diver in a hyperbaric chamber at the dive location, and under controlled conditions.

DRAFT

3. General Requirements

Scientific diving operations must be carried out according to the rules of this GUV (Statutory Accident Insurance Association) regulation.

The employer takes responsibility for ensuring that equipment and facilities operate in accordance with these regulations and meet appropriate technical standards.

See also the accident prevention regulation 'Principles of prevention' ("Grundsätze der Prävention" – GUV-V A1).

Deviations from the GUV regulations are acceptable if alternative measures ensure the same level of safety. The employer must document this.

DRAFT

4. Equipment

4.1 Underwater breathing apparatuses

Underwater breathing apparatuses (UBAs) may be used only if they can provide the diver with a sufficient supply of breathing-gas regulated to a given diving depth, and without producing harmful pressure differences relative to that pressure at diving depth.

This is achieved if

UBAs comply with the following DIN standards respectively:

- *DIN EN 250 “Autonome Leichttauchgeräte mit Druckluft” (“Respiratory equipment Open-circuit self-contained compressed air diving apparatus - Requirements, testing, marking”),*
- *DIN EN 15 333-1 “Schlauchversorgte Leichttauchgeräte mit Atemgasen” (“Respiratory equipment. Open-circuit umbilical supplied compressed gas)*
- *DIN EN 13 949 “Autonome Leichttauchgeräte mit Nitrox-Gasgemisch und Sauerstoff” (“Respiratory equipment. Open-circuit self-contained diving apparatus for use with compressed Nitrox and oxygen. Requirements, testing, marking”)*
- *Pressure tanks have been filled with air according to DIN EN 12 021 “Druckluft für Atemschutzgeräte” (“Respiratory protective devices - Compressed air for breathing apparatus)*
- *The connection between the pressure tank valve(s) and the pressure regulator (1st stage) is secured through screw-thread connection*
- *The apparatus complies with the requirements of PPE regulations (certification).*

4.2 Additional diving equipment

Equipment to be provided under section 5.7, must meet the technical safety demands.

This is achieved if, for instance,

- *Weight systems or weights can be easily removed under water*
- *Diving knives (or comparable tools) can be easily fastened to the body (rather than to the weight system)*
- *Diver protection suits, in concordance with diving conditions, provide effective protection against hypothermia*
- *Diving suits manufactured according to DIN standards are used: DIN EN 14 225-1 “Tauchanzüge – Teil 1 Nasstauchanzüge” (“Diving suits – part 1: Wet suits - Requirements and test methods’) and DIN EN 14 225-2 “Tauchanzüge – Teil 2 Trockentauchanzüge” (“Diving suits – part 2: Dry suits - Requirements and test methods’), respectively*
- *Depth gauges comply with the standard DIN EN 13 319 “Tauchzubehör, Tiefenmesser und kombinierte Tiefen- und Zeitmessgeräte” (“Diving accessories - Depth gauges and combined depth and time measuring devices - Functional and safety requirements, test methods’)*

Diving computers may be used additively. Tables, however have precedence. Alerts and warnings of devices have to be considered.

4.3 Buoyancy devices

In addition to the minimum equipment requirements listed under section 5.7, the employer must provide diving operations using underwater breathing apparatuses with further equipment which, if necessary, will allow the controllable return of the diver to the surface, as well as the safe recovery of a diver involved in an accident.

To maintain hydrostatic balance, combined buoyancy and rescue devices (DIN EN 12 628) or buoyancy compensators (DIN EN 1809) are to be used.

Furthermore, dry suits made of neoprene are particularly suitable in that they provide enough buoyancy to bring the diver to the surface after removal of the weight system, even if they are damaged and become filled with water (this requirement must be ensured for the individual diver in relation to the respective equipment used).

4.4 Lines

4.4.1 Signal lines have a diameter of 10 to 14 mm and a minimum breaking strength of at least 2000 N. They are buoyant and easily visible. Their length must not exceed 80 m. It is not permissible to join several lines. Telephone lines do not need to be buoyant.

Well visible colours include zinc-yellow and orange-red.

4.4.2 Orientation lines have a minimum diameter of 8 mm and a minimum breaking strength of at least 2000 N. Their length must not exceed 40 m.

4.4.3 Drop ropes have a diameter of 24 to 28 mm.

4.4.4 Buddy lines are buoyant, have a minimum diameter of 6 mm and a minimum breaking strength of at least 1000 N. The actual length of Buddy lines will be determined individually, based on a risk assessment of the specific conditions of the diving operation.

4.5 Breathing-air compressors

4.5.1 Compressors used to fill pressurised gas tanks have to provide breathing-air according to DIN standard DIN EN 12 021 "Druckluft für Atemschutzgeräte" ('Respiratory protective devices - Compressed air for breathing apparatus'). They must be positioned so that no harmful gases can enter the air-intake.

4.5.2 It must be ensured that high pressure in diving tanks cannot reach dangerous levels. This may be achieved e.g. by a pressure control unit, a pressure-limiter or a pressure relief valve).

4.6 Air supply system

- 4.6.1** Air supply systems must be able to provide air of sufficient quality and quantity to all surface-supplied divers under water and to stand-by divers, according to the diving depth.
- 4.6.2** For every diver and underwater breathing apparatus, the air supply system must provide an air flow of 30 l/min for the anticipated dive, measured at diving depth pressure. In addition, the system must allow a supply increase of the total air volume to 50 l/min for every underwater breathing apparatus over a period of at least 15 min. Furthermore, reserve air for emergencies must be available in storage tanks as outlined in appendix 2¹. The reserve air carried by the diver must not be taken into account for the overall air budget calculations.
- 4.6.3** If a compressor is used for air supply, a pressure tank must be connected in-line, i.e. between the compressor and the diver(s), to equalise pressure fluctuations.

4.7 Hyperbaric chambers

Regarding hyperbaric chambers, the employer must ensure that

1. the hyperbaric chamber allows for oxygen breathing,
2. contact with persons in the chamber can be maintained both visually and through speaking,
3. a minimum positive pressure of 5 bar can be established in the chamber within no more than 6 minutes,
4. the chamber allows for the independent introduction of an accompanying person, and for treatment of an injured diver in the chamber.

4.8. Electrical systems and operating devices

The employer must ensure that electrical systems and operating devices comply with technical safety standards and are suitable for operation under water. Specifically, the following requirements must be met:

1. Electrical systems and operating devices must have a conspicuously marked main switch with a clearly labelled switch position, so that power can be easily switched off across all poles,
2. Cables must be suitable rubber-coated wires or equivalent cable types,
3. Electrical systems and operating devices must be equipped with
 - protective insulation with insulation surveillance
 - protective extra-low voltage
 - protective separation
 or
 - protection through deactivation by means of a ground fault interruptor with a residual current level of 30 mA maximum,
4. Electrical operating devices must be water-pressure resistant.

