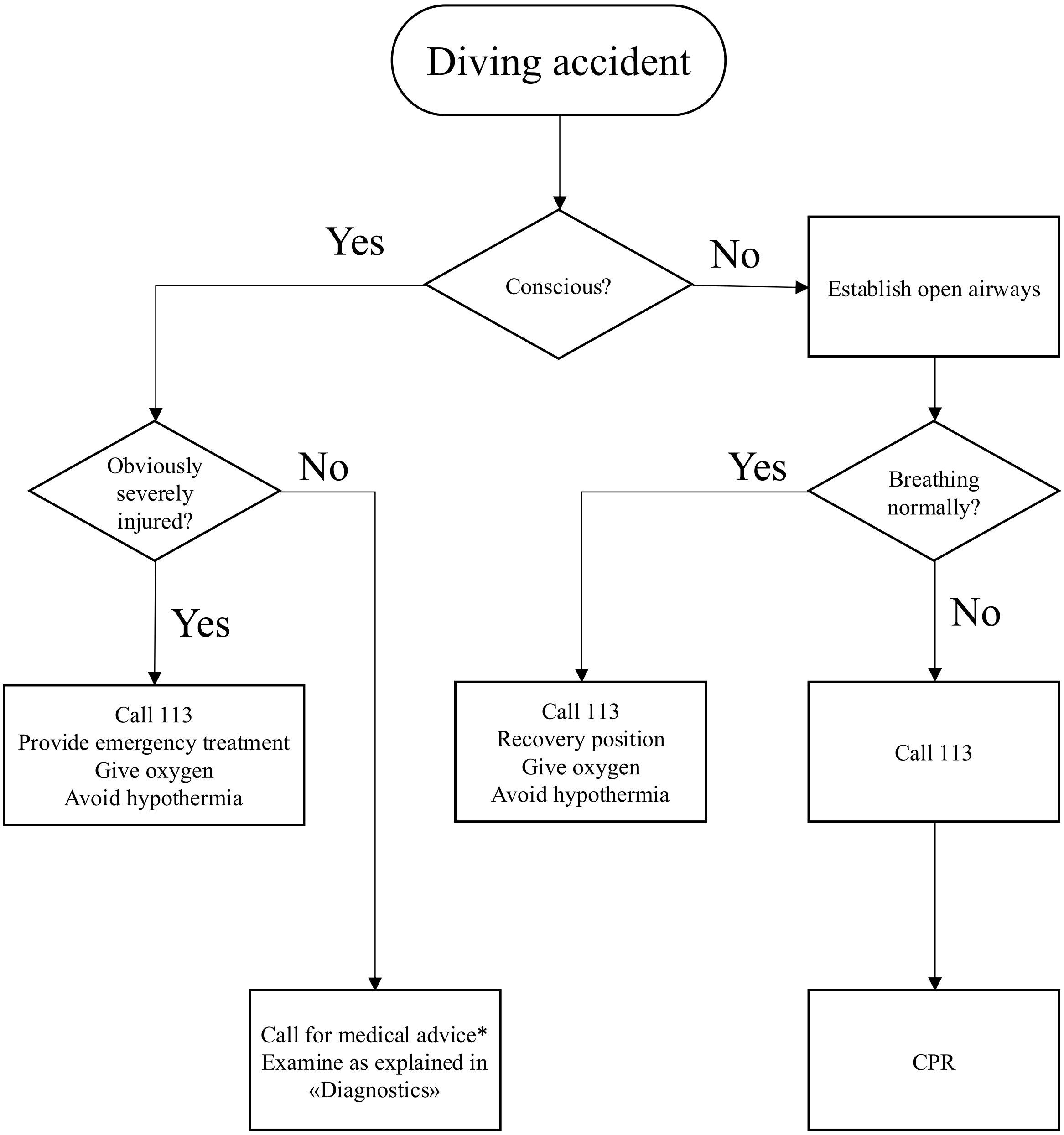
Norwegian Diving- and Treatment Tables

Risberg | Gundersen | Eftedal

6th edition

Emergency Action Plan



*Depending on situation: Emergency medical dispatch service (113) or the out-patient emergency ward (116117)

Jan Risberg • Geir Gundersen • Olav Sande Eftedal

Norwegian Diving- and Treatment Tables

Tables and guidelines for surface orientated diving on air and nitrox. Tables and guidelines for treatment of decompression illness.

This is an authorized translation of the sixth edition of
"Norske dykke- og behandlingstabeller"

Third edition: English translation by:
Hans Petter Roverud, Jan Risberg, Bob Gardiner
Fourth to sixth edition: English translation by Jan Risberg

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Preface

The Norwegian Diving- and Treatment Tables is now published in its sixth edition. This book contains tables for diving on air or nitrox, as well as therapeutic recompression procedures for decompression illness and other ailments requiring hyperbaric treatment.

The tables have been extensively revised since the first edition in 1980. The most important change in this edition is the inclusion of closed bell (TUP) decompression tables and we have provided new guidance on how oxygen toxicity should be calculated. In addition, we have included procedures for emergency decompression and we have removed the advice for a day without diving after three consecutive days of diving. We will express our gratitude to those readers providing feedback on the contents in the previous edition Such feedback has allowed us to correct errors and inaccuracies though they are too numerous to be listed. Please visit our website www.dykketabeller.no to learn the detailed revision history of this edition.

This publication aims to further increase the understanding of safe diving procedures. Hence, we emphasize the correct application of diving tables to limit the risk of decompression illness. We also focus on the correct procedures whenever an incident takes place. This publication targets all personnel involved in diving operations and a thorough knowledge of diving medicine and diving physiology is no prerequisite.

With regard to diving medicine, there are divergent views on several issues. Most of the controversy stems from the lack of documented research and/or from inconclusive results. The reader should keep this in mind.

Geir Gundersen has accepted our invitation as a co-editor for this edition. We appreciate the valuable contributions from Andreas Møllerløkken in the two preceding editions. We would still like to emphasize that Cdr SG (ret) Arne-Johan Arntzen and the late head of submarine and diving medicine Surg Cdr SG Svein Eidsvik wrote the first edition and provided the basis for these tables.

Bergen, 7.5.2024

Jan Risberg Geir Gundersen Olav Sande Eftedal

Contents

Introduction

1. **The objective of these tables** is to provide guidance for decompression in surface-oriented diving and diving with air or nitrox with closed bell (TUP-diving). The tables are developed for commercial diving. The document holds information equally relevant for recreational and military divers, but such users should consider whether other guidance material is better suited for the purpose.

2. **Any Diving Table Will Entail a Compromise** between maximizing bottom time versus decompression time on the one hand and minimizing the risk of decompression illness (DCI) on the other. During the latest years we have seen an increased focus on lowering the risk of contracting DCI. While these tables do not offer a novel approach to the problem, they represent a modified approach being based on the best of well-tested tables and procedures. Any of these modifications have been based on real-life experience, namely a great number of various profiles that have been logged by Norwegian diving companies, using a variety of equipment.

3. **The "Norwegian" Decompression Tables (NDTT)** have remained essentially unchanged since they were issued for the first time in 1980 (NUI-report 30-80). The tables were printed as an independent publication in 1986 and later revised in 1991, 2001, 2008 and 2017. The air decompression table (staged in-water decompression with air as a breathing gas) is based on Royal Navy"s Table 11 (1979 edition), though modified with a slower ascent rate and a different procedure for repetitive dives. Bottom times contracting decompression time exceeding approximately 35 min are identified with asterisk (dives not recommend to be planned for).

4. **The Surface Decompression Table Using Oxygen** ($SurDO_2$) is based on the US Navy Diving Manual Rev (USN DM) Ed 7 (2016 edition). There are certain national adjustments, e.g. units of diving depth in metres rather than feet and the Norwegian procedures do not allow repeated $SurDO_2$ dives.

5. **The Use of Oxygen-enriched Air** (nitrox), including its optional use with surface decompression, is fairly uncommon in Norwegian commercial diving. Used properly, nitrox may improve safety as well as cost effectiveness.

6. **The Responsibility of the Dive Supervisor.** Care should be taken when reading the decompression tables. Tables may appear to provide the correct decompression for any exposure, solely based on depth and bottom time. Other factors such as workload and diver's individual predisposition for DCS should affect decompression obligation. We try to bring these and other matters to the attention of the reader.

7. **Decompression Illness and Long-term Health Effects.** Recent research confirms that neurological DCI is more common than previously thought. Additionally, the incidence and extent of long-term health effects of DCI seems more extensive than previously believed. It is thus important to use diving procedures that minimize the risk of DCI.

8. **Table Safety.** A given dive table's safety is commonly presented as expected DCI incidence. To ascertain the true incidence of DCI, a large number of properly logged dives are required. Despite this, the end results may be equivocal. Several tables have been subject to testing (among these US Navy (USN), French and Norwegian tables), but there is presently no substantial advice to support superior safety performance of one table compared to the others. Measurement of venous gas embolism ("silent bubbles") are frequently accepted as an outcome measure when testing new tables. Decompression tables may be compared measuring venous gas embolism. There is a positive correlation between bubble grade and DCI incidence. Measurement of venous gas emboli is a useful method in research related to effects of altered ambient pressure. However, extent of intravascular bubbles is not a sensitive measure for health effects. Diving may cause long term health effects on e.g. lungs, the skeleton and nervous system, but these health effects develop so slowly that they are difficult to associate with the use of a certain decompression table. It is extensively documented that DCI is a risk factor for later development of long-term health effects on the nervous system. In the absence of better outcome measure, the incidence of DCI is commonly accepted as a performance indicator of a decompression table.

9. **The "Norwegian Tables"** have been used by Norwegian Society of Underwater Contractors. Diving contractors have logged diving activity (hours of diving) and DCI incidence since 1994. Through the decade of 1993–2003 ~ 220,000 hours were logged, and the DCI incidence reached ~ 0.05 ‰ per hour, i.e. one case of DCI per 20,000 hours. The Norwegian Petroleum Directorate published a report in 1994 on standard decompression tables for surface-oriented diving. Six institutions were questioned concerning their experience using the Norwegian standard tables. The diving on the Kalstø project had a particular high incidence (9259 dives, DCI incidence 0.18%). The other dives (52353) had a DCI incidence of 0.04%. Studies have reported that some divers experience symptoms after decompression not being reported to physicians ("unreported DCI"). Treatment of DCI using the company's recompression chamber will add to this. Still, we assume that the number of such unreported treatments are small.

10. **Shields and Coworkers** published in 1989 a report analysing the incidence of DCS after some 130 000 surface-oriented dives on the UK continental shelf. The decompression procedures at the time differed significantly from those presented in the NDTT. The incidence of DCS was 0.26%, but the most important result in the report was the description of risk associated with dives with high inert gas load. Dives with high inert gas load (as indicated by their "PRT" – i.e., the product of pressure (bar) and square root of time (min)) had significantly higher risk of DCS than dives with less inert gas load. Shields and co-workers recommended a PRT=25 to border the high- and low risk dives. UK authorities (HSE) introduced bottom time limitations restricting PRT to approximately 30 (27-34) for surface-oriented dives without the use of TUP (Transfer Under Pressure, pressurized diving bells). The UK bottom time limitations, which now are enforced by the Norwegian Labour Inspection Authority are referred in the section "Prevention of decompression illness" in this publication.

11. **Traditional Models for Decompression** (decompression algorithms) compute gas flow in and out of mathematical "tissues" (compartments) and mandate decompression to restrict the supersaturation of these compartments. Though there are multiple algorithms for calculation of gas transfer, the so-called deterministic models have a common conception that dives are either categorized as "safe" or "unsafe" depending on whether the maximum permitted gas tension has been exceeded.

12. **New Statistical Models** (probabilistic models) have been used by the US Navy since the 6th edition of the US Navy Diving Manual. Even though the algorithm for calculation of gas flow and the concept of maximum permitted gas tension remains unchanged, the statistical model allows estimation of the *probability* of DCS for a given dive profile. This allows construction of tables that is a compromise between efficacy and risk. Rev 7 of the US Navy Diving Manual has a typical estimated probability of DCS between 2% and 6% depending on depth, bottom time and decompression mode.

13. **Standard Air Table.** In our work process with the 4th edition of the Norwegian diving tables we have estimated the risk of DCS using the previous (3rd) edition of the tables. The analyses showed that DCS risk typically ranged 2% to 5% for "non-indexed" (non-exceptional) dives. The DCS risk was in the same order as compared to US Navy Diving Manual Rev 7. The experience using the Norwegian diving tables for non-exceptional air staged decompression dives is generally good (see earlier discussion in this chapter) and the new (Rev 7) US Navy Diving manual advice significantly longer decompression time without demonstrating a similar significant improvement in safety compared to the Norwegian tables. By this reason, only minor changes in decompression obligation were introduced in the 4th edition of the Norwegian tables for non-exceptional staged decompression dives. Except for provision of Repetitive Group designators for a bottom time of 5 min for the very deepest dives, no change in air decompression tables has been introduced since the 4th edition.

14. **$SurDO_2$ procedures.** The Risk for DCS was high using the previous US Navy procedures for surface decompression, exceeding 8% for the longest dives. Wayne Gerth (US Navy Experimental Diving Unit) estimated the DCS risk for a selection of $SurDO_2$ profiles as published in the 3rd edition of the tables to range 7-8%. Due to this, the USN $SurDO_2$ procedures were introduced in Ed 4 of these tables. There are no changes in the $SurDO_2$ tables since the 4th edition except for some minor changes in text, some graphical corrections and adjustment of miscalculations in total decompression time. The changes are detailed on the webpage for this document.

15. **The Procedures for Repeated Dives**, diving at altitude and flying after diving are unchanged from the previous edition, some minor changes have been done in text. Visit the webpage for details.

16. **Estimated DCS incidence when using these tables.** If the procedures in this table are used, the probability for DCS is expected not to exceed 5% for non-exceptional dives. Exceptional dives (indexed by *) should not be planned for, but if the situation requires their use (e.g., exceeded bottom time by a mistake or an emergency situation) the DCS probability will range between 5% and 6%. The values listed here would be the expected occurrence when tables are tested scientifically. In operational diving the DCS occurrence will be significantly less (typically 0.2-0.5%). This disparity is partly due to under-reporting, partly the fact that the tables seldom are dived to the marginals of depth and bottom time. In addition, it is common to consider individual risk factors as listed in the section "Prevention of Decompression Sickness".

17. **Multilevel Diving.** A procedure for multilevel diving was introduced in the 4th edition of these tables. We have not received any feedback related to use and experience. The Norwegian Labour Inspection Authority has detailed requirements for multilevel diving (Regulations concerning the Performance of Work). We provide guidance for multilevel diving in compliance with these regulations.

19. **Other Changes.** In the 6th edition we have changed guidance for calculating oxygen toxicity and we have produced tables for TUP diving. A procedure for emergency decompression has been included. Please review the webpage for details on other minor text changes.

20. **Adjustments compared to USN DM Ed 7**. As previously explained, most of the contents of these tables (except for air decompression tables) are based on USN DM Ed 7. We have converted units 3 feet = 1m. To ease use and for other practical reasons we have done several other adjustments. The residual Nitrogen Penalty is increased in 5-min increments. The Residual Nitrogen Timetable has been adjusted (times rounded) to ensure 10 min increments in time.

21. **Formal Status – Translations and Revisions.** These tables are published in electronic and printed versions. They are additionally published in English language. The original version is in Norwegian, and in the case of inconsistencies between Norwegian and foreign versions, the Norwegian version should be given precedence. Changes will be published on www.dykketabeller.no. A list of changes will not be printed but may be downloaded from the website. The authors recommend that readers of printed tables manually correct the printed text when changes are published on the website.

22. **Recommendation for Use.** We recommend that the Norwegian decompression tables should be used because they by experience have given an acceptable protection against DCS. The present edition is expected to contribute further to safe diving. It is important to have standardized decompression procedures to avoid the risk for errors when divers co-operate as a team.

Standard Air Decompression Table

1. **Table Depths,** that is, the depths listed in the tables, provide the maximum depth for a given profile. Thus, a dive to 30 m uses the 30 m entry. A dive to 30.5 m uses the 33 m entry (next higher) and so on.

2. Whenever the depth is determined by actual measurement of the water depth, the deepest point being measured should be used for table depth. Preferably, depth should be determined pneumatically or electronically, in which case the measurement should be read at the diver's lower chest level. Regarding units and accuracy, 1 bar translates to a depth of 10 m and there is no need to differentiate between sea water and freshwater.

3. **Bottom Time** is defined as the time from the diver leaving the surface (descent) until the start of the ascent. A given table time means the maximum bottom time allowed for a given decompression schedule at a given depth. To avoid exceeding the table time it is a good idea to prepare the diver for ascent shortly before the maximum time is up. By doing so he will avoid the need to switch to the next longer schedule.

4. Based on the actual bottom time and depth the table is consulted to determine the proper ascent, decompression stops included. Note that except for the first/deepest stop, the stop time at each mandatory stop should include the proper ascent time to reach the stop depth. The diver should position himself with the lower part of his chest at the stop depth.

5. PROBLEM: You have made a dive to 19 m for 64 min. Which table entry should be chosen and what is the proper ascent?
   SOLUTION: The correct table entry is 21 m for 70 min. The prescribed decompression is 5 min at 6 m and 10 min at 3 m. This means that 5 min should elapse from arrival at the 6 m stop until he leaves it. Then a further 10 min should elapse from leaving the 6 m stop until leaving the 3 m stop and heading for the surface.

6. **The descent rate** is not critical, but should in general not exceed 20 m/min.

7. **The Ascent Rate** is 10 m/min. This rate of ascent applies to surface ascents (no-stop dives) as well as ascents from the bottom to the first decompression stop. The same rate shall be applied for the ascent between the shallower stops. A no-stop (or no-decompression) dive is defined as a dive that does not require any decompression stops. The time for ascent to the first decompression stop should not be included in the decompression time listed for that stop in the table. Whenever the actual ascent rate has been too slow one should not increase the ascent rate to "catch up" during final ascent. The time from one stop to the next should be about one minute. When the time at 3 m is up the mandatory decompression has been completed and the diver ascends to the surface. Note that

a proper ascent rate constitutes an integral part of a proper decompression schedule. A careless, rapid ascent may cause the same kind of problems as omitted decompression time at mandatory stops. If the time for ascent to the first stop is delayed by more than one minute relative to the prescribed time, the extra time should be added to the bottom time and decompression be adjusted according to this longer bottom time.

8. **The Total Decompression Time** as tabulated in the tables list the time to be spent at the staged decompression stops, but do not include ascent time from bottom depth to deepest decompression stop nor ascent time from shallowest water stop to surface. "Total decompression time" is not listed for no-decompression dives.

9. **A Single Dive**, or a "Non-Repetitive Dive" as opposed to a "Repetitive Dive", is defined as a dive that starts when all excessive gas accumulated during the previous dive has off-gassed. How long this will take depends on the depth and bottom time of the previous dive. All excessive gas is expected to be eliminated after 16 hours and consecutive dives are considered "Single Dives".

10. **Repetitive Group.** When the diver returns to the surface after finishing a dive, he will still have an excess of nitrogen in the body. A letter for each combination of time/depth in the column "Repetitive group" indicate the extent of this nitrogen excess. It is identified with the letters A through Z (actually A through O in addition to Z) where A indicate the smallest and Z the highest nitrogen load.

11. **A Repetitive Dive** is a dive starting before all excessive gas from the previous dive has off-gassed. In such cases the repetitive dive will carry a penalty, meaning that the exposure will be calculated by adding the penalty (the Residual Nitrogen Time) from the previous dive to the actual bottom time.

12. **Repetitive Group Adjusted for Surface Interval.** The longer the diver stays on the surface after the dive before carrying out a repetitive dive, the less is his residual nitrogen. To find the adjusted Repetitive Group, use the **Residual Nitrogen Timetable for Repetitive Air Dives.** The letters from A to Z sloping diagonally across the table are the Repetitive Groups after the dive. To the right of every Repetitive Group, times (in hours and minutes) since surfacing from the last dive have been listed. On the bottom line, vertically under the time period spent on the surface, is the adjusted repetitive dive group for that surface interval. The table shows how long you must wait before a repetitive dive may take place without a penalty to the bottom time.

13. **The Residual Nitrogen Penalty** (The Residual Nitrogen Time) will be determined by the planned depth of the next dive and the amount of excess nitrogen that the diver holds from the previous dive. The higher the amount of nitrogen still being dissolved in the diver's tissues, the higher the penalty. The Residual Nitrogen Time is a measure of how long it would take to acquire the actual amount of nitrogen at the second dive's planned depth. Hence, the Residual Nitrogen Time will be less the deeper one dives on the second dive since it would take less time to acquire the actual nitrogen load at a greater depth. The 60m table does not provide data on residual nitrogen penalty, accordingly a dive to 60m cannot be a repetitive dive.

14. **Dives to Depths not Exceeding 6 Metres.** The highest Repetitive Group Designator to be acquired for dives to depths not exceeding 6 m is "K". For those cases where a diver holds a Repetitive Group Designator exceeding "K" no reduction should take place during the dive, but the Repetitive Group Designator should be corrected for surface interval only.

15. PROBLEM: You dive to 23 m for 28 min. After having spent two hours on the surface you conduct a second dive, this time to a depth of 19 m. Which adjusted Repetitive Group Designator applies and how much time can you spend at 19 m without incurring a need for a decompression stop?
    SOLUTION: The first dive gives a table depth of 24 m and a table time of 30 min (next higher in both cases) which earns Repetitive Group "H". To find the adjusted letter group, pick "H" on the diagonal line and run across the time groups until you reach the one that applies to a surface interval of two hours. It falls within the 1:41 – 2:40 entry. Moving down from this entry you find the letter "F". This is the adjusted letter group for a 2-hour surface interval. Now, the next problem will be to select the table depth of the second dive. Since 19 m isn't listed the correct choice is a table depth of 21 m. To the bottom of the 21 m table, you'll find a row listing the Residual Nitrogen Time for various Repetitive Group Designators. An "F" translates to a 30 min penalty for a dive to 21 m. Since the maximum no-stop time is 45 min at 21 m a 30 min Residual Nitrogen Time means that we have 15 min left. Thus, the maximum no-decompression bottom time for the second dive is 15 min. Longer bottom times will require decompression stops.

16. **A Surface Interval of Less than 10 Minutes.** In this case the bottom time is taken as running continuously without regard for the surface interval. However, this is not recommended if the initial part of the dive would have required decompression stops or come close to requiring decompression stops.

17. **Strenuous Dives.** Some dives are more strenuous that others or are more predisposing for DCS. This is covered more thoroughly in the chapter "Prevention of Decompression Illness". Repetitive dives may increase risk, especially when the dives are strenuous. This holds true even if the dives are completed according to the decompression table. This warrants a definition of what we consider "strenuous". Common sense as well as practical experience indicates that these factors should qualify a dive as "strenuous":
    • Dives deeper than 30 m
    • Multilevel-dives
    • Dives earning a decompression penalty of more than 15 min.
    • Physically challenging dives
    • Being uncomfortably cold while decompressing

18. **Repetitive Dives** should normally be limited to one. However, two repetitive dives are acceptable when neither of them falls within the strenuous category. In any event, a dive can always be followed by another dive to a maximum depth of 9 m (or an equivalent air depth of 9 m when using nitrox).

19. **Diving Several Consecutive Days.** We previously advised for a day without diving (a non-diving day) after three days of diving if any of the preceding dives had been strenuous. There is no knowledge to support such an advice and we have suspended it.

20. **Other Restrictions.** The tables mark the longest exposures with an asterisk (*). This is done to indicate that these exposures should be avoided. Such exceptional dives will either require long decompression time in water (exceeding 35 min) or an increased risk of DCS (ranging 5% to 6%). Both the Norwegian Labour Inspection Authority (inshore diving) and the Norwegian Ocean Industry Authority have stipulated bottom time restrictions. These are marked with bold horizontal lines in the tables. Air should not be used as breathing gas in dives exceeding 50 m. Due to this, the profiles for depths ranging 54 through 60m are identified with asterisk.

21. **Multi-level Dives.** According to basic guidance for the use of decompression tables, the depth of a dive is determined by the greatest depth reached. The multi-level approach, on the other hand, considers the inert gas uptake at various levels. This will allow a considerably longer total bottom time, provided that the deeper levels come first. These tables may be used for planning of multilevel-dives as explained in the appropriate chapter.

22. **Dive computer.** The Norwegian Labour Inspection Authority requires use of dive computers for multilevel diving. Dive computers are not allowed for use as the single measure for planning of decompression for other types of diving. The diving supervisor, rather than the diver, should have the responsibility for supervising the dive in a safe manner. The dive supervisor should monitor the diver's depth and dive time to ensure that the ascent and any decompression stops comply with agreed procedures. For occupational diving, with a constant working depth, the dive computer will usually allow shorter bottom time than traditional written decompression tables.

23. **Deep chamber dives.** These tables had previously (until the 6th edition) separate tables for deep chamber dives. Such tables were previously used in the Norwegian Armed Forces, but these tables are not commonly used and are used for this reason. We recommend that deep chamber dives used for training purposes (typically to experience nitrogen narcosis) should comply with the standard air decompression tables but the diver should breathe oxygen by BIBS for decompression stops 9 meters and shallower.

Diving at Altitudes above 250 m

1. **The Ambient Pressure at Sea Level** (standard barometric pressure) is one atmosphere. This pressure translates to 760 mm of mercury (mm Hg), 10.332 m of fresh water and 1013.25 hPa. For all practical purposes we can use the approximation 1 bar = 1000 hPa = 10 m of water, whether freshwater or sea water.

2. As we ascend above sea level the ambient pressure drops. Close to sea level pressure drop is about 1 hPa per 8.6 m increase in altitude. However, the higher up we go the less the pressure drops with a further increase in altitude. The summit of Mount Everest is at 8849 m above sea level (m asl.). At this altitude the ambient pressure is 314 hPa.

3. **Meteorological changes affect ambient pressure**, i.e. high- or low-pressure weather systems. A pressure of 938.5 hPa is the lowest atmospheric pressure recorded at sea level in Norway. This corresponds to the standard barometric pressure at a height of 640 m asl.

4. **Diving at Altitude.** The ratio between the pressure at a given depth versus the surface pressure will be larger when diving in a mountain lake compared to sea diving. This will affect decompression obligation. There are two basic approaches to this problem, namely, to use corrective factors for standard tables or to switch to tables that have been recalculated for a specific altitude.

5. **Cross correction.** A simple, widely used approach is to calculate the "corrected depth" based on the ratio between the absolute ambient pressure at depth and the surface atmospheric pressure. Since this procedure was worked out by E. R. Cross it is commonly being referred to as the "Cross correction". Corrected depth (D_c) can be calculated according to this equation:

$$D_c = \frac{Actual\ depth\ at\ dive\ site\ \times\ Atmospheric\ pressure\ at\ sea\ level}{Atmosperic\ pressure\ at\ dive\ site}$$

6. While it is impractical to measure the current atmospheric pressure at a dive site it is usually no problem to identify elevation by consulting a map of the area. Then one can choose the correct table applicable to this elevation. The table "Correction for Dive Site Altitude" provides the table depth to be used for a given diving depth.