¹ Appendix 2 presently under review

5 Operation

5.1 Direction and supervision

The employer must ensure that every diving operation is directed and overseen by a professionally competent and experienced diving supervisor.

The diving supervisor must be appointed in writing by the employer. Should the diving supervisor be part of a dive team, diving personally during a diving operation, he/she must appoint and instruct a suitable substitute for the duration of his/her dive.

The diving supervisor must assess conditions throughout the diving operation, oversee safety of the diving operation, and be able to take the necessary actions during emergencies and disruptions. For the use of nitrox gas mixtures, the diving supervisor must document additional certification according to section 5.5.6

A professionally competent diving supervisor is an experienced scientific diver with a minimum of 100 documented dives of at least 60 hours total diving time under diving operation conditions, certified by a Scientific Diving Training Institution.

5.2 Risk assessment and preparation of the diving operation

5.2.1 Prior to every diving operation and based on conditions at the dive site, the diving supervisor must identify risks and hazards according to Occupational Health and Safety Legislation ("*Arbeitsschutzgesetz*", *ArbSchG*) and take the necessary actions. This must be documented in writing.

Conditions to be assessed include, for instance:

Tides, currents, shipping traffic, water temperature, visibility under water, health risks through (contaminated) water bodies, weather conditions, diving depth, dive time.

5.2.2 If specific hazards and complications have been identified for a dive, an operational voice-communication system must be used during diving.

Specific hazards and complications may include, for instance:

Strong currents, operations in closed spaces, intake openings of suction pipes, structures with risk to collapse, areas with risk of entanglement, diving in depths over 30 m.

5.2.3 Specifically in areas with shipping traffic, the diving supervisor, in consultation with the relevant authorities, must ensure that the dive site is marked and that hazards are removed.

5.2.4 In planning the dives, the diving supervisor must ensure that the stand-by diver can perform a rescue operation according to decompression tables at all times, including during repetitive dives.

5.3 Instruction

5.3.1 Prior to the diving operation, and using the hazard assessment, the diving supervisor must inform all persons concerned about specific hazards and complications at the

dive site, about actions taken, equipment and gear used, and about conduct during potential accidents and disruptions.

- 5.3.2** The diving supervisor must ensure that all members of the dive team have been instructed in the necessary procedures of the emergency response plan and are able to respond according to section 7.

5.4 Dive teams

- 5.4.1** Diving operations may only be carried out by dive teams.

- 5.4.2** A dive team may be supplemented by one or two additional divers, connected to the primary diver by buddy lines.

5.5 Requirements for scientific divers

- 5.5.1** As scientific divers, employers may only appoint persons who
- are covered by Statutory Accident Insurance Association,
 - have a valid health certificate,
 - have been trained in a training institution recognised by the Board of Examiners for Scientific Divers and the Building Trade Commission according to section 3
 - have demonstrated their knowledge to the Board of Examiners through an examination.

The Board of Examiners for Scientific Divers is associated with the institution to be contacted under the following address:

*Fachausschuss Tiefbau
Prüfungskommission für Forschungstaucher
c/o
BG BAU Berufsgenossenschaft der Bauwirtschaft
Landsberger Str. 309
80687 München*

- 5.5.2** The medical fitness must be confirmed by a physician who is authorised to do so following the Trade associational principle for occupational health examinations G31 'High Pressure' (occupational diving) [*"Berufsgenossenschaftlicher Grundsatz für arbeitsmedizinische Vorsorgeuntersuchungen G31 Überdruck (Taucherarbeiten)"*].

Repeat medical examinations according to G31 (occupational diving) must be carried out within a 12 month period. An early medical examination is required after:

- *every decompression accident,*
- *every diving incident that caused health disorders,*
- *Illnesses and accident effects that might impair fitness for diving.*

- 5.5.3** The scientific diving training includes at least 70 dives and a minimum of 50 diving hours with at least 30 of those in open water. The training course must be completed within 24 months and has to comply with the training plan outlined in appendix 4.

It is left to the discretion of the training institution to reduce the training period if sufficient diving experience exists.

In addition, scientific divers require life guard certification at the 'silver level' of an approved German life guard association. Furthermore, they must have recognised training in First Aid with cardiopulmonary resuscitation (CPR), dating back no more than 2 years.

- 5.5.4** Within a 12-month period, every scientific diver must perform at least 12 dives, six of those under diving operation conditions, with a total dive time of at least 300 min. Dives must be recorded and signature-validated in the scientific diving logbook.

If the scientific diver does not meet these requirements, a recognised training institution (see appendix 3) must verify, prior to a new diving operation, whether he/she still has the necessary practical skills to participate. The verification must be documented in the scientific diving logbook.

In addition, every scientific diver should demonstrate an annual recertification of CPR training and familiarity with the required rescue equipment.

- 5.5.5** Scientific divers of foreign nationality may only be appointed to a diving operation after providing evidence of their qualifications to the employer and the diving supervisor, and if they are secure in communicating within the dive team.

- 5.5.6** (Paragraph in *italic style* presently under review). *Only experienced divers may use nitrox gas mixtures under water.* Additional training, which must be documented (see also Trade associational information 897 - Diving operations using mixed gas ("*Berufsgenossenschaftliche Information 897 - Tauchereinsätze mit Mischgas - BGI 897*"), is necessary for use of this gas mixture.

5.6 Tasks and requirements of the signal person

- 5.6.1** Only a trained and certified scientific diver may serve as signal person.

- 5.6.2** Scientific divers who have no valid G31 medical certification or who have not performed the required dives within any given year may still serve as signal person during that period.

- 5.6.3** If diving apparatuses with nitrox gas mixtures are used, the signal person must also document the appropriate additional certification.

5.7 Provision of equipment and devices

- 5.7.1** Minimum equipment requirements, to be provided by the employer for every diver (including stand-by divers), include:

- Underwater breathing apparatus with full-face mask

- Signal line or telephone line
- Diving fins
- Diving knife
- Thermal protective clothing
- Weight system with instant removal option
- Buoyancy devices as outlined in section 4.3.

The following may serve as appropriate thermal protection, for instance:

A dry suit with thermal underwear or, should diving period, diving depth and water quality allow, a wet suit with hood, booties and gloves if necessary.

5.7.2 The diving supervisor must assess, depending on the diving operation conditions, which additional equipment should be provided.