7. **Altitudes Lower than 250 m Above Sea Level.** There is no conversion table for altitudes that do not exceed 250 m asl. Further, there is no need to consider normal barometric variations, even though a low-pressure system may actually correspond to a few hundred metres increase in altitude.

8. **Altitude Acclimatisation.** When a diver arrives at a high-altitude site his tissues will hold an excess of dissolved nitrogen (super saturation). This residual nitrogen load is like the one acquired after a repetitive dive. Depending on the altitude, this nitrogen surplus will call for a decompression obligation corresponding to an extension to the actual bottom time, like the situation for a repetitive dive. During the stay at altitude, this residual nitrogen load will be reduced as presented in the residual nitrogen timetable. As shown in The Residual Nitrogen Timetable for Repetitive Dive, there is no penalty if the diver has stayed in the altitude for at least 8 hours (actually 7h 10min).

9. PROBLEM: A diver is acclimatized to an altitude of 400 m asl. Then he moves up to a dive site at 1,300 m asl. To carry out a dive to a depth of 18 m. Which table will you use to determine Repetitive Group Designator and corrected depth?
SOLUTION: The dive site at 1,300 m asl. Falls within the 1250 – 1500 m asl. Entry. The depth entry that applies to 18 m is 20 m (equal or next higher). By following the 20 m row to right you find the corrected depth, namely 24 m.

10. Provided the diver had ascended directly from sea level his Repetitive Group Designator would have been "D" as per the 1250-1500 m asl. Column. Since he has only ascended 900 m we can safely use the 750 – 1000 m asl. Entry which earns him a "B". This translates to a 10 min penalty (addition to the actual bottom time) at a table depth of 24 m.

11. **Reduction of Repetitive Group Designator.** Like sea level condition, the body will eliminate nitrogen-excess when you stay at altitude. The Repetitive Group Designator will therefore be reduced the longer you remain at altitude. If you hold excessive nitrogen (a Repetitive Group Designator) from a previous dive, this should be added to the one attributed to the one mandated by lack of acclimatisation.

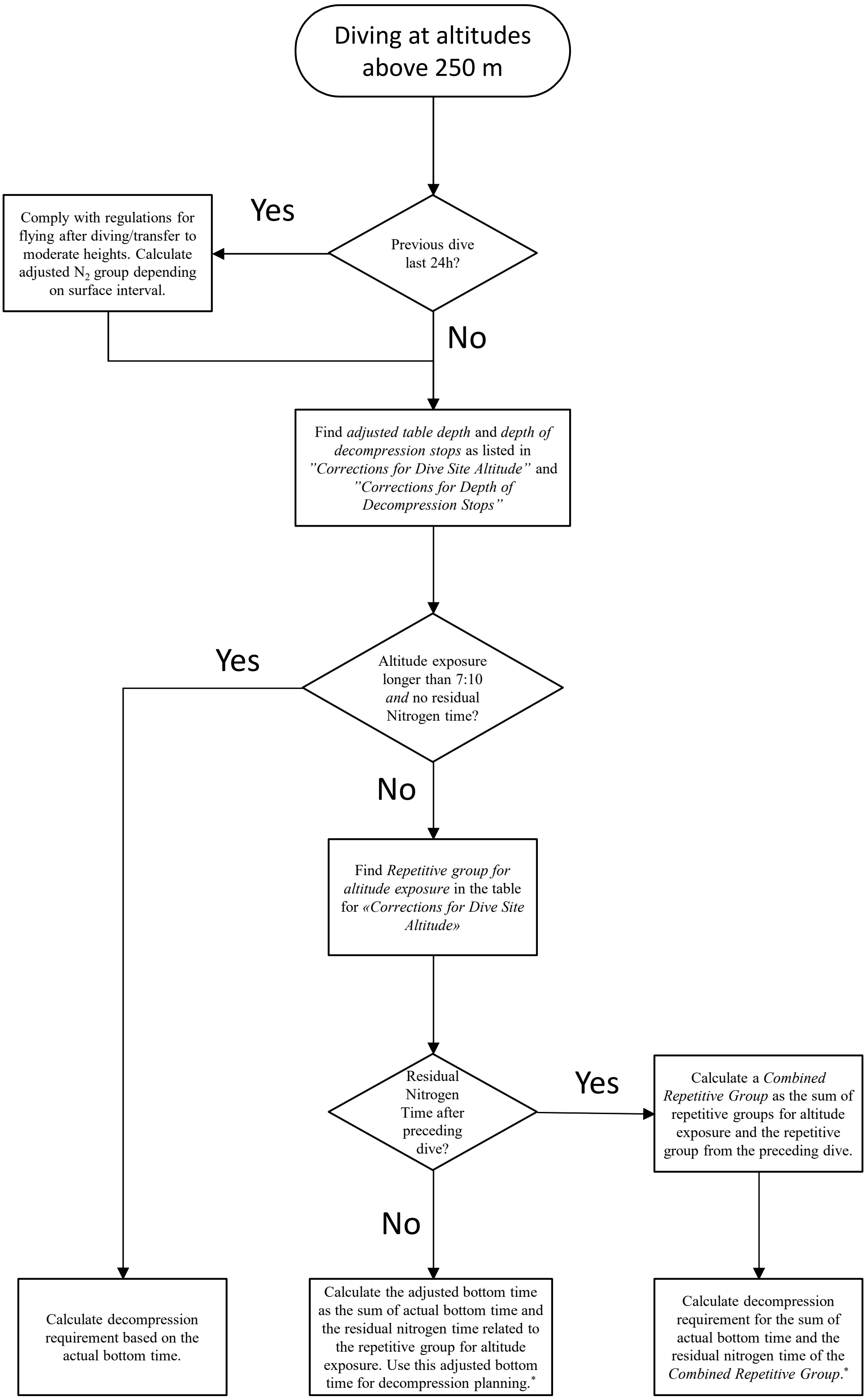
12. **Calculating the Residual Nitrogen Time** for repetitive dives at altitude when the diver is not acclimatized. The residual nitrogen time for a dive at altitude which takes place before the diver is acclimatized and while the diver still carries a Repetitive Group from the previous dive is done by adding the Repetitive Groups. Start by converting the Repetitive Group Designators to numbers. The Repetitive Group A is given the number 1, Repetitive Group B is number 2 etc. Following this, the Repetitive Groups may be added. A diver holding a Repetitive Group of “B” (2) after the previous dive and Repetitive Group “D” (4) due to lack of acclimatization will carry a residual nitrogen time as prescribed by letter “F”. The reason is that the Repetitive Group from the previous dive and the Repetitive Group associated with ascent to altitude will summarize to 6, i.e. the 6^{th} letter (F).

13. PROBLEM: A diver drives from Bergen to Finse (1222 m asl) and wants to dive without considering a penalty to bottom time. He holds a Repetitive Group Designator of “B” from his last dive at time of arrival at Finse. How long will he have to wait before diving?
    SOLUTION: The altitude (1222 m asl.) is within the column for 1000-1250 and address a Repetitive Group Designator of “C” when arriving at Finse. His Repetitive Group Designator from last dive (“B”) should be added as two extra letters, calling for diving compliance with an “E”. In agreement with the Residual Nitrogen Timetable for Repetitive Air Dives he must wait at least 6:21 before he can dive without considering penalty for nitrogen excess from sea level exposure and his last dive.

14. **Compliance With Regulations for Flying After Diving.** If the diver has a Repetitive Group Designator after the previous dive, the rules for flying after diving should be complied with. A diver intending to fly to a dive site at altitude should thus comply with the regulations in chapter “Flying after diving”. A diver returning by aircraft after a dive in a mountain lake should consider the additional pressure loss during the return flight. This is described in the next chapter.

15. **Decompression Stop Depths.** Theoretically, the most correct altitude conversion would involve a slight upward shift of the decompression stop depths. However, for all practical purposes the correctly adjusted stop depths would be insignificantly different from the standard stop depths and there's no need to adjust depths by a few centimetres. Hence, the standard stop depths will be used whenever the corrected stop depth differs by less than one metre. Neither theoretical nor practical concerns indicate that there is any need to observe these minor adjustments of stop depths.

Flowchart for Diving at Altitudes Above 250 m



*: The repetitive group should be reduced depending on surface interval at altitude according to the "Residual Nitrogen Timetable for Repetitive Dives".

Flying after Diving

1. **Extensive Practical Experience** confirms that flying after diving increases the DCS risk. The problem is not flying per se, but the additional decompression caused by a reduced cabin pressure. International regulations allow the cabin pressure in commercial aircrafts to drop as low as the ambient pressure at 2,500 m (8,000 ft). Our recommendations are based on this cabin pressure. The same kind of problem may arise whenever a diver is exposed to lower ambient pressure shortly after a dive, for instance by driving to mountain areas.

2. **There Are Many Factors to Consider.** For this reason, it is hard to provide safe and simple guidelines without being overly strict. Acknowledged organizations such as DAN, PADI, USN and DMAC all have their own guidelines as to flying after diving, but they are hardly in agreement.

3. Generally, the deeper and/or longer the dive, the lower the cabin pressure and the shorter the time since the dive was completed the higher the DCS risk. Factors listed under "strenuous dives" in chapter Standard Air Table will additionally increase DCS risk.

4. **Flying After Occupational Diving.** When diving according to the standard air table or the surface decompression table in this publication, which is the normal practice for occupational divers, the "Time before flying after diving" tables in paragraph 8 on the next page should be used. These numbers are based on new recommendations provided by the US Navy. Minimum surface interval before flying is dependent on highest repetitive group designator acquired during the last 24h.

5. **Flying Under Extreme Conditions.** Note that we do not intend to cover flights in an unpressurized aircraft above 2,500 m asl. (8,000 ft asl.). If such flights are being planned, we recommend that you contact baromedical expertise for advice.

6. **Flying after DCI.** Whenever a diver has suffered DCI, even when successfully treated and fully resolved, extra time before flying may be warranted. In these cases, baromedical advice should be sought before flying. You may expect widely different guidelines in various countries. Anything from one to 30 days prohibition of flying may be advised! The Diving Medical Advisory Committee (DMAC) has published a guidance note for this purpose (DMAC 07).

7. **Time before flying after diving**

The highest repetitive group after any dive the last 24h	Minimum time from end of last dive to flying
A to C	0 hours
D	2 hours
E	5 hours
F	7 hours
G	9 hours
H	11 hours
I	13 hours
J	14 hours
K	16 hours
L	17 hours
M	18 hours
N	19 hours
O	20 hours
Z	21 hours

Dives not identified by a Repetitive Group Designator should incur a minimum of 24 hours without flying.

8. **Transfer to Moderate Heights** (e.g., mountain passes) will impose a certain risk of DCS if it takes place too shortly after a dive**.** The rules for flying after diving should be respected for all exposures to heights exceeding 1750 m asl. For exposures to heights not exceeding this threshold, the table below may be used.

	Altitude (m asl.)				
Wait	250-600	600-1000	1000-1250	1250-1500	1500-1750
No waiting time required	I	H	G	F	E
Wait at least 3h	L	J	I	H	G
Waiting time (h) with higher Repetitive Group Designator	7	9	11	16	16

If the highest Repetitive Group Designator achieved during the last 24h is equal or less than indicated in the row for "No waiting time required" one may move to the height indicated without delay. If the travel may be suspended by 3 hours, the Repetitive Group Designator may equal the one indicated in the row below. Finally, the lowest row indicates the number of hours to wait if the Repetitive Group Designator exceeds this. Wait 24 hours before transfer to heights exceeding 250 m asl. if the previous dive has not been attributed a Repetitive Group Designator.

9. **Rescue Divers** may be scrambled for a rescue mission in mountain waters shortly after sea water routine training. The diver may fly immediately after a dive with Repetitive Group Designator "C" or less. With Repetitive Group Designator "D" or higher, the diver must comply with the guidelines for flying after diving. Rotary wing (helicopter) flying with altitude not exceeding 4000 feet may nevertheless take place immediately after a training dive with Repetitive Group Designator "G" or less. Oxygen breathing during the surface interval will be an effective way of eliminating gas excess and may be used if extraordinary circumstances make it necessary and the earlier listed limitations cannot be respected. A competent diving physician should be consulted in such cases. The table depth should be adjusted according to the procedure for adjustment of dive site altitude. The bottom time penalty is calculated by the "addition" of Repetitive Group Designator from the previous dive to the Repetitive Group Designator allocated to the specific height of the dive site. If the diver remains at altitude before the rescue dive, this combined Repetitive Group Designator will be reduced according to the Residual Nitrogen Timetable.

10. **Waiting Time Before Flying After a Dive at Altitude.** Flying home after a dive at altitude will impose an additional pressure loss and risk of DCI if the diver has a too high Repetitive Group Designator. To calculate required waiting time before returning by helicopter after diving at altitude, the table on the preceding page may be used ("Transfer to moderate heights"). Use the actual depth at the dive site to find the correct Repetitive Group Designator for this table (not the adjusted depth as prescribed by the table for corrections for dive site altitude). No waiting time is required if the helicopter avoids further altitude while returning to lowland.

11. **Example – Flying for a Rescue Mission After a Training Dive in Sea.**
PROBLEM: A diver has a Repetitive Group Designator of "C" after a training dive and wishes to do a rescue dive to 18 m in a lake at 1220 m asl. What is the allowed bottom time if this dive should be completed as a no-decompression dive? The diver will be transported to the dive site 2 hours after the training dive and will complete his rescue dive immediately after arrival at site. How long should he wait before returning by helicopter? We expect the helicopter to fly at a maximum altitude of 1700 m asl.
SOLUTION: The dive to 18 m in a mountain lake at 1220 m asl. should be planned according to a table depth of 21 m. The surface interval causes a reduction in the Repetitive Group Designator from "C" to "B" after 2 hours. In addition to this a Repetitive Group Designator of "C" should be added during the movement from sea level to 1220 m altitude. By "adding" Repetitive Group Designators "B" and "C" the diver will be given a new Repetitive Group Designator of "E". The "E" Repetitive Group Designator will give additional 25 min of bottom time to the 21 m table. The rescue diver may accordingly plan for 20 min bottom time if the dive is be planned as a no-decompression dive.
To calculate the minimum waiting time before returning by helicopter, the Repetitive Group Designator should not be adjusted for altitude. Use the actual diving depth, in this example 18 m. The diver has a Repetitive Group Designator of "B" from the preceding dive giving a penalty of 15 min to the 18 m table. The repetitive group designator should be calculated for a bottom time of 35 min (15 min penalty + 20 min actual bottom time). A 35 min bottom time at 18 m will cause a Repetitive Group Designator of "F". As prescribed by the previous table, this will impose a minimum waiting time of 3h before returning by helicopter.

Multilevel Diving

1. **Background.** Conventional use of the decompression tables assumes that the diver remains at the maximum depth throughout the bottom time. This will be the situation calling for the longest decompression, alternatively dictating the shortest allowed bottom time for a no-decompression dive. If the diver ascends successively to more shallow water, the tissue inert gas partial pressure will decrease. This will allow a longer total dive time without need for staged decompression listed in the dive table and based on maximum depth and running bottom times. Dives characterized with defined time intervals and depth ranges are termed ”multilevel dives”.

2. **There are Few Published Procedures** for the use of traditional decompression tables for multilevel diving, but the Canadian (DCIEM) tables include advice for such. It is worth mentioning that there is less evidence associated with use of the tables for multilevel diving compared to traditional prescription of staged stops. Due to this, we recommend several restrictions for such multilevel diving until more data related to safety performance is available.

3. **The Standard Air Decompression Table** can be used for the planning of multilevel dives. The planning is based on the principles of repetitive diving. The dive is separated into discrete steps with certain depth ranges (levels). The tabulated bottom time for any level is calculated by adding the actual bottom time at the step with the Residual Nitrogen Time as dictated by the Repetitive Group Designator. The bottom time for any level should include ascent time to the next shallower level.

4. **Several Limitations Apply** to decompression planning of multilevel-dives:
   - The dive should be executed to successively shallower depths (one may ascend and descend within a stage range though this should be avoided as far as possible.
   - The dive should at any time be allowed to be aborted as a no- decompression dive.
   - The depth levels (steps) should be separated by at least 6 m for diving depths not exceeding 30 m and at least 9 m for diving depths exceeding 30 m.
   - The shallowest depth level should be 12 m. However, the dive may be completed at depths shallower than 6 m without restraint of dive time at such shallow depths.
   - The dive should be completed with a 3 min safety stop between 3 and 6 m.

5. **Repetitive Dives** may be planned for as described in chapter “Standard Air Decompression Table”. A repetitive dive may be a multilevel dive or a dive according to the standard air decompression table. Dives to depths not exceeding 6 m could be planned for without limitation on bottom time.

6. **If Maximum Allowed Dive Time at Any Level is Exceeded,** the diver should complete a staged decompression as prescribed for this table depth. The diver should breathe oxygen at surface pressure for 30 min after the dive. No repetitive dive is allowed for the next 18 h.

7. The table on the next page may be used for an overview of maximum allowed bottom times at various depth levels depending on the maximum depth of the multilevel dive.
   PROBLEM: A dive is planned for 28 m. Maximum exploitation of bottom times at all depth levels is wanted. How should the dive be planned?
   SOLUTION: The next deeper table depth is 30 m. Review the column 30 m and read the maximum bottom time which is 20 min. Next level is 24 me. The diver has 20 min to spend at diving depths ranging between 24 and 30 m. Maximum allowed bottom time at 24 m is 5 min, next level is 18 m. The diver may spend 5 min at diving depths ranging between 18 and 24 m. The next level is 12 m. The diver can spend 10 min in diving depths ranging 12 and 18 m. The diver can spend 50 min ranging 12 to 6 m. The dive should be completed with a 3 min safety stop between 3 and 6 m.

8. **Multilevel dives with other separation of depth levels.** The dive may be planned with other levels/bottom times than those listed if the above listed restrictions are respected. This will allow longer dive times at shallower depths.
   PROBLEM: A diver is planning a short (5 min) inspection dive at 32 m. The rest of the dive is planned to be take place from 18 m depth to the surface. How could this dive be planned?
   SOLUTION: The bottom time at the deepest level should be planned for 10 min to accommodate ascent time to the next level. We should use the 33 m table and note that a bottom time of 10 min is penalized with a Repetitive Group Designator of ”D”. The next depth level is 18 m where Repetitive Group Designator ”D” will give a Residual Nitrogen Time of 25 min. Maximum bottom time for a no-decompression dive to 18 m is not allowed to exceed 60 min and such a dive will give a Repetitive Group ”K”. The final part of the dive could be planned with a maximum depth level of 12 m. Actual bottom time should not be allowed to exceed 50 min if the dive is planned with a 12 m limit. The diver should execute a 3 min safety stop at the very end of the dive.

9. The table below may be used for calculation of maximum allowed bottom times at various stages of a multilevel dive.

Succeeding depth level (m)	Deepest diving depth (m)								
	39	36	33	30	27	24	21	18	15
39	10								
36		10							
33			15						
30	5			20					
27		10			25				
24	5		10	5		35			
21		10			10		45		
18	10		10	10		10		60	
15		15			15		15		90
12	50		50	50		50		50	
9		45			45		45		45

Table 1 The table should be read vertically by initially identifying the column listing the deepest diving depth. Maximum allowed bottom times at the various depth levels are listed in the rows below. The bottom time at any depth level should include ascent time to the shallower depth.

10. **Regulatory Requirements for Multilevel Diving.** The Norwegian Labour Inspection Authority has stipulated requirements for decompression planning of multilevel dives. The diver is required to use a dive computer, there shall be continuous topside electronic depth monitoring, digital recording of depth and time and there shall be a system for registration of remaining no-decompression time. The diver should ascend to surface before the dive computer calls for an in-water decompression stop. We provide guidance on how to comply with these requirements in the following sections. We would nevertheless emphasize that any questions related to the interpretations of the regulations should be directed to the Norwegian Labour Inspection Authority.

11. **Use of Dive Computers as an Additional Safety Measure for Multilevel Diving.** The dive computer to be used with multilevel diving should be based on the Bühlmann, Thalmann or RGBM algorithm. The dive computer should present remaining no-decompression time in a clear manner. The procedure for transfer of dive data from the dive computer to the desktop computer should be simple. The software should allow export of dive data to a generic spreadsheet or database file format. In our opinion, the dive computer is a personal protective equipment and should not be shared with other divers to avoid ambiguity and frank errors in calculation of decompression. If additional safety is wanted, we recommend shortening dive times at depth levels exceeding 10 m. Ascent to shallower depth should be initiated 5 min or more before end of no-decompression time. The dive should be completed without violation of no-decompression time and ceiling level provided by the dive computer. However, no additional measure is required even if the dive computer presents a mandatory safety stop.

12. **Requirement for Continuous Depth Monitoring at Surface.** The requirement is self-explanatory and implies that the dive supervisor at any time should be able to monitor the diving depth.

13. **Requirement for Digital Registration of Depth and Time.** One way to comply with this requirement would be to transfer data from the dive computer to a computer. We will strongly advice that depth-time data is stored in a format readable for conventional spreadsheets or database software. We further recommend that routines are established for follow-up of alerts from the dive computer (violation of ascent rates or omitted decompression).

14. **Requirement for Digital Registration of Remaining No-Decompression Time at Each Stage.** The guideline elaborate that this requirement is related to the dive computer's stipulation of no-decompression time. One way to fulfil this requirement would be if the dive supervisor request the diver to report no-decompression time at the beginning of each stage. The supervisor should record this information– in writing or electronic format – and transfer this information in electronic format (e.g. a spreadsheet) after the dive.

Diving Related to Offshore Energy

1. **Diving Regulated by the Norwegian Ocean Industry Authority (HAVTIL)**. The regulations of the HAVTIL regulate all offshore energy-related diving as well as diving on some onshore facilities and pipeline systems as specified by the Framework Regulations. The Norsok U-100 standard provide additional details. Most of the offshore diving takes place with saturation diving techniques. Surface oriented diving is mainly used with light diving crafts. There is a 30-metre depth limitation for diving with light diving crafts and the diving should be done within the table limits for no-stop decompression. Nitrox may be used to allow extended bottom times for such diving operations.

2. **Offshore Energy Related Diving Regulated by the Labour Inspection Authority.**
The common rule is that the regulations of the Labour Inspection Authority are used even for offshore energy-related inshore diving. Norsok U-103 is the recommended standard for such diving. Norsok U-100 is used for those rare instances of inshore saturation diving. Norsok U-103 gives the same recommendations with respect to table use, bottom time restrictions and proximity of recompression chambers as Norsok U-100.

3. **Use of the Norwegian Diving and Treatment Tables for Offshore Energy Related Diving Inshore and Offshore.** The Norwegian diving and Treatment tables are used for all surface-oriented diving, with bottom time limitations as presented in the Chapter "Prevention of Decompression Illness" and marked in the tables by a thick horizontal line. In addition to this, the dive program shall be designed to ensure that the diver has one calendar day without diving for every 3 days of diving (multiday skip). However, diving to a maximum depth of 9 m (or 9 m equivalent air depth) is accepted for air as well as $SurDO_2$ dives.

4. **An example:**
PROBLEM: A large diving project is to be undertaken at the landfall of a petroleum pipeline. The diving is planned for a water depth of 32 m. The diving procedures shall comply with Norsok U-103. Which alternatives should be considered in the planning phase?
SOLUTION: Using air as breathing gas, the closest table depth will be 33 m. According to Norsok U-103 the bottom time limitation is 40 min at this water depth (25 min of decompression). An alternative may be to choose Nitrox. pO_2 shall not exceed 1.5 bar so Nitrox 32 is the most appropriate standard gas mixture and will give EAD of 26.2 m at 32 m diving depth. This allows decompression according to the 27m table. Bottom time may be extended to 60 min with 30 min of decompression if in-water decompression is used. Alternatively, $SurDO_2$ may be chosen which will eliminate in-water decompression in exchange for 30 min of chamber O_2 breathing. From an operational point of view, the major benefit is the bottom time extension of 20 min if breathing gas is exchanged from air to Nitrox. TUP might be considered as an alternative option.

Oxygen Toxicity

1. **A high Partial Pressure of Oxygen** (pO_2) in the breathing gas (hyperoxia) may cause injury. Various organs may be involved, depending on pO_2 and exposure time. The main concerns are related to the central nervous system (acute oxygen toxicity) and the lungs ("chronic" or pulmonary oxygen toxicity). It seems that the damage is being caused by free radicals – that is, short-lived, highly reactive oxygen compounds that cause cellular damage or dysfunction.

2. **Acute Oxygen Toxicity**. A high pO_2 affects the central nervous system (brain and spinal cord) directly and may cause convulsion and loss of consciousness. Some divers may get warning symptoms like minor muscular twitches (around lips and eyes), tingling sensation in fingers, tunnel vision or vertigo and uneasiness. Other but less common symptoms are visual or auditory impairment, confusion, euphoria or troubled breathing. Unfortunately, such warnings are unreliable and may be too vague to raise the diver's attention. The time from the onset of symptoms until a diver convulses may be anything from a few seconds to about an hour.

3. **Risk Factors**. The risk of suffering acute oxygen toxicity increases with pO_2 and exposure time. Further, it seems that a submerged diver is more susceptible than a diver in a dry hyperbaric chamber, given the same pO_2 and exposure time. Other known factors that increase susceptibility are:

   – High intensity physical activity
   – Increased level of CO_2
   – (Strong) auditory or visual stimulation
   – Vibrations
   – Chilling (hypothermia), over-heating (hyperthermia) and fever

4. **"Chronic" or Pulmonary Oxygen Toxicity** is a pulmonary injury. A high pO_2 causes reduced pulmonary diffusion capacity, reduced airflow through the small airways and reduced pulmonary elasticity. The first detectable symptoms are chest soreness and shortness of breath. Further damage causes coughing and painful respiration. It was previously believed that pulmonary damage was fully reversible, even in severe cases. Today we know that permanent damage may ensue, as evidenced by a persistent decrease in some measures of pulmonary function. Still, the likelihood of long term sequelae after moderate oxygen exposure such as treatment for decompression illness or a prolonged series of dive with $SurDO_2$ is small. However, after years of diving a few divers may develop symptoms of pulmonary impairment.

5. **Pulmonary oxygen toxicity** is for all practical purposes not a problem using the standard air decompression table. Neither will $SurDO_2$ dives with air as the bottom breathing gas be a concern if the bottom time restrictions are adhered to. It is primarily long $SurDO_2$ and TUP dives with Nitrox as the bottom breathing gas that should call for attention. For saturation diving with very long exposure time, it is important to stay withing the pO_2 thresholds stipulated in Norsok U-100. Symptoms of oxygen toxicity will be more pronounced the higher pO_2 is and the longer the exposure lasts.