Such items may, for instance, include:

- *Underwater voice-communication system*
- *Depth gauge*
- *Lighting devices*
- *Boat with sufficient carrying capacity and stability to collect a diver*
- *Diving computer*
- *Surface-supplied underwater breathing apparatus*
- *Heatable changing room*

5.7.3 The employer must ensure that every dive site is equipped with a device or facility to place an emergency call, and that every dive team has at hand a watch, as well as the decompression tables as specified in appendix 1.

The employer must ensure that clear and unequivocal documentation about the following topics is available at the dive site:

- First Aid Procedures
- The nearest facility to place an emergency call
- The nearest expert physician
- The nearest standby hyperbaric chamber for treatment of diving-related diseases.

5.7.4 The employer must ensure that the appropriate equipment for entering the water, reaching the desired water depth, and leaving the water is available at the dive site. Specifically, the employer must ensure that the chosen equipment also allows a diver to be recovered safely from the water.

Such equipment may include, for instance:

- *A secured ladder*
- *A drop rope with 3m-labels indicating potential stop-levels*
- *An auxiliary winch aboard a ship for recovering a diver*

5.7.5 The employer must ensure the presence of an oxygen breathing device, allowing administration of pure oxygen for at least 3 hours, at the dive site.

5.7.6 Under the following conditions, the employer must provide a hyperbaric chamber (Trade associational rule 235 - Hyperbaric chambers for divers "*Berufsgenossenschaftliche Regel 235 - Taucherdruckkammern - BGR 235*") at the dive site:

1. For dives with decompression times exceeding 35 minutes
or
2. For diving depths below 10 m if transport to the nearest standby hyperbaric treatment centre for diving related diseases is not possible within 3 hours.

5.8 Requirements for operating diving apparatuses

5.8.1 The diving supervisor must ensure that dives using self-contained underwater breathing apparatuses (SCUBA) are limited in terms of time and depth, including when repetitive dives are performed, so that decompression stops as listed in the decompression tables remain dispensable as far as possible.

5.8.2 In addition to a safe ascent of a maximum 10 m/min, a safety stop of 3 min should be implemented at the 3-m depth level.

5.8.3 Should certain work assignments require decompression stops, either nitrox gas mixtures or surface-supplied underwater breathing apparatuses must be used.

5.8.4 If diving according to section 5.8.3, the diving supervisor must ensure that the breathing gas reserve required for decompression stops is available at all times. When diving with surface-supplied underwater breathing apparatuses, the diver must carry the breathing gas reserve required for surfacing, with him/her in tanks.

5.8.5 The diving supervisor's deviation from regular full-face mask diving is only permissible if it does not increase hazards for the diver.

5.9 Written documentation

5.9.1 Every scientific diver must keep a scientific diving logbook, recording every dive at the end of a working day with the following information:

- Date
- Dive location
- Diving depth
- Start and finish time, as well as total diving time, of the dive
- Decompression depths
- Completed work assignments
- Type of diving apparatus used

- Specific hazards and complications
- Name and signature of the diving supervisor

5.9.2 The diving supervisor must record extraordinary incidents during diving operations in the respective scientific diving logbook:

- Emergency decompression, including explanation
- Abandonment of a dive, including explanation
- Occurrence of sickness symptoms after the dive

5.9.3 Prior to every dive, the diving supervisor must construct a dive plan with the following information:

- Air volume budget
- Maximum diving depth
- Permissible maximum time for the dive
- If necessary, decompression-stop-levels (depths) with associated decompression times.

This information must be easily visible to the signal person.

When determining decompression-stop-levels and associated decompression times, comments to the decompression tables in appendix 1 must be observed.

The beginning of a dive (start time) must be documented immediately.

5.10 Communication

5.10.1 A signal line must serve as a communication tool between signal person and diver.

The purpose of the signal line may also be fulfilled by a suitable air-supply hose or a strain-relieved telephone line of appropriate strength.

5.10.2 A one-time pull of the signal line represents the emergency signal. All other signals may be chosen freely.

5.10.3 The diving supervisor must post the agreed signals at the dive site. Signals are given by pulling on the line. Every given signal must be confirmed by the diver or signal person respectively, through responding with the same pull-signal.

Even when underwater voice-communication systems are used, a signal line remains obligatory.

5.10.4 If contact with the diver by the signal person is from a boat, the communication between the signal person and the remaining members of the dive team must be ensured.

Communication with the diver may be achieved through

- A signal line or a signal buoy attached to the diver, used for communicating signals;

- Additional wireless underwater voice-communication system in the case of several operating dive teams.

The distance between boat and signal buoy must not exceed 15 m.

If a motor boat is used, it must have a protective cover around the propeller.

5.10.5 If the scientific task cannot be accomplished while using a signal line or signal buoy, a dive may take place without these items given that?

- A two-way wireless voice- or signal-communication system exists between the divers and the signal person,
- Several divers or diving pairs with visual contact to one another are operating simultaneously under water, and are able to observe and assist each other,
- The signal persons have visual contact to the divers and are able to provide immediate assistance in an emergency.

The exceptional practice must be justified in writing prior to the dive, and the explanation must be kept ready at the dive site.

5.11 Preparation of a dive

5.11.1 Only after the diving supervisor has confirmed that diver and stand-by diver are fit to dive, he/she may give his/her final approval of the dive. The divers' general wellbeing must not be compromised by a cold or other indisposition. Divers must be able to equalise pressure in their ears.

5.11.2 Divers must use the equipment and devices listed under section 5.7 and must follow the instructions of the diving supervisor.

5.11.3 Signal line and diving knife, as well as the air supply hose if applicable, must be fastened to the diver in such a way that the diver can reach them under water, and they must not be attached to the weight system. The weight system must be easily removable in a hazardous situation.

5.11.4 Fastening of the signal line to the diver must allow for transfer of force sufficient to recover the diver in an emergency situation, without the line tightening around the diver.

This may, for instance, be accomplished by using a bowline knot to tie the signal line around the diver, or by using a harness which is worn directly over the diving suit, with a screwgate carabiner connecting the harness to the line.

5.12 Descent of divers

5.12.1 Prior to every descent, the diver must recite the agreed signals to the signal person.

5.12.2 Prior to the diver's descent, the signal person must, once again, check the diver's equipment for completeness and proper assembly.

- 5.12.3 Prior to the diver's descent, the signal person must confirm that the diver's diving suit and equipment are sealed properly.
- 5.12.4 For the purpose of descending under water, the diver must make use of the equipment and devices listed under section 5.7.4.
- 5.12.5 The signal person has to ensure that lines run smoothly without loops and are not drawn across sharp edges.
- 5.12.6 The signal person must monitor the diver during the entire dive. In particular, the signal person must observe the diver's descent, maintain a continual connection to the diver throughout the underwater operation and oversee the diver's surfacing. During the dive, the signal person must not do anything to distract him/her from his/her monitoring task.