6. **Caution should be paid** to the cumulative effect of high pO_2. A single nitrox dive, even with TUP or $SurDO_2$ will not be likely to cause symptomatic lung injury. However, multiple long dives with nitrox combined with either $SurDO_2$ or TUP should call for attention of the total hyperoxic exposure.

7. **The Oxygen Dose** was previously termed UPTD or OTU (Unit Pulmonary Toxic Dose/Oxygen Toxicity Unit). These indices are still used, but they should be replaced with ESOT (Equivalent Surface Oxygen Time). The equation for calculating ESOT is not presented here, but the index is calculated based on pO_2, exposure time as well as surface interval after the last exposure. ESOT will be high immediately after a dive with much hyperoxia but will be reduced during air breathing in the surface interval. ESOT=1 corresponds to breathing 100% O_2 at surface pressure for 1 min.

8. **Calculation of ESOT** after a dive with high pO_2 is most conveniently done using a table as presented in section 11 below.

9. **The Hyperoxic Exposure Should Not Exceed** ESOT=660 and if ESOT exceeds 500 the diver should have two succeeding days without diving. For five days of diving followed by two days at surface ESOT=500 is allowed daily. A maximum of seven successive days of diving followed by two days off diving are allowed if the daily exposure doesn't exceed 450. Air in-water decompression dives may take place during the days "off diving" due to the minimal hyperoxic load during such dives.

10. **Air Breaks.** Experiments as well as practical experience have shown that intermittent periods with a lower pO_2 (for instance, by breathing chamber air) will delay the onset of acute as well as chronic oxygen poisoning. Thus, a 5 min air break is advised for every 20 – 30 min period on oxygen. Such an air break is included for every 30 min of O_2 breathing in the $SurDO_2$ and TUP diving procedures (as described in the respective chapters). It may be acceptable to allow higher hyperoxic exposure (allow ESOT to exceed threshold values listed above) if air breaks are included. Such adjustments of hyperoxic threshold values should only be allowed after consultation with a diving physician experienced in such assessments.

11. **Table for Calculating ESOT** is shown below. Find the column listing an equal or next higher exposure time in the very first row. Secondly use the first column to find the row with the correct pO_2. The ESOT is found in the intersecting cell of the row and column. For other bottom times, cells may be added. If the diver has been exposed for pO_2=1.3 bar for 30 min the ESOT can be found adding the contents of the "10" and "20" min cell. In this case ESOT=18+36=54. ESOT could as well be calculated multiplying the appropriate row in the "*k*" column with exposure time. In this case ESOT=1.82 x 30=55. Rounding will cause small, and practically irrelevant differences, dependent on whether the table is used or ESOT is calculated using *k*. Some dives may expose the diver to different pO_2 levels. In such cases the ESOT for all levels should be summarized to learn the accumulated exposure level.

pO_2 (bar)	*k*	Time (min)						
		5	10	20	40	80	160	320
0.5	*0.21*	1	2	4	8	16	33	66
0.6	*0.31*	2	3	6	12	25	50	100
0.7	*0.44*	2	4	9	18	35	71	142
0.8	*0.60*	3	6	12	24	48	96	192
0.9	*0.79*	4	8	16	31	63	126	252
1	*1.00*	5	10	20	40	80	160	320
1.1	*1.24*	6	12	25	50	99	199	398
1.2	*1.52*	8	15	30	61	121	243	485
1.3	*1.82*	9	18	36	73	146	291	583
1.4	*2.16*	11	22	43	86	173	345	690
1.5	*2.53*	13	25	51	101	202	404	808
1.6	*2.93*	15	29	59	117	234	468	937
1.9	*4.33*	22	43	87	173	347	694	1387
2.2	*6.06*	30	61	121	242	485	970	1939
2.5	*8.12*	41	81	162	325	649	1298	2597

12. **Repeated dives.** Repetitive hyperoxic dives may potentiate the pulmonary toxicity. For dives with ESOT>660 (such dives should not be planned for) the minimum surface interval before a succeeding hyperoxic dive should exceed 48 h. For dives with ESOT≤660 the minimum surface interval should be 12 h. Air in-water decompression dives may take place after a hyperoxic dive irrespective of the minimum surface intervals listed above. The surface intervals listed above are conservative to ensure protection from pulmonary oxygen toxicity. It may in some cases be justified to shorten these surface intervals, but a diving physician should be consulted if this is needed.

Nitrox Diving

1. **Nitrox** is a mixture of nitrogen and oxygen in different proportions than the composition of air. For a long time, nitrox has been used as a breathing gas for divers, in open circuit systems as well as rebreathers. We will investigate the use of open-circuit nitrox with a higher oxygen fraction than air. Such mixtures are commonly known as oxygen-enriched air or enriched air nitrox (EAN).

2. Breathing a gas with higher oxygen content than air allows longer bottom time without incurring a higher decompression obligation. The reason is that the partial pressure of nitrogen (rather than depth per se) and time decide the table depth. Thus, by replacing some of the nitrogen with oxygen we may decompress according to a shallower table depth. Further, during the decompression phase of the dive the higher oxygen content will provide a safer and more efficient decompression.

3. **Equivalent Air Depth** (EAD) is a key concept in nitrox diving. It is the depth at which air would provide the same nitrogen partial pressure as the actual nitrox mix at a given depth.

4. EXAMPLE: You dive to 20 m using a nitrox mixture composed of 40 % oxygen and 60 % nitrogen. The absolute pressure at 20 m is 3 bar, hence the nitrogen partial pressure will be 60 % of bar = 1.8 bar. The EAD will be the depth where air provides 1.8 bar of nitrogen, namely 12.8 m. In other words, we may dive to 20 m using this gas mixture and plan the dive according to the 15 m air table. In practical terms this means an increase in no-stop time from 45 to 90 min.

5. The following equation gives equivalent air depth:

$$EAD = \frac{(D + 10) \times N}{79} - 10$$

   D represents depth in metres
   N represents the percentage of nitrogen in the nitrox mixture

6. **Safe Oxygen Limits.** From a decompression perspective the highest possible oxygen fraction will be the most advantageous. However, the risk of oxygen toxicity limits the safe use of oxygen. The individual susceptibility for acute oxygen toxicity varies significantly from one day to another. During the bottom phase of a dive, the pO_2 shall not exceed 1.5 bar, but it may be increased to 1.6 bar during in-water decompression.

7. **Oxygen Toxicity.** For all diving operations involving nitrox the diver as well as the surface support must consider the risk of oxygen toxicity. This is particularly important whenever the exposures approach the threshold levels. In surface supplied diving, provisions must be made to allow an instant gas switch to air. For hard hats it is important to ensure a constant and sufficient gas flow to avoid the risk of a CO_2 build-up. Should a diver suspect an attack of oxygen toxicity he must notify the diving supervisor immediately. In this situation, breathing gas should be switched from nitrox to air. Keep in mind that the first and only sign of oxygen poisoning may be a vague, uncanny feeling of "something is wrong". Whenever a case of oxygen convulsion is suspected or confirmed the diver should promptly be brought back to the surface, disregarding the risk of pulmonary barotrauma due to gas expansion during ascent. Obviously, the risk of drowning is the most imminent problem, particularly when a convulsing diver isn't protected by a hard hat or a full-face mask.

8. **Nitrox mixes.** Ideally having many gas mixes available could minimize the decompression obligation for any profile. However, logistical considerations make it more prudent to use a set of standard mixes, thereby limiting the risk of confusion and error. The standard mixes contain 32, 36 and 40 % oxygen respectively and these are recommended unless specific reasons call for other mixes. A nitrox mix is identified by its oxygen fraction or alternatively as the oxygen fraction/nitrogen fraction. A mix containing 40 % oxygen will thus be referred to as Nitrox 40 or Nitrox 40/60.

9. **Tolerance and Labelling.** The tolerance is ± 0.5 % for the oxygen and nitrogen in a nitrox mix. Whenever a mix falls within this tolerance we may use the nominal value (e.g. for calculation of maximum allowed pO_2 with respect to oxygen toxicity or for the calculation of equivalent air depth). However, if a nitrox mix has a different composition than anticipated the consequences may be serious. Thus, we advise the use of dedicated cylinders for each mix including air. Each cylinder should be labelled and painted according to international standards.

10. **Nitrox and Decompression Stops.** Nitrox dives using the standard table may decompress at a greater depth without increasing the stop time. In principle, the stop depth may be increased until the actual nitrogen partial pressure matches that of air at the prescribed stop depth. To simplify one may shift the ascent profile to the next greater standard depth increment, that is, the 3 m stop may be performed at 6 m and so on. The only prerequisite is that the breathing gas contains at least 36 % oxygen. Dives with lower oxygen fraction should not adjust the depths of the decompression stops. A deeper stop profile is particularly useful whenever swells/wave action make it difficult or uncomfortable to spend time at shallow depths. Air divers may use the same procedure provided they switch to nitrox 36 or higher during the ascent.

Surface Decompression Using Oxygen

1. **Surface Decompressio**n breathing oxygen in the pressure chamber (SurDO_2) is a decompression technique using in-water stops up to a depth of 12 m. Then the diver surfaces and is promptly recompressed to a depth of 15 m in a hyperbaric chamber breathing oxygen supplied through a mask. This procedure requires a pressure chamber with a main lock and an entry lock as well as provisions for oxygen breathing.

2 **Fire Hazard.** The divers' breathing gas should be supplied through breathing masks (BIBS) with an exhaust line expelling the exhaled gas out of the chamber. Further, the chamber must be equipped with sensors to allow continuous oxygen monitoring. Even a small increase in chamber oxygen fraction presents a substantial fire hazard. Fire in a hyperbaric chamber is a catastrophic event. While the overboard dump ensures that most of the oxygen is evacuated without enriching the chamber atmosphere, minor leaks around the breathing mask may increase chamber oxygen content. The oxygen fraction shall not exceed 22 %. Hence, whenever the oxygen percentage rises the chamber should be flushed with air. When uncontrolled leaks are suspected these must be located and repaired promptly. Keep in mind that the oxygen concentration may be much higher close to the leak than readings from the oxygen sensors indicate.

3. **Deeper In-Water Decompression Stops.** Since the last in-water stop is at a depth of 12 m the diver is less likely to be affected by swell and surge than he would be at a 3 m stop. Further, since the total in-water decompression time tends to be less with SurDO_2 this procedure has major operational advantages. This is beneficial for the diver as he will avoid excessive decompression time in cold water.

4. **Nitrox** is a good choice for in-water breathing gas for SurDO_2 dives. The exposure limits for oxygen listed in the chapter of oxygen toxicity must be respected.

5. **Using the Table.** The table is used in the same way as for ordinary dives. That is, select a table that matches the actual depth (for nitrox, the EAD) or the next deeper table depth. The bottom time runs from the moment the diver leaves the surface until he leaves the bottom on the final ascent. Table-wise this means rounding off to the next longer bottom time unless there is a table time listed that matches the bottom time exactly.

6. **Ascent to Work Depths Shallower Than 12 m** is only allowed for dives with no planned staged in-water decompression stops. The working depth should never be shallower than 6 m. Neither should work depths shallower than 12 m be planned if the tabulated bottom time is highlighted with italics. For dives finished shallower than 12 m, timing of surface interval should begin once ascent to surface starts.

7. **Example** – ascent to work depths shallower than 12 m. You are asked to fasten a rope to a chain at 38 m. The chain is then lifted to an anchor at 9 m. You are asked to connect the chain to the anchor at this depth. How could this be planned? The SurDO_2 table for 39 m table depth allows a maximum of 30 min bottom time, but the 30 min schedule is printed in italics. You therefore have to limit bottom time to 25 min. There is no need for a staged in-water decompression stop if you limit bottom time to 25 min and you are allowed to finish the dive at depths not shallower than 6 m (in this example 9 m). The bottom time runs until ascent to surface starts. This dive will call for 15 min of oxygen breathing in the chamber at 15 m.

8. **The Ascent Rate** to the first decompression stop and between the decompression stops should be approximately 10 m/min. Minor deviations are acceptable, and it is better to be too slow than too fast. The times listed for the deepest decompression stop is the time the diver should stay at this depth. The time listed for shallower stops include the ascent time from the deeper stop. Any major delays (more than one min) during the deeper part of the ascent should be compensated by adding the additional ascent time to the bottom time and increase decompression time if necessary.

9. **The Surface Interval** should be as short as possible. The maximum time from leaving the 12 m stop until the diver is recompressed to 15 m in the chamber is 5 min. The surface interval run from the time the diver ascends past 12 m for those dives that do not require in-water decompression stops. The ascent time from 12 m to the surface should be *approximately* one minute and the recompression to 15 m in the chamber will usually take about 30 seconds. Hence, the diver has three and a half minutes to leave the water, remove the equipment and enter the chamber. Usually, this is more than enough time. However, the diver should be aided in removing his diving gear and be subject to minimal strain and exertion. He should be assisted by two persons. It is important to practice the procedure and the exact order of events and assign specific tasks to each member of the team. Under no circumstance should the ascent rate from the 12 m stop be increased to try to gain time! If surface interval exceeds 5 min, recompress the diver on Table 5. (This is not considered as treatment.)

10. **Chamber Decompression.** Oxygen breathing should commence as soon as the diver has entered the chamber and continue for the recompression. The chamber should be pressurized as soon as the hatch is closed and secured, whether the diver has put on the oxygen mask or not. Oxygen breathing time starts running when chamber pressure has reached 15 m. The chamber is recompressed fast (during

some 30 sec) to 15 m. The first 15 min of the oxygen breathing time shall take place at 15 m. The chamber is then decompressed to 12 m where further oxygen breathing takes place. The diver shall breathe from the chamber atmosphere (compressed air) during decompression from 12 m to surface pressure. The chamber decompression should ideally be approximately 10 m/min. If the decompression rate is reduced due to technical limitations of the decompression chamber, the diver should be decompressed at a rate of 10 m/min for as long as possible. Too slow decompression at the terminal phase of decompression should not be compensated by accelerated decompression at the deepest part. The diver should breathe chamber gas throughout decompression even if decompression time from 12 m to surface is extended.

11. **Air Breaks.** After each 30 min of oxygen breathing the diver removes the mask and breathes chamber air for 5 min. There should be no air break after the last oxygen session before commencing the chamber decompression. These air breaks are not to be counted as oxygen time nor are any unplanned interruptions of the oxygen breathing. No more than 15 min of extra air breaks should be added.

12. **The Total Decompression Time** listed in the last column is defined as the time from the diver leaves the bottom until he returns to the surface following the chamber run. This includes the 5 min air breaks following each 30 min of oxygen breathing. Additional unplanned air breaks are not included. The time listed may differ from the actual by one minute due to rounding of numbers.

13. **Oxygen Toxicity.** Oxygen seizures in a chamber at 15 or 12 m are unlikely. Nonetheless, should seizures occur the oxygen mask should be removed immediately. Contact diving physician and follow advice given. Anti-convulsive medication (Diazepam, Midazolam) may be given by trained personnel after doctor’s prescription. If it is impossible to reach a diving physician, follow advices given below:
    -If the symptoms are limited and non-convulsive (e.g. paraesthesias in skin, visual disturbances and similar) the oxygen breathing may be resumed at unchanged depth if 15 min has passed since the last symptoms disappeared.
    -If the diver experienced convulsions, delay decompression until all seizures have subsided. Then decompress 3 m at 0.3 m/min. Resume oxygen breathing at the shallower depth.
    -If the divers should experience a second convulsion at shallower depth, O_2 breathing should not be resumed unless explicit advice to do so has been given by a diving physician. In this situation follow the procedure for chamber air decompression provided below.

14. **If the Oxygen Supply Should Fail** the diver will breathe chamber atmosphere at the current depth. Provided the oxygen supply is re-established within 15 min oxygen breathing will resume. In this case the oxygen period should be extended to make up for the interruption. If the oxygen supply cannot be re-established within 15 min follow the procedure described below.

15. **Chamber Decompression with Air as Breathing Gas.** Decompress according to the standard air decompression schedule if acute oxygen toxicity or failure of oxygen supply should make it necessary to decompress using air as breathing gas. Time spent at 15 and 12 m should not be subtracted from the decompression time in the air decompression schedule. Calculation of air decompression will be more complex and decompression time extended significantly if the bottom time is longer than the air decompression table lists. As a first step determine omitted oxygen breathing time at depth. Multiply this time with four to determine the total air decompression time required. Distribute 10% of the decompression time at 12 m, 20% at 9 m and 70% at 6 m. If chamber depth is 9 m, 30% of the decompression time should be spent at 9 m and 70% at 6 m.

16. **Example.** A SurDO_2 dive has been completed to 29 m for 45 min, the table for 30 m/50 min was used. The table calls for 30 min oxygen breathing in the chamber. After10 min of oxygen breathing the diver suffers a seizure. The chamber is decompressed to 12 m and oxygen breathing is resumed. After 5 min at 12 m a second seizure occurs. Plan further decompression according to the air table. Decompress the chamber 10 m/min to 6 m (start decompression countdown time when 6 m is reached). Stay 5 min at 6 m and 20 min at 3 m.

17. **Repetitive and Multiday Diving.** SurDO_2 dives should not be a repetitive dive, neither should a repetitive dive be planned after a SurDO_2 dive. The minimum surface interval required for a new single dive is determined conventionally based on the Repetitive Group and the table for adjustment of Repetitive Group during the surface interval. A number of profiles have not been assigned a Repetitive Group. These are profiles with high inert gas load and a minimum of 18 hours should pass before the next dive. A second dive not exceeding an actual depth or EAD of 6 m is allowed after any dive. If the diver completes a dive to depth not exceeding 6 m, the minimum surface interval before the next single dive should be extended by the dive time.

18. **Multiday diving.** If the diver breathes Nitrox during the bottom phase there is a need to monitor oxygen exposure as explained in more detail later. If the diver breathes air during the bottom phase he may dive for seven successive days before a two-days break from SurDO_2 dives. Conventional air dives may be dived during these two days.

19. **Bottom Time Limitations and "Exceptional Dives"**. Dives carrying a DCS risk ranging 5-6% or requiring more than 90 min of chamber oxygen breathing are identified by asterisk. Bottom time limitations as stipulated by the Norwegian Labour Inspection Authority and the Norsok standards U-100 and U-103 are identified by horizontal bold line in the tables.

20. **Example: SurDO2 dive with air as the bottom breathing gas.** PROBLEM: You are planning a $SurDO_2$ dive to 29 m with air as the bottom breathing gas. What is the longest allowed bottom time and how should the dive be executed?
ANSWER: You have to use the 30 m table depth. The longest allowed bottom time is 50 min. After finished bottom time the diver should ascend approximately 10 m/min. The "surface interval" starts running when the diver passes 12 m water depth. When the diver is at surface he should be helped undressing during the allowed 4 min surface interval. The chamber should be pressurized to 15 m. The oxygen breathing time starts on arrival 15 m even if the diver started BIBS breathing during compression. The pressure is reduced to 12 m after 15 min. After 30 min O_2-breathing time the diver removes the BIBS mask and chamber is decompressed approximately 10 m/min to surface. The diver will reach surface pressure 38 min after the immersed ascent started.

21. **$SurDO_2$ Dives with Nitrox as Breathing Gas** may cause a high hyperoxic exposure. For such dives the oxygen exposure should be calculated (ESOT) as described in the chapter Oxygen Toxicity. We plan to provide more detailed guidance on our website later. Oxygen breathing time of 15, 30, 45 and 60 min will give a oxygen toxicity dose of 122, 213, 304 and 394 ESOTs respectively. Any additional oxygen exposure during the bottom phase should be added to this.

22. **Example: $SurDO_2$ Dive with Nitrox as breathing gas**
PROBLEM: A $SurDO_2$ dive is planned for 22 m with Nitrox 40. What is the longest bottom time that may be planned for and for how many days are you allowed to dive?
SOLUTION: The EAD table for Nitrox 40 shows that you should plan your dive according to the 15 m table depth. The pO_2=1.28 bar (rounded 1.3 bar). The SurDO2 table allows a bottom time of 180 min which would call for 45 min of oxygen breathing (ESOT=304, see serial 19 above). Use the table in serial 11 in the Oxygen Toxicity chapter. Choose the pO2=1.3 bar row. There is no column for 180 min, but you may add the cell contents for the 20 and 160 min columns (18+291) to get a bottom phase oxygen toxicity load of 309 ESOT. This will add to 304-309=613 ESOT. You are thus only allowed to plan one such dive and should have two days succeeding without Look at the table above. You may dive a single dive for 180 min, but you will then need a two day break without oxygen exposure (air dives are allowed). You should plan for a shorter bottom time if you need to dive for successive days.

Transfer Under Pressure (TUP)

1. **Transfer Under Pressure (TUP)** is a means by which the diver is transferred from diving depth to surface in a closed and pressure-controlled diving bell. At surface the diving bell is connected to a deck decompression chamber (DDC). Normally the diving bell is pressurized once it has been lowered to working depth. The diver locks out from the bell once pressure has been equalized. The diver breathes air or Nitrox during the bottom phase. After finished lock out the hatch is closed, and decompression of the diving bell starts. The diver breathes air within the bell. Depending on diving depth and bottom time oxygen breathing starts at 9 or 6 m, usually within the DDC.

2. **Benefit vs. Conventional Surface-Oriented Diving and SurDO_2.** The most significant safety achievement is probably avoidance of the interim decompression in the surface interval. Other benefits include thermal comfort, relaxed seating, possibility to drink and eat.

3. **Bottom Time May be Extended** compared to conventional surface-oriented diving since UK (HSE, ACOP Commercial diving projects offshore Serial 44) and Norwegian (Norsok U-100:2023, Regulations concerning the Performance of Work) allow significantly longer bottom times with TUP decompression compared to in-water and SurDO_2.

4. **Table Design and Origin.** These tables are based on the US Navy air decompression tables with air/O_2 in-water decompression as published in US Navy Diving Manual Rev 7. Decompression is completed in the diving bell and DDC, the decompression stages and decompression times are otherwise identical to those published in US Navy Diving Manual Rev 7 except for the metric conversion. Estimated risk for DCS ranges 3.5-4.5% for the longest bottom times, i.e. in the same order as for conventional in-water air breathing decompression.

5. **Using the Table.** The table is used in the same way as for ordinary dives except that all decompression takes place in the diving bell or the DDC. Select a table that matches the actual depth (for nitrox, the EAD) or the next deeper table depth. The bottom time runs from the moment the pressure is increased within the diving bell until the bell hatch is closed and decompression is started. Table-wise this means rounding off to the next longer bottom time unless there is a table time listed that matches the bottom time exactly.

6. **Using Nitrox as the Diver's Breathing Gas in the Bottom Phase** may challenge decompression planning unless the bell diver can breathe Nitrox through a BIBS mask. Positioning the bell at a water depth equal to the diver's equivalent air depth is a possible alternative solution.

7. **The Bell Decompression Rate** to the first decompression stop and between the decompression stops should be 10 m/min. Minor deviations are acceptable, and it is better to be too slow than too fast. The travel times listed for the deepest decompression stop includes the time the diver should stay at this depth. The time listed for shallower stops include the decompression time from the deeper stop. Any major delays during the deeper part of the ascent should be compensated by switching to a longer bottom time, thus increasing the decompression penalty.

8. **Transfer From Bell to DDC** should ideally take place while breathing chamber gas (compressed air). If the bell is mated to the DDC at 9 or 6 m the diver may use 15 min for transfer. This time will not affect the trailing O_2 breathing time. If planned decompression time on 9 m is 5 min or shorter, and there is a need to delay O_2 breathing by more than 15 min, the chamber should be decompressed from 9 to 6 m after 15 min. If O_2 breathing at 9 or 6 m is delayed or interrupted by more than 15 min of air breathing, the remaining O_2 breathing time may be shortened as described in section 11 below.

9. **Oxygen Breathing** should start when the internal pressure of the bell (or the DDC) reaches 9 m. The diver may delay O_2 breathing with 15 min if so needed to allow transfer from the bell to the DDC. After each 30 min of oxygen breathing the diver removes the mask and breathes bell or DDC air for 5 min. Exception is made for the last O_2 breathing period which may last for 35 min without a mandatory air break. Decompression can start immediately after the last O_2 breathing period and the diver will breathe chamber gas during the final decompression to surface pressure. The air breaks are not to be counted as oxygen time nor are any unplanned interruptions of the oxygen breathing periods. If unplanned air breathing exceeds 15 min, the trailing O_2 breathing time may be reduced as explained in section 11 below.

10. **Chamber Decompression.** The chamber decompression should ideally be approximately 10 m/min. If the decompression rate is reduced due to technical or other limitations of the decompression chamber, the diver should be decompressed at a rate of 10 m/min for as long as possible. Too slow decompression at the terminal phase of decompression should not be compensated by accelerated decompression at the deepest part. The diver should breathe chamber gas throughout the decompression from 6 m even if decompression time from this depth is extended.

11. **The Total Decompression Time** listed in the last column is defined as the time from the start of bell decompression until the final decompression of the DDC to surface pressure. Scheduled air breaks are included, but additional unplanned air breaks are not included. The time listed may differ from the actual by one minute due to rounding of numbers.

12. **Oxygen Toxicity.** Oxygen seizures in a chamber at 9 m are unlikely. Follow the general guidance for handling Oxygen Seizures as described in chapter Surface Decompression with Oxygen. Contact diving physician. Let the diver breathe chamber air at 9 m for twice the period of remaining O_2 breathing time. Decompress to 6 m and resume O_2 breathing. If a second seizure occurs, or a delay of resuming O2 breathing is needed, the decompression may be completed with air breathing. Extend decompression time at 6 m by a factor of three if the dive has a repetitive group of A-Z. If the dive profile has not been designed a repetitive group, the remaining O_2 breathing time should be replaced with air breathing increased by a factor of four.

13. **If the Oxygen Supply Should Fail** the diver will breathe chamber atmosphere at the current depth. Complete decompression in accordance with section 11 above.

14. **Repetitive Dives.** TUP dives should not be a repetitive dive, neither should a repetitive dive be planned after a TUP dive. The minimum surface interval required for a new single dive is determined conventionally based on the Repetitive Group and the table for adjustment of Repetitive Group during the surface interval. Several profiles are not associated with a Repetitive Group. For such profiles a minimum of 18 hours should pass before the next dive. A second dive to a depth not exceeding an actual or EAD of 6 m is allowed after any dive. If the diver completes a dive to depths not exceeding 6 m, the minimum surface interval before the next single dive should be extended by the dive time.

15. **TUP Dive With Nitrox as Breathing Gas** may cause a high hyperoxic exposure. For such dives the oxygen exposure should be calculated (ESOT) as described in the chapter Oxygen Toxicity. We plan to make guidance material available on our website later.