5.13 Dives

- 5.13.1 Diving operations may only be carried out to a diving depth of 50 m. The diving supervisor must take into consideration the training and experience of individual divers and, where appropriate, have them approach dives to greater depths gradually.

In particular, psychological strains, such as darkness, cold, breathing gas density, problems relating to nitrogen narcosis and drastically reduced bottom times must be taken into consideration.

- 5.13.2 The diving supervisor must not permit dives which endanger the diver.

A situation is hazardous

- if the signal connection is interrupted,
- in case of a thunderstorm.

A situation may be hazardous

- if poor visibility prevents the signal person from observing the diver
- if wind speeds exceed 11 m/s
- if current speeds exceed 1 m/s
- in the presence of drift ice
- during hoisting and lowering of loads
- if the signal line may get entangled.

- 5.13.3 The stand-by diver (section 2.3) must be ready for immediate intervention at the dive site. The stand-by diver must be equipped with full-face mask and two regulators or alternatively two second stages (see also DIN EN 250).

Depending on the conditions of the diving operation, immediate intervention is ensured, for instance, if the stand-by diver only needs to add diving mask, diving apparatus and weight system to his/her otherwise completely assembled equipment.

5.13.4 The diving supervisor must ensure that during the dive

- installations and devices, which may endanger the diver, are switched off,
- no heavy loads are hoisted, lowered or dropped,
- necessary propeller-, rudder- and anchor movements of watercraft are not initiated without knowledge of the diver,
- all other work activities which may disrupt, hamper or endanger the course of the dive, are suspended. If this is not possible the dive must be abandoned.

5.13.5 Referring to appendix 1 and taking into consideration water depth and breathing gas supply, the bottom time must be calculated so that a minimum reserve of 20% of the nominal tank fill pressure will not have to be utilised. This also applies to repetitive dives (appendix 1, table 4). The air supply must be monitored throughout the dive using the pressure gauge. Should this not be possible for reasons of reduced visibility, a second, independently operating safety feature, is required.

A reserve valve (warning through increased breathing resistance) or an active warning device may be used. A second pressure gauge does not fulfil this requirement.

5.13.6 With reference to the diving time calculation, the signal person must monitor and check the diving time by means of a watch. If necessary, the signal person must recall the diver.

5.13.7 For diving operations in mountain lakes, the actual diving depth must be re-calculated, according to table 3 of the decompression tables in appendix 1. Furthermore, extreme weather conditions can also cause reduced atmospheric pressure at the dive site, requiring adjustments to mountain lake levels.

5.13.8 The maximum permissible speed of ascent is 10 m/min. If diving computers are used, the indicated warnings must be followed. Safety stops must be observed, and the following ascent to the surface should take place as slowly as possible.

5.14 Abandoning dives

5.14.1 Under the following conditions, the diving supervisor must terminate the dive:

- if requested by the diver,
- if the diver does not respond to signals,
- if the dive team is no longer complete,
- if an existing voice- or signal-connection is lost,
- if important equipment items are damaged,
- during thunderstorms,
- if changes occur at the dive site that might endanger the diver.

5.15 Operation of surface-supplied Underwater Breathing Apparatuses

- 5.15.1** Surface-supplied underwater breathing apparatuses may only be operated in conjunction with an operational voice-communication system. When using surface-supplied diving apparatuses, the diving supervisor must ensure that diving times and depths are well within limits of the reserve-air volume held, i.e. so as to cover surfacing time, including required decompression stops.
- 5.15.2** The signal person must make sure that the diver is surfacing according to the decompression stops identified in the dive plan.
- 5.15.3** The diver must observe decompression stops, using equipment aids and devices identified in section 5.7.4.
- 5.15.4** The diver must not perform exercises during the decompression stop. He/she should remain relaxed and calm.
- 5.15.5** If a diver has accidentally failed to observe decompression stops, the signal person must arrange for the diver, immediately after reaching the surface, to return to the first stop-level that was left prematurely.
Subsequently, decompression stops must be re-calculated as the sum of the diving time and the time necessary to return to the depth that was left prematurely.
- 5.15.6** Contrary to section 5.15.5, the diving supervisor must initiate the emergency response plan immediately, if the diver shows any medical symptoms. This also applies if external conditions no longer permit the observation of decompression stops.
- 5.16 Post-dive measures**
- 5.16.1** While the diver takes off the diving equipment, the signal person must secure the diver so that he/she cannot fall into the water.
- 5.16.2** Flights or stays at altitudes 500 m or more above the dive site must not be commenced within 24 hours after surfacing. This waiting period may only be reduced with consent of an expert physician.
- 5.16.3** Observation of the waiting periods is not required for helicopter transports not exceeding a flying altitude of 150 m above the dive site.

6. Inspection of equipment

- 6.1 Prior to every dive, the diver must confirm that the diving apparatus to be used is in working order, and that all of the equipment is complete and operational.
- 6.2 During diving operations, the diving supervisor must check daily all equipment items used in diving work (apparatuses, facilities and devices) and ensure their completeness and proper working order.
- 6.3 The employer must have the diving equipment, as well as other equipment items, inspected with pre-determined frequency by a qualified person. Pressure gas tanks must be inspected according to legal provisions. The inspection result must be documented in writing [see also Ordinance on Industrial Safety and Health "*Betriebssicherheitsverordnung (BetrSichV)*"]
- 6.4 The qualified person has acquired the professional knowledge necessary to inspect the working equipment through professional training, professional experience and recent professional work.
- 6.5 Defective and non-operational equipment must be clearly labelled and prevented from further operation.

DRAFT

7. Code of Practice during diving accidents

- 7.1** The diving supervisor must ensure that divers showing symptoms of decompression sickness (DCS) are transferred immediately to a hyperbaric medical centre, while being administered 100% oxygen.
- 7.2** If a hyperbaric chamber is present, recompression treatment can be initiated at the dive site. The diving supervisor must instigate instantaneous consultation of a physician familiar with diving medicine.
- 7.3** If a dive was terminated prematurely and decompression stops could not be observed, an emergency decompression is permissible if
- the dive's total surfacing time does not exceed 35 minutes,
 - the speed of ascent did not exceed 10 m/min,
 - decompression stops were observed at all stop-levels below and including 9 m,
 - an operational hyperbaric chamber, together with trained operating person is available at the dive site,
 - no DCS symptoms occurred.
- 7.4** The diving supervisor must ensure that the following requirements are met during an emergency decompression:
- the decompression pressure must be 1.2 bar above normobaric conditions (= 12 m water column),
 - the time from beginning of surfacing (leaving the 9 m stop-level, respectively) until recompression of the diver to recompression pressure in the hyperbaric chamber must not exceed 3 minutes.
 - the diver must be administered oxygen while being maintained at recompression pressure for 30 minutes, and
 - the subsequent decompression must be equivalent to a 2 m/min speed of ascent.
- 7.5** After an emergency decompression, the diving supervisor must ensure that the diver is examined by a physician familiar with diving medicine prior to the next dive.

Appendix 1 Remarks on decompression tables

1. General remarks

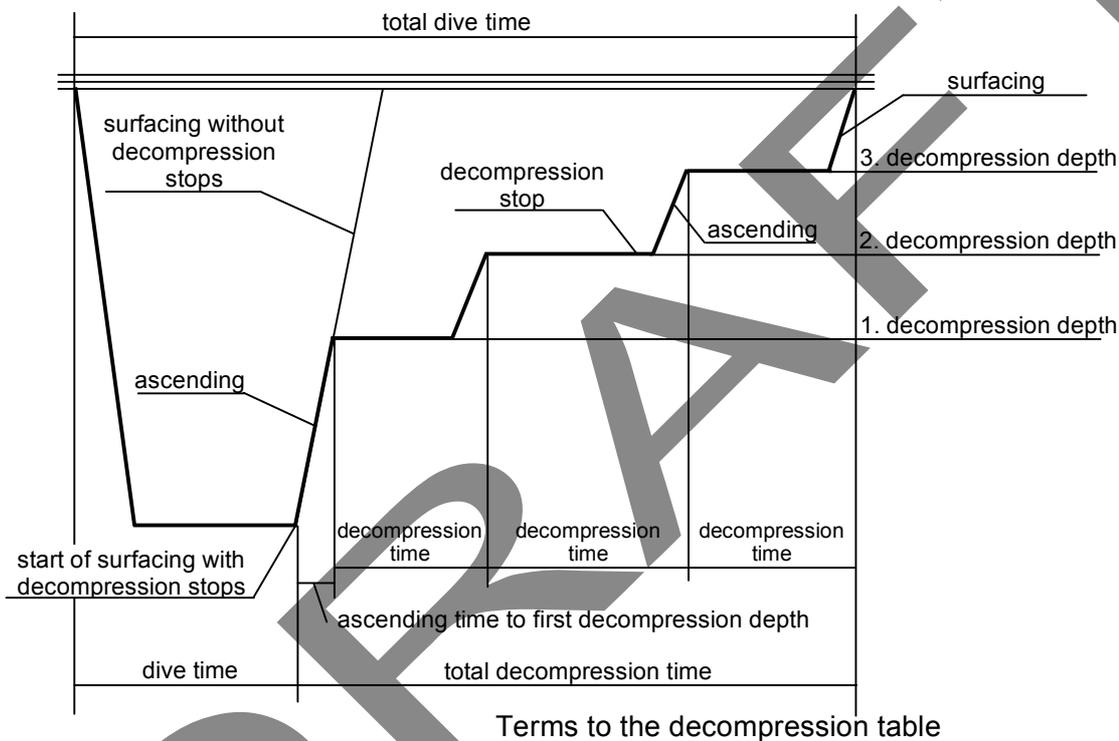
In this appendix, all tables referring to surfacing are grouped as follows:

Table 1: Maximum diving times with diving depths not exceeding 10.5 m

Table 2: Compressed-air surfacing with diving depths in excess of 10.5 m

Table 3: Corrections to diving depths at dive sites exceeding 300 m above sea level

Table 4: Correction times for surfacing after repetitive dives



2. Limitations of scope for table 2

2.1. Total dive time of a single dive

A dive's total dive time must not exceed values indicated in table 1 (with 10.5 m maximum diving depth), or values indicated by a horizontal red line in table 2 (diving depths below 10.5 m). The values listed below the horizontal red line are intended exclusively for emergencies.

2.2. Diving depth

Tables apply to diving depths of 50 m maximum. The table values applying to diving depths of 60 m maximum, indicated in red, are intended exclusively for emergencies; they must not be reached under normal circumstances.

2.3. Atmospheric pressure at the dive site

Table values are standardised to an atmospheric pressure at the dive site of 1000 hPa (in the following: 1 bar). If the atmospheric pressure is reduced below 970 mbar due to the altitude

of the dive site (300 m above sea level) or weather related air pressure fluctuations (low pressure system), corrections listed in table 3 must be applied (see section 7).

2.4. Repetitive dives

Repetitive dives are dives following within 12 hours after the end of the previous dive. The times listed in table 2 only apply to single (non-repetitive) dives. For calculation of surfacing times after repetitive dives, recommendations outlined in section 8 must be followed.

3. General conduct

3.1. If the work assignment requires diving at different water depths, the dive must be planned so that tasks at the greatest depth are carried out first, with subsequent working locations in continuously shallower water depths.

3.2. Throughout the work assignment under water the diver, where applicable, must not ascend above the depth of the first stop-level.

3.3. Even when working in water depths shallower than 7 m, repetitive surfacing and descending (yo-yo diving) should be avoided, as it significantly increases the decompression risk.

3.4. When surfacing without decompression stops, the maximum speed of ascent must not exceed 10 m/min². When surfacing with decompression stops, the guidelines from the tables must be observed.

3.5. If a diver has accidentally failed to observe decompression stops, he/she must, immediately upon reaching the surface, return to the first stop-level that was left prematurely. When determining decompression stops for the make-up (second) surfacing, the time of the previous dive must be extended by the time necessary to return to first stop-level that was left prematurely.

3.6. In general, a diver who will act as stand-by diver immediately after his/her own dive, must not exhaust the maximum permissible dive time. In addition, a repetitive dive must still be permissible after the planned dive (see last column in tables).

4. Interpretation and applicability of decompression tables

4.1. Decompression tables are applicable to surfacing after medium physical exertion. If the diver has performed heavy physical work, the required decompression time must be adjusted to the next higher diving time level.

4.2. If either the period spent under water or the maximum diving depth do not correspond to any value in the table, calculations of decompression times must be based on the next higher value.

² Editor's remark: Table 2 is calculated using a maximum ascend speed of 12 m/min

4.3. The decompression time listed in the table does include the time required to ascend to the next higher stop-level, or to the surface respectively. This means that the last minute of each decompression stop may be used to ascend to the next stop-level.

5. Conduct of divers during the period following a dive

5.1. Within two hours after the end of the dive, the diver must not perform heavy physical work.

5.2. Within the 12 hours following regular diving-decompression, the diver must remain within 3 hour travel range of an operational hyperbaric chamber.