16. **Predisposing Factors.** To compensate for factors known to increase the risk of DCS, the decompression may be planned with a bottom time longer than the actual. In such cases consideration should be given to the total hyperoxic exposure as discussed in chapter Oxygen Toxicity.

17. **Example:**

PROBLEM: A TUP dive is planned for to 29 m with air as the breathing gas. What is the longest bottom time that may be planned for and how should the dive be executed? What is the divers' oxygen exposure level?

SOLUTION: The 30 m table must be used, the longest bottom time that is allowed is 110 min. At the end of the bottom time, the diver returns to the bell. Pressure should be reduced approximately 10 m/min until internal bell pressure reaches 12 m. The bell is mated to the DDC and the divers transit to the chamber. Hold the pressure for 14 min, then decompress to 9 m. The diver should start breathing O_2 from the BIBS. After 14 min at 9 m, pressure should be reduced to 6 m – the diver should continue breathing O_2. After 16 min of O_2 breathing at 6 m (30 min total O_2 breathing time so far), the diver should remove the BIBS mask for 5 min and breathe air. After 5 min of air breathing, he should resume O_2 breathing for two 30 min periods with an intermittent 5 min air break. He may remove the mask after the last O_2 breathing period and the chamber surfaced 10 m/min. The diver is at surface approximately 1h 57 min after the ascent started. If longer air breaks are needed (e.g. for transfer from bell to chamber) this will add to the decompression time. The oxygen exposure can be calculated based on the periods of O_2 breathing. Air breathed during the bottom phase and air breaks can be ignored. Use the table in serial 11 in the chapter of oxygen toxicity. The diver will initially breathe oxygen on BIBS for 14 min at 9m (pO_2=1.9 bar; k=4.33). The oxygen exposure at 9 m will therefore reach 14*4.33=61 ESOT. After this, the diver shall breathe oxygen for a total of 76 min at 6 m (pO_2=1.6 bar; k=2.93). The exposure level at 6 m is therefore 76*2.93=223 ESOT. The total oxygen exposure is 61+223=284 ESOT. This oxygen dose is less than 450 and the exposure can be repeated daily for a maximum of seven successive days.

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
6 metres	25	–	–	–	–	–	–	A
	45	–	–	–	–	–	–	B
	60	–	–	–	–	–	–	C
	80	–	–	–	–	–	–	D
	105	–	–	–	–	–	–	E
	135	–	–	–	–	–	–	F
	165	–	–	–	–	–	–	G
	205	–	–	–	–	–	–	H
	240	–	–	–	–	–	–	I
	255	–	–	–	–	–	–	I
	330	–	–	–	–	–	–	J
	460	–	–	–	–	–	–	K

Repetitive group adjusted for surface interval										
A	B	C	D	E	F	G	H	I	J	K
25	45	60	85	105	135	165	205	255	330	460
Minutes to be added to the bottom time for a repetitive dive										

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
9 metres	15	–	–	–	–	–	–	A
	25	–	–	–	–	–	–	B
	40	–	–	–	–	–	–	C
	50	–	–	–	–	–	–	D
	60	–	–	–	–	–	–	E
	75	–	–	–	–	–	–	F
	90	–	–	–	–	–	–	G
	105	–	–	–	–	–	–	H
	125	–	–	–	–	–	–	I
	145	–	–	–	–	–	–	J
	165	–	–	–	–	–	–	K
	195	–	–	–	–	–	–	L
	225	–	–	–	–	–	–	M
	240	–	–	–	–	–	–	N
	260	–	–	–	–	–	–	N
	305	–	–	–	–	–	–	O
	370	–	–	–	–	–	–	Z

Repetitive group adjusted for surface interval															
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
20	30	40	50	65	75	90	110	125	145	170	195	225	260	310	370
Minutes to be added to the bottom time for a repetitive dive															

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
12 metres	10	–	–	–	–	–	–	A
	20	–	–	–	–	–	–	B
	25	–	–	–	–	–	–	C
	35	–	–	–	–	–	–	D
	45	–	–	–	–	–	–	E
	55	–	–	–	–	–	–	F
	65	–	–	–	–	–	–	G
	75	–	–	–	–	–	–	H
	85	–	–	–	–	–	–	I
	95	–	–	–	–	–	–	J
	110	–	–	–	–	–	–	K
	120	–	–	–	–	–	–	L
	135	–	–	–	–	–	–	M
	150	–	–	–	–	–	–	N
	160	–	–	–	–	–	–	O
	165	–	–	–	–	5	5	O
	195	–	–	–	–	10	10	Z
	225	–	–	–	–	15	15	Z
	240	–	–	–	–	35	35	Z
	270 *	–	–	–	–	45	45	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
15	20	30	35	45	55	65	75	85	95	110	120	135	150	170	190

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
15 metres	10	–	–	–	–	–	–	A
	15	–	–	–	–	–	–	B
	20	–	–	–	–	–	–	C
	30	–	–	–	–	–	–	D
	35	–	–	–	–	–	–	E
	40	–	–	–	–	–	–	F
	50	–	–	–	–	–	–	G
	55	–	–	–	–	–	–	H
	65	–	–	–	–	–	–	I
	70	–	–	–	–	–	–	J
	80	–	–	–	–	–	–	K
	90	–	–	–	–	–	–	L
	105	–	–	–	–	5	5	O
	120	–	–	–	–	10	10	O
	135	–	–	–	–	15	15	Z
	145	–	–	–	–	20	20	Z
	160	–	–	–	–	25	25	Z
	180 *	–	–	–	5	25	30	Z
	190 *	–	–	–	20	40	60	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
10	15	25	30	35	40	50	55	65	75	80	90	100	110	120	130

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
18 metres	5	–	–	–	–	–	–	A
	10	–	–	–	–	–	–	B
	15	–	–	–	–	–	–	C
	20	–	–	–	–	–	–	D
	30	–	–	–	–	–	–	E
	35	–	–	–	–	–	–	F
	40	–	–	–	–	–	–	G
	45	–	–	–	–	–	–	H
	50	–	–	–	–	–	–	I
	55	–	–	–	–	–	–	J
	60	–	–	–	–	–	–	K
	70	–	–	–	–	5	5	L
	80	–	–	–	5	5	10	N
	90	–	–	–	5	10	15	O
	100	–	–	–	5	15	20	Z
	110	–	–	–	5	20	25	Z
	120	–	–	–	5	25	30	Z
	130 *	–	–	–	20	40	60	Z
	140 *	–	–	5	30	40	75	Z

Repetitive group adjusted for surface interval															
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
10	15	20	25	30	35	40	45	50	60	65	70	80	85	95	100

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
21 metres	5	–	–	–	–	–	–	A
	10	–	–	–	–	–	–	B
	15	–	–	–	–	–	–	C
	20	–	–	–	–	–	–	D
	25	–	–	–	–	–	–	E
	30	–	–	–	–	–	–	G
	35	–	–	–	–	–	–	H
	40	–	–	–	–	–	–	I
	45	–	–	–	–	–	–	J
	50	–	–	–	–	5	5	K
	55	–	–	–	–	5	5	L
	60	–	–	–	5	5	10	M
	70	–	–	–	5	10	15	N
	75	–	–	–	5	15	20	O
	85	–	–	–	5	20	25	Z
	90	–	–	–	5	25	30	Z
	95 *	–	–	5	5	25	35	Z
	110 *	–	–	5	20	45	70	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
10	10	15	20	25	30	35	40	45	50	55	60	65	70	75	85

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
24 metres	5	–	–	–	–	–	–	A
	10	–	–	–	–	–	–	C
	15	–	–	–	–	–	–	D
	20	–	–	–	–	–	–	E
	25	–	–	–	–	–	–	F
	30	–	–	–	–	–	–	H
	35	–	–	–	–	–	–	I
	40	–	–	–	–	5	5	J
	50	–	–	–	5	5	10	M
	55	–	–	–	5	10	15	M
	60	–	–	–	5	15	20	N
	70	–	–	–	5	20	25	O
	80 *	–	–	5	5	30	40	Z
	85 *	–	–	5	20	40	65	Z
	90 *	–	5	5	30	45	85	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	10	15	20	20	25	30	35	40	40	45	50	55	60	65	70

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
27 metres	5	–	–	–	–	–	–	B
	10	–	–	–	–	–	–	C
	15	–	–	–	–	–	–	E
	20	–	–	–	–	–	–	F
	25	–	–	–	–	–	–	G
	30	–	–	–	–	5	5	I
	40	–	–	–	5	5	10	L
	45	–	–	–	5	10	15	M
	50	–	–	–	5	15	20	N
	55	–	–	–	5	20	25	O
	60	–	–	5	5	20	30	O
	65 *	–	–	5	5	25	35	Z
	70 *	–	–	5	10	30	45	Z
	75 *	–	–	5	30	45	80	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	10	10	15	20	20	25	30	35	35	40	45	50	50	55	60

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min)	Repetitive group
		15	12	9	6	3		
30 metres	5	–	–	–	–	–	–	B
	10	–	–	–	–	–	–	D
	15	–	–	–	–	–	–	E
	20	–	–	–	–	–	–	G
	25	–	–	–	–	5	5	H
	30	–	–	–	5	5	10	J
	35	–	–	–	5	10	15	L
	40	–	–	–	5	15	20	M
	45	–	–	–	5	20	25	N
	50	–	–	5	5	20	30	O
	55 *	–	–	5	5	25	35	Z
	60 *	–	–	5	10	30	45	Z
	65 *	–	5	5	30	40	80	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	10	10	15	15	20	25	25	30	35	35	40	45	45	50	55

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
33 metres	5	–	–	–	–	–	–	B
	10	–	–	–	–	–	–	D
	15	–	–	–	–	–	–	F
	20	–	–	–	–	5	5	H
	25	–	–	–	5	5	10	I
	30	–	–	–	5	10	15	K
	35	–	–	–	5	15	20	M
	40	–	–	–	5	20	25	N
	45	–	–	5	5	20	30	O
	50 *	–	–	5	10	25	40	Z
	55 *	–	5	5	20	40	70	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	10	10	15	15	20	20	25	25	30	35	35	40	40	45	50

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
36 metres	5	–	–	–	–	–	–	B
	10	–	–	–	–	–	–	D
	15	–	–	–	–	5	5	F
	20	–	–	–	–	5	5	H
	25	–	–	–	5	5	10	J
	30	–	–	–	5	15	20	L
	35	–	–	–	5	20	25	N
	40	–	–	5	5	25	35	O
	45 *	–	–	5	10	25	40	Z
	50 *	–	5	10	25	40	80	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	5	10	10	15	15	20	20	25	25	30	30	35	40	40	45

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
39 metres	5	–	–	–	–	–	–	C
	10	–	–	–	–	–	–	F
	15	–	–	–	–	5	5	G
	20	–	–	–	5	5	10	I
	25	–	–	–	5	10	15	K
	30	–	–	–	5	20	25	M
	35 *	–	–	5	5	20	30	O
	40 *	–	–	5	10	25	40	Z
	45 *	–	5	10	25	40	80	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	5	10	10	15	15	20	20	20	25	25	30	30	35	35	40

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
42 metres	5	–	–	–	–	–	–	C
	10	–	–	–	–	5	5	E
	15	–	–	–	5	5	10	H
	20	–	–	–	5	10	15	J
	25	–	–	–	5	15	20	L
	30	–	–	5	5	20	30	N
	35 *	–	5	10	15	35	65	O
	40 *	–	5	15	20	40	80	Z

Repetitive group adjusted for surface interval															
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	5	10	10	10	15	15	20	20	25	25	25	30	30	35	35
Minutes to be added to the bottom time for a repetitive dive															

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
45 metres	10	–	–	–	–	5	5	F
	15	–	–	–	5	5	10	H
	20	–	–	–	5	15	20	K
	25	–	–	5	5	20	30	M
	30 *	–	–	5	10	25	40	O
	35 *	–	5	15	20	40	80	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	5	10	10	10	15	15	15	20	20	25	25	30	30	30	35

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
48 metres	10	–	–	–	5	5	10	F
	15	–	–	–	5	10	15	I
	20	–	–	5	5	15	25	L
	25	–	–	5	10	20	35	N
	30∗	–	5	5	10	25	45	O

Repetitive group adjusted for surface interval															
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	5	5	10	10	15	15	15	20	20	20	25	25	30	30	30
Minutes to be added to the bottom time for a repetitive dive															

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
51 metres	10	–	–	–	5	5	10	G
	15	–	–	–	5	10	15	J
	20	–	–	5	5	15	25	L
	25*	–	–	5	10	25	40	O
	30*	5	5	15	25	35	85	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	5	5	10	10	10	15	15	15	20	20	20	25	25	30	30

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
54 metres	10 *	–	–	–	5	5	10	G
	15 *	–	–	5	5	10	20	K
	20 *	–	–	5	10	15	30	M
	25 *	–	5	5	10	25	45	O

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	5	5	10	10	10	15	15	15	20	20	20	25	25	25	30

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
57 metres	10 *	–	–	–	–	10	10	H
	15 *	–	–	5	5	15	25	K
	20 *	–	–	5	10	20	35	N
	25 *	–	5	5	15	25	50	Z

Repetitive group adjusted for surface interval

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
5	5	5	10	10	10	10	15	15	15	20	20	20	25	25	25

Minutes to be added to the bottom time for a repetitive dive

Standard Air Decompression Table

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)					Total decomp. time (min.)	Repetitive group
		15	12	9	6	3		
60 metres	10*	–	–	–	–	15	15	H
	15*	–	–	–	10	15	25	L
	20*	–	5	10	15	30	60	O

There is no repetitive group designator for this table depth.