6. Emergency decompression

For reasons of associated health risks, emergency decompression is only permissible in emergency situations. Detailed provisions are listed in section 7.4. of this regulation.

7. Diving at altitudes exceeding 300 m above sea level, or with atmospheric pressures at the dive site below 970 mbar

7.1. If atmospheric pressure at the dive site drops below a value of 970 mbar, the decompression time must be adapted according to the calculated depths listed in table 3. Generally, this applies to dive sites (surface position) located 300 m or more above sea level; depending on weather related air pressure fluctuations, corrections may be necessary even earlier – but also later.

7.2. The calculated depth is determined according to the method described below:

1. Determination of the actual diving depth,
2. Determination of altitude at dive site (surface location) in metres above sea level, and of atmospheric pressure respectively,
3. Identification of calculated diving depth from table 3: the calculated diving depth represents the value at the intersection of the actual diving depth with the column identifying altitude, or atmospheric pressure respectively.

Example:

Actual diving depth:	30 m
Altitude of dive site:	850 m
Calculated diving depth	36 m

The value for the calculated diving depth provides the basis for determining decompression times from table 2.

8. Repetitive diving

8.1. For dives, which in table 2 have ‘yes’ marked in the last column, a subsequent dive within 12 hours (repetitive dive) is permissible.

In contrast, dives marked 'no' in the last column of table 2, do not permit repetitive dives. Calculation methods for decompression times and –levels after a repetitive dive are described in sections 8.2. and 8.3.

For repetitive dives to diving depths exceeding 7 m, a decompression safety stop of 3 min at the 3 m level should be observed if possible, even if the table does not require any decompression stops.

8.2. In order to determine decompression time and –levels after a repetitive dive, the actual time of the repetitive dive must be extended by a certain amount of time obtained from table 4. This correction time is found at the point of intersection of the column identifying the surface interval, with the line containing the diving depth of the repetitive dive. The correction time depends solely on the specifics of the repetitive dive, whereas the attributes of the previous dive are taken into account through remarks of the last column in table 2.

Sample calculation

1. dive	(33 m diving depth) (35 min dive time) = repetitive dive permissible
Repetitive dive	30 m diving depth 30 min dive time 90 min surface interval
From table 4:	25 min correction time = calculated dive time 55 min
From table 2:	Decompression time 54:45 min

Comment: Values in brackets are not required for the calculation; instead they serve as comparative values for calculations in section 8.3.

8.3. Other than described in section 8.2., decompression times may also be determined as follows:

Both dives are combined into one by adding dive times and using the maximum depth reached during either dive. Table 2 is then used for determination of decompression time.

Sample calculation

1. dive	33 m diving depth 35 min dive time = (repetitive dive permissible)
From table 2:	Decompression time 22:15 min
Repetitive dive:	30 m diving depth 30 min dive time (90 min surface interval) = calculated dive time: 65 min = calculated diving depth: 33 m
From table 2:	Decompression time 91:45 min

Comment: Values in brackets are not required for the calculation; instead they serve as comparative values for calculations in section 8.2.

Table 1: Maximum permissible underwater time (in minutes) with diving depths not exceeding 10.5 m (see also section 5.9.)

Diving depth (m)

Surface interval^{*)} (hrs)

^{*)} Surface interval means the time between the end of the first dive and beginning of the repetitive dive.

**Table 2: Compressed air table (decompression using air as breathing gas)
Diving depth 12 m**

Dive time (min)

Ascent times to first decompression level (min:sec)

Decompression time at respective stop-levels during surfacing (min)

Total decompression time (min:sec)

Repetitive dive permissible

Yes / No

**Table 3: Corrections for dives at altitudes exceeding 300 m above sea level
(‘calculated diving depth’) (see remarks, section 7.2)**

Diving depth

Actual altitude / atmospheric pressure

300-500 m / 970-950 mbar

To 1000 m / to 900 mbar

**Table 4: Correction times for decompression after repetitive dives
(see remarks, section 8)**

Diving depth of repetitive dive

Surface interval (min) ^{*)}

^{*)} Surface interval (min) means the time between finishing decompression of the first dive and beginning of the repetitive dive

Appendix 2

Calculations of reserve air volume according to section 5.15.

Presently under review

Appendix 3

Principles for approval of Scientific Diving Training Institutions following section 5.5. of this GUV (Statutory Accident Insurance) regulation

Training Centers for Scientific Diving must be approved by The Board of Examiners for Scientific Divers of the technical committee for civil engineering . (“Prüfungskommission für Forschungstaucher des Fachausschusses Tiefbau”)

Approval of a training institution for scientific diving is based on the following principles:

1. Approval process
 - 1.1 The application for approval must be directed to ‘The Board of Examiners for Scientific Divers of The Building Trade Commission’ BG Bau, Landsberger Str. 309, 80687 Munich.
 - 1.2 Specifically, the application must contain the following information:
 - 1.2.1 Exact title and address of the institution
 - 1.2.2 Existing diving apparatuses (manufacturer, type, year of manufacture, number)
 - 1.2.3 Type of air supply systems
 - 1.2.4 Existing auxiliary diving equipment (equipment for underwater work, hyperbaric chambers, boats)
 - 1.2.5 Details of persons responsible for diver training: Name, address, concise curriculum vitae with unbroken records of professional career and professional training leading up to the date of application.
 - 1.2.6 Number of additional skilled staff in the institution who are assigned diving-related tasks
 - 1.3 The approval is provided in writing by The Board of Examiners for Scientific Divers of The Building Trade Commission. The Statutory Accident Insurance Provider responsible will receive a copy of the approval document.

2. Requirements for approval

Institutions may be approved as Scientific Diving Training Institutions if they

1. guarantee proper and comprehensive training
2. have the necessary equipment and facilities to convey knowledge and skills according to the training schedule for scientific divers (appendix 4) and
3. employ at least one qualified dive trainer, as well as one training assistant.

Approval as qualified dive trainer requires a minimum 5 year-employment as scientific or professional diver, with at least 500 hours of diving time during this period. In addition,

the person must be reliable and able to communicate his/her knowledge and skills to the trainees.

A diver may be approved as training assistant if he/she has a total of 400 documented diving hours.

3. Responsibilities of a Scientific Diving Training Institution

- 3.1.** The approved Scientific Diving Training Institution is committed to providing conscientious and reliable training for scientific divers.
- 3.2.** The Scientific Diving Training Institution must register scientific divers in training for examination at the 'The Board of Examiners for Scientific Divers of The Building Trade Commission'. Registration, including all required documentation, must be complete at least 3 weeks prior to the examination date.
- 3.3.** The Scientific Diving Training Institution must open a scientific diver logbook for every scientific diver in training. All components of the training programme, i.e. theoretical training, practical dive training and applied diving, must be entered into the logbook. Entries must be signed regularly, at least monthly, by the director of the training institution. Entries should be made in accordance with section 5.9. of this regulation.
- 3.4.** Scientific divers in training may only dive under the instruction and supervision of a training assistant and an additional certified diver. At any one time, one of the two certified divers must be attending outside the water. Scientific divers in training are only allowed to participate in dives which they are qualified for through their respective training level.
- 3.5.** The Scientific Diving Training Institution must notify 'The Board of Examiners for Scientific Divers of The Building Trade Commission' immediately if it terminates training activities. Similarly, changes to staff details listed in section 1.2.5., or to conditions listed under section 2, must be instantly disclosed to the Board.

4. Revocation of approval

- 4.1.** The approval must be revoked
 - If there is evidence indicating that either the requirements for approval were never or are no longer valid, or that the conscientious fulfilment of the obligations of the Scientific Diving Training Institution can no longer be guaranteed,
 - If the Scientific Diving Training Institution abandons its training activities.
- 4.2.** Approval can be revoked if the Scientific Diving Training Institution violates its obligations outlined in section 3.
- 4.3.** The Statutory Accident Insurance Provider is advised instantly and in writing of any revocation according to sections 4.1. and 4.2.
- 4.4.** In case of approval revocation, the Scientific Diving Training Institution must return the approval document. The same applies if diving training is abandoned.

Appendix 4 Training schedule

Requirements for participation

- The training must serve the professional development or be required as part of an employment contract,
- Valid diving medical certificate G31,
- 'Silver level' German life guard certification or documentation of equivalent skills (may be completed during training),
- First Aid certification, dating back no more than 2 years (may be completed during training).

Minimum total training time of 240 hours

1. practical training (186 hours minimum)

1. Swimming and Snorkelling

20 hours (swimming, as well as diving with snorkelling equipment and SCUBA)

1.1.1. Swimming and diving requirements without using snorkelling-equipment

- Competence in two different swimming styles (breast stroke and freestyle)
- Physical fitness, free-diving skills and rescue skills according to 'Silver level' German life guard certification

1.1.2. Swimming and diving requirements using snorkelling-equipment

- Correct fin movement,
- Clearing snorkel,
- Snorkelling without mask,
- Descending head-first and feet-first,
- Ear equalising techniques (swallowing, Valsalva manoeuvre),
- While diving: continual buddy check, clear hand signalling, prudent and calm movement under water, during ascent checking or scanning upward,
- Swimming 1000 m distance with fins and mask in less than 18 minutes
- Diving towards mask, putting on mask, clearing mask
- Apnoe diving to a distance of at least 40 m under continual observation (singly or in group)
- Remaining under water for 1 minute diving while moving slightly
- Knot-tying under apnoea (holding breath): Half hitch, Reef knot, Bowline, Sheet bend, Clove hitch, Figure 8-knot
- Rescue using snorkelling-equipment (diving-approach, recovery to surface, 50 m rescue towing, rescue to land, recovery position).

1.2 Diving skills using SCUBA

30 diving hours with at least 70 open water dives, including:

- 10 dives between 15 and 24 m and
- 5 dives below 25 m.

1.2.1 General diving skills using SCUBA and full-face mask

- Underwater hand signals,
- Buoyancy control using lungs and buoyancy compensator, maintaining constant distance to bottom with and without using fins,
- Maintaining stability at decompression stops / safety stop respectively
- Use of dry suit
- Diving 'blind'
- Clearing mask
- Removal of mask, finding mask, putting mask back on, clearing mask
- Removal of diving apparatus, putting diving apparatus back on
- Approaching diving apparatus under water (optional in open water)
- Buddy breathing while standing, floating, swimming
- Buddy breathing while ascending (optional in open water)
- Second diving regulator³/Octopus breathing without mask for at least 3 minutes
- Emergency ascent on drop line from 6-10 m depth without mask, using own second diving regulator/Octopus
- Emergency ascent on drop line from 6-10 m depth without mask, using second diving regulator/Octopus of stand-by diver
- Handling of signal line (both guided and using signal buoy)
- Buddy diving with / without buddy line
- Self rescue to the surface, e.g. dropping of weights and / or controlled ascent using buoyancy compensator (mechanical inflator device/emergency tank).

1.2.2 Emergency and rescue manoeuvres

(at least 6 dives)

- Rescue using SCUBA (controlled surfacing, 50 m towing, removal of equipment, recovery position on land),
- Rescue of an unconscious diver in open water (4 -10 m depth), with fully extended signal line, recovery back to land or vessel, rescue on land / deck respectively, monitoring of vital signs, recovery position,
- Neurological primary examination,
- Initiating emergency response plan ,
- Administration of normobaric oxygen.

1.2.3 Specific diving skills for carrying out scientific work

(20 dives)

³ definition: diving regulator means the unit of pressure regulator (diving regulator 1. stage) and breathing device (diving regulator 2. stage). Second regulator means a complete diving regulator mounted additional at a second valve of the pressure tank. Octopus means a second breathing device (diving regulator 2. stage) mounted at the pressure regulator of the primary diving regulator.

1.2.3.1 Principles

- Becoming accustomed to activities such as sawing, hammering, chiselling,
- Search exercises,
- Marking of objects and areas, e.g. placing buoys, laying out transects, placing quadrates and counting grids, establishment of a bottom survey system,
- Recovery exercise: working with lift bags or other buoyancy devices,
- Handling of lines: tying knots while wearing gloves, reducing line length,
- Orientation diving using compass, e.g. triangle or rectangle course, descending right or left,
- Measurements; e.g. thermometer, meter stick, tape measure, callipers,
- Documentation: writing slate (counting, data recording, drawings), (digital) underwater imagery (if possible),
- Sampling / excavating techniques.

1.3 Diving service (136 hours)

1.3.1 Cooperation in the dive team

- Diving supervision: planning, risk assessment, instruction, marking of dive site, supervision, responses during disruptions, ?emergency chain of command,
- Responsibilities and activities as signal person, issuing equipment to the diver, equipment check, confirming signals, assistance/securing, communication and monitoring during the dive, removing equipment, recognising and communicating problems, assistance in emergencies,
- Emergency operation (stand-by diver), rapid preparation of equipment, quick descent, assessing the situation, assistance, recovery to the surface and perhaps transport to land/vessel, assistance during further rescue efforts on land.

1.3.2 Performing emergency drills as a dive team

Performing activities listed under section 1.2.2. as a dive team.

1.3.3 Completing work assignments as a dive team

Planning and execution of methods listed under section 1.2.3. as a dive team.

1.3.4 Practical assignments

Operating, handling and maintenance of apparatuses, diving hygiene.

1.3.5 Seamanship

- Operating, securing and anchoring of boats (if present),
- Knots and lines, rope types (characteristics)

2. Theoretical training (54 hours)

2.1. Occupational health and safety (10 hours)

2.1.1. Legal basis

Criminal and civil law, liability, statutory accident insurance, SGB VII, accident insurance provider,

2.1.2 'Occupational Health and Safety Law'

'Arbeitsschutzgesetz' (Occupational Health and Safety Legislation), 'Geräte- und Produktsicherheitsgesetz (GPSG)' (Equipment and Product Safety Legislation), 'Betriebssicherheitsverordnung' (Ordinance on Industrial Safety and Health), 'Regeln für den Einsatz von Forschungstauchern' (GUV-R 2112 Operation of scientific divers), 'Normen' (Standards).

2.2 Planning of a diving operation

(4 hours)

2.2.1. Planning

Diving permit, information research, risk assessment, specifying additional safety measures, emergency planning, completion of the dive plan

2.2.2. Execution

- Requirements for diving supervisor, signal person and diver,
- Responsibilities,
- Diving under challenging conditions,
- Use of decompression tables,
- Flying after diving.

2.3 Scientific principles

(6 hours)

2.3.1. SI units

2.3.2. Physical properties of H₂O

- Density,
- Pressure,
- Buoyancy (Archimedes' principle),
- Optics,
- Acoustics,
- Thermal properties,
- Flow properties.

2.3.3. Gas laws

- Respiratory gases and their composition: air, nitrox (only briefly mention heliox, hydrox, trimix),
- Ideal and real gases,
- Molecular movement, diffusion, Fick principle,
- Dalton's law,
- Boyle-Mariotte law,

- Henry's law,
- Gay-Lussac's law,
- Joule-Thompson effect,
- Properties of flow.

2.4. Medicine (16 hours)

2.4.1. Anatomy and physiology

Anatomy and function of respiratory and cardiovascular systems, reflexes, diuresis (immersion- and cold diuresis)

2.4.2. Problems during compression phase

Barotrauma (causes, symptoms, treatment), various natural and artificial cavities, flexible and half-flexible cavities (skull cavities with emphasis on ears -outer middle and inner ear), lungs, stomach/intestines, skin, eyes, teeth).

2.4.3. Problems during the isobaric phase

Intoxications [N_2 , O_2 (acute/sub-acute), CO_2 (increased content in breathing gas, breathlessness), CO]: threshold values, causes, symptoms, treatment, prevention.

2.4.4. Problems during the decompression phase

2.4.4.1. High pressure barotrauma of the lung

Causes, effects [arterial gas embolism (AGE), pneumothorax (tension and valve pneumothorax), emphysemas]

2.4.4.2. Decompression sickness (DCS)

Henry's law, N_2 assimilation and -release in different compartments, classification of DCS (type I and type II) including symptoms, treatment, prevention, risk factors (H_2O deficiency, cold, heat, exercise, body fat, mountain lakes, repetitive dives and yo-yo diving, shunts), background and application of the decompression table, auxiliary use of diving computers.

2.4.5. Other problems

Drowning/near-drowning, hypothermia, heat injuries (surface crew), black-outs (swimming pool, shallow water), dangerous marine organisms, dehydration, infection of the auditory canal, significance of diet, effects of tobacco smoke, alcohol and other drugs)

2.4.6. First Aid during diving accidents

Normobaric oxygen administration and supply of liquids, emergency response plan, positioning, CPR

2.5. Technical equipment (12 hours)

2.5.1. Rules and Regulations for technical implements

- Occupational Safety Regulations
- GPSG, Regulations of the 'Equipment and Product Safety Law'

2.5.2. Snorkelling equipment

2.5.3. Thermal protection

2.5.4. Breathing regulators

Definition diving apparatus, DIN EN 250, valve types (upstream/downstream), structural design/function 1st and 2nd stage of regulator, operation, service, maintenance and disinfection, compensation, freezing (interior, exterior, co-factors, prevention), auxiliary devices (injector, venturi jet, spring setting), secondary regulator, octopus

2.5.5. Pressure tanks and valves

Structural design, materials, labelling (air, nitrox, O₂), inspection, inspection frequency, 'Safety at Work Regulation', operation, safety features after DIN EN 250 standard, transport ('Gefahrgutverordnung Straße/ADR' – 'Hazardous Materials Regulation Road/ADR'), storage, structural design and function valve (including reserve mechanism)

2.5.6. Breathing-air compressor

Structural variations (types), structural design, function, DIN EN 12 021, filter, safety features, operation (installation, oil types), instruction

2.5.7. Rescue and buoyancy devices

Definition (life jackets, combined rescue and buoyancy devices DIN EN 12 628, buoyancy compensators DIN EN 1809), structural design, operation, maintenance

2.5.8. Instruments

Pressure gauge, depth gauge, compass, diving computer

2.5.9. Systems for administration of normobaric oxygen

Open and closed systems, differences, advantages and disadvantages, ventilation choices, administration, record keeping

2.5.10. Hyperbaric chamber

BGR 235, DIN 13 256, structural design, function, treatment schemes

2.6. Scientific assignments and work methods under water

(6 hours)

- Orientation above and under water, positioning (bearing, charts, GPS)
- Markings
- Documentation
- Sampling
- Auxiliary devices and equipment (air suction lift, scooter, metal detection devices, electronic underwater positioning systems),
- Methods from various disciplines

Presented by and obtainable through the responsible Statutory Accident Insurance Association

Note:

Since October 2002, the re-structured regulations on 'Health and Safety Protection', published by the BUK (Central Federation of Public Accident Insurers), have been available under new designations and with new order numbers. In agreement with the 'Hauptverband der gewerblichen Berufsgenossenschaften', all publications were assigned to one of the following categories: 'Unfallverhütungsvorschriften' ('Accident Prevention Regulations'), 'Regeln für Sicherheit und Gesundheitsschutz' ('Regulations for Health and Safety Protection'), 'Informationen' ('Information'), and 'Grundsätze' ('Principles').

During the process of revision or re-printing, these publications will be modified to reflect the new designations and order numbers. For an interim period of two to three years, and to facilitate the transition process, the publications will be identifiable by old and new order numbers alike.

Furthermore, the transition to new designation and order numbers may be obtained from a so-called 'transfer list', which is published in the index of printed matters, as well as on the homepage of the Central Federation of Public Accident Insurers (www.dguv.de, (formerly www.unfallkassen.de)).