Residual Nitrogen Timetable for Repetitive Dives

Surface Interval Times are given as Hours:Minutes

	Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
A →																0:10 2:20
B →															0:10 1:20	1:21 3:40
C →														0:10 1:00	1:01 2:10	2:11 4:30
D →													0:10 0:50	0:51 1:50	1:51 3:00	3:01 5:20
E →												0:10 0:50	0:51 1:40	1:41 2:40	2:41 4:00	4:01 6:20
F →											0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:50	4:51 7:10
G →										0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:40	5:41 8:00
H →									0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:20	5:21 6:30	6:31 8:50
I →								0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:10	5:11 6:10	6:11 7:20	7:21 9:40
J →							0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:10	5:11 6:10	6:11 7:00	7:01 8:20	8:21 10:40
K →						0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:10	5:11 6:10	6:11 7:00	7:01 7:50	7:51 9:10	9:11 11:30
L →					0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:10	5:11 6:10	6:11 7:00	7:01 7:50	7:51 8:40	8:41 10:00	10:01 12:20
M →				0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:10	5:11 6:10	6:11 7:00	7:01 7:50	7:51 8:40	8:41 9:40	9:41 10:50	10:51 13:10
N →			0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:10	5:11 6:10	6:11 7:00	7:01 7:50	7:51 8:40	8:41 9:30	9:31 10:30	10:31 11:50	11:51 14:10
O →		0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:10	5:11 6:10	6:11 7:00	7:01 7:50	7:51 8:40	8:41 9:30	9:31 10:30	10:31 11:20	11:21 12:40	12:41 15:00
Z →	0:10 0:50	0:51 1:40	1:41 2:40	2:41 3:30	3:31 4:20	4:21 5:10	5:11 6:10	6:11 7:00	7:01 7:50	7:51 8:40	8:41 9:30	9:31 10:30	10:31 11:20	11:21 12:10	12:11 13:30	13:31 15:50
	Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A

Repetitive group adjusted for surface interval

Corrections for Dive Site Altitude

	Altitude (metres above sea level)							Use table for
	250-500	500-750	750-1000	1000-1250	1250-1500	1500-1750	1750-2000	
Depth in metres not to exceed:	8	8	7	7	7	7	7	9 m
	11	10	10	10	10	9	9	12 m
	14	13	13	12	12	12	11	15 m
	16	16	15	15	15	14	14	18 m
	19	19	18	18	17	17	16	21 m
	22	21	21	20	20	19	18	24 m
	25	24	23	23	22	21	21	27 m
	28	27	26	25	25	24	23	30 m
	31	30	29	28	27	26	25	33 m
	33	32	31	30	30	29	28	36 m
	36	35	34	33	32	31	30	39 m
	39	38	37	36	35	33	32	42 m
	42	41	39	38	37	36	35	45 m
	45	43	42	41	40	38	37	48 m
	48	46	45	43	42	41	40	51 m
	50	49	47	46	45	43	42	54 m
	53	52	50	49	47	46	44	57 m
	56	54	53	51	50	48	47	60 m
	A	B	B	C	D	E	F	
	Repetitive group for altitude exposure							

Corrections for Depth of Decompression Stops

Altitude metres	250-500	500-750	750-1000	1000-1250	1250-1500	1500-1750	1750-2000	Re-placing
Adjusted depth of staged Stops	No adjustments							3 m
						5	5	6 m
				8	8	8	8	9 m
			11	11	11	10	10	12 m
			14	14	13	13	13	15 m
		17	17	16	16	15	15	18 m

EAD-table for Open-Circuit Nitrox with 32 % O_2

(Dives should not be planned to depths indicated by italics)

Depth (metres)	EAD (metres)	Use table (metres)	pO_2 (bar)
12	8.9	9	0.70
13	9.8	12	0.74
14	10.7	12	0.77
15	11.5	12	0.80
16	12.4	15	0.83
17	13.2	15	0.86
18	14.1	15	0.90
19	15.0	15	0.93
20	15.8	18	0.96
21	16.7	18	0.99
22	17.5	18	1.02
23	18.4	21	1.06
24	19.3	21	1.09
25	20.1	21	1.12
26	21.0	21	1.15
27	21.8	24	1.18
28	22.7	24	1.22
29	23.6	24	1.25
30	24.4	27	1.28
31	25.3	27	1.31
32	26.2	27	1.34
33	27.0	30	1.38
34	27.9	30	1.41
35	28.7	30	1.44
36	29.6	30	1.47
37	30.5	33	1.50
38	*31.3*	*33*	*1.54*
39	*32.2*	*33*	*1.57*
40	*33.0*	*36*	*1.60*
41	*33.9*	*36*	*1.63*
42	*34.8*	*36*	*1.66*
43	*35.6*	*36*	*1.70*

EAD-table for Open-Circuit Nitrox with 36 % O_2

(Dives should not be planned to depths indicated by italics)

Depth (metres)	EAD (metres)	Use table (metres)	pO_2 (bar)
13	8.6	9	0.83
14	9.4	12	0.86
15	10.3	12	0.90
16	11.1	12	0.94
17	11.9	12	0.97
18	12.7	15	1.01
19	13.5	15	1.04
20	14.3	15	1.08
21	15.1	18	1.12
22	15.9	18	1.15
23	16.7	18	1.19
24	17.5	18	1.22
25	18.4	21	1.26
26	19.2	21	1.30
27	20.0	21	1.33
28	20.8	21	1.37
29	21.6	24	1.40
30	22.4	24	1.44
31	23.2	24	1.48
32	*24.0*	*27*	*1.51*
33	*24.8*	*27*	*1.55*
34	*25.6*	*27*	*1.58*
35	*26.5*	*27*	*1.62*
36	*27.3*	*30*	*1.66*
37	*28.1*	*30*	*1.69*
38	*28.9*	*30*	*1.73*
39	*29.7*	*30*	*1.76*

EAD-table for Open-Circuit Nitrox with 40 % O_2

(Dives should not be planned to depths indicated by italics)

Depth (metres)	EAD (metres)	Use table (metres)	pO_2 (bar)
15	9.0	9	1.00
16	9.7	12	1.04
17	10.5	12	1.08
18	11.3	12	1.12
19	12.0	15	1.16
20	12.8	15	1.20
21	13.5	15	1.24
22	14.3	15	1.28
23	15.1	18	1.32
24	15.8	18	1.36
25	16.6	18	1.40
26	17.3	18	1.44
27	18.1	21	1.48
28	*18.9*	*21*	*1.52*
29	*19.6*	*21*	*1.56*
30	*20.4*	*21*	*1.60*
31	*21.1*	*24*	*1.64*
32	*21.9*	*24*	*1.68*
33	*22.7*	*24*	*1.72*
34	*23.4*	*24*	*1.76*
35	*24.2*	*27*	*1.80*

Surface Decompression Table Using Oxygen

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)			O2 at 15 and 12 m in chamber (min.)	Total decomp. time (min.)	Repeti-tive group
		18	15	12			
15 metres	130	–	–	–	15	22	Z
	170	–	–	–	30	37	Z
	180	–	–	–	45	57	Z
	200	–	–	–	45	57	Z
	240	–	–	–	60	72	
	270 *	–	–	–	75	92	
18 metres	90	–	–	–	15	22	O
	120	–	–	–	30	37	Z
	140	–	–	–	45	57	Z
	170	–	–	–	60	72	
	200	–	–	–	75	92	
	220	–	–	–	90	107	
	240 *	–	–	–	105	127	
21 metres	70	–	–	–	15	22	N
	90	–	–	–	30	37	Z
	110	–	–	–	45	57	Z
	130	–	–	–	60	72	Z
	150	–	–	–	75	92	
	170	–	–	–	*90*	*107*	
	190 *	–	–	–	*105*	*127*	

Surface Decompression Table Using Oxygen

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)			O_2 at 15 and 12 m in chamber (min.)	Total decomp. time (min.)	Repetitive group
		18	15	12			
24 metres	55	–	–	–	15	22	M
	70	–	–	–	30	37	O
	90	–	–	–	45	57	Z
	110	–	–	–	*60*	*72*	*Z*
	120	–	–	–	*75*	*92*	
	130	–	–	–	*90*	*107*	
	*150 **	–	–	–	*105*	*127*	

27 metres	45	–	–	–	15	23	M
	60	–	–	–	30	38	O
	70	–	–	–	45	58	Z
	90	–	–	–	*60*	*73*	*Z*
	100	–	–	–	*75*	*93*	
	110	–	–	–	*90*	*108*	
	*130 **	–	–	*5*	*105*	*133*	

Surface Decompression Table Using Oxygen

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)			O_2 at 15 and 12 m in chamber (min.)	Total decomp. time (min.)	Repeti-tive group
		18	15	12			
30 metres	35	–	–	–	15	23	L
	50	–	–	–	30	38	O
	60	–	–	–	45	58	Z
	70	*–*	*–*	*–*	*60*	*73*	*Z*
	90	*–*	*–*	*2*	*75*	*95*	
	100	*–*	*–*	*9*	*90*	*117*	
	110 *	*–*	*–*	*14*	*105*	*142*	
33 metres	30	–	–	–	15	23	K
	40	–	–	–	30	38	N
	45	–	–	–	30	38	O
	55	*–*	*–*	*–*	*45*	*58*	*Z*
	60	*–*	*–*	*–*	*60*	*73*	*Z*
	80	*–*	*–*	*9*	*75*	*102*	
	100 *	*–*	*–*	*25*	*105*	*153*	
36 metres	30	–	–	–	15	24	L
	35	–	–	–	30	39	N
	40	*–*	*–*	*–*	*30*	*39*	*O*
	50	*–*	*–*	*–*	*45*	*59*	*Z*
	60	*–*	*–*	*–*	*60*	*74*	*Z*
	70	*–*	*–*	*13*	*75*	*107*	
	80	*–*	*–*	*24*	*90*	*133*	
	90 *	*–*	*7*	*26*	*105*	*161*	

Surface Decompression Table Using Oxygen

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)			O_2 at 15 and 12 m in chamber (min.)	Total decomp. time (min.)	Repetitive group
		18	15	12			
39 metres	25	–	–	–	15	24	K
	30	–	–	–	*30*	*39*	*M*
	35	–	–	–	*30*	*39*	*O*
	45	–	–	*1*	*45*	*60*	*Z*
	55	–	–	*4*	*60*	*78*	*Z*
	60	–	–	*12*	*75*	*106*	*Z*
	70	–	*1*	*26*	*90*	*136*	
	80 *	–	*12*	*26*	*105*	*167*	
42 metres	20	–	–	–	15	24	J
	30	–	–	–	*30*	*39*	*N*
	40	–	–	*4*	*45*	*63*	*Z*
	50	–	–	*8*	*60*	*82*	*Z*
	55	–	*1*	*15*	*75*	*110*	*Z*
	60	–	*2*	*23*	*90*	*134*	
	70 *	–	*14*	*25*	*105*	*168*	
45 metres	*20*	–	–	–	*15*	*25*	*K*
	25	–	–	–	30	40	M
	35	–	–	*6*	*45*	*66*	*Z*
	45	–	*3*	*8*	*60*	*85*	*Z*
	50	–	*4*	*14*	*75*	*112*	*Z*
	60 *	–	*11*	*26*	*90*	*146*	

Surface Decompression Table Using Oxygen

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min.)				O_2 at 15 and 12 m in chamber (min.)	Total decomp. time (min.)	Repetitive group
		21	18	15	12			
48 metres	*20*	–	–	–	*1*	*15*	*26*	*L*
	25	–	–	–	*4*	*30*	*44*	*N*
	35	–	–	*4*	*6*	*45*	*70*	*Z*
	40	–	–	*6*	*6*	*60*	*87*	*Z*
	45	–	*2*	*5*	*11*	*75*	*112*	*Z*
	55 ∗	–	*3*	*11*	*26*	*90*	*149*	
	60 ∗	–	*6*	*17*	*25*	*105*	*177*	

51 metres	*15*	–	–	–	–	*15*	*26*	*J*
	20	–	–	–	*3*	*30*	*43*	*M*
	25	–	–	*1*	*7*	*30*	*48*	*O*
	30	–	–	*5*	*7*	*45*	*72*	*Z*
	35	–	*2*	*6*	*6*	*60*	*89*	*Z*
	45	–	*5*	*7*	*16*	*75*	*123*	*Z*
	50 ∗	*1*	*5*	*11*	*23*	*90*	*149*	
	55 ∗	*2*	*7*	*16*	*26*	*105*	*180*	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)				Total decomp. time (min.)	Repetitive group
		15	12	9	6		
		Air		O_2			
12 metres	**160**	–	–	–	–	1	O
	170	–	–	–	2	3	O
	180	–	–	–	5	6	Z
	190	–	–	–	7	8	Z
	200	–	–	–	9	10	Z
	210	–	–	–	11	12	Z
	220	–	–	–	12	13	Z
	230	–	–	–	16	17	Z
	240	–	–	–	19	20	Z
	270	–	–	–	26	27	Z
	300	–	–	–	33	34	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)				Total decomp. time (min.)	Repetitive group
		15	12	9	6		
		Air		O_2			
15 metres	**90**	–	–	–	–	2	M
	95	–	–	–	1	3	M
	100	–	–	–	2	4	N
	110	–	–	–	4	6	O
	120	–	–	–	7	9	O
	130	–	–	–	12	14	Z
	140	–	–	–	16	18	Z
	150	–	–	–	19	21	Z
	160	–	–	–	23	25	Z
	170	–	–	–	26	28	Z
	180	–	–	–	30	32	Z
	190	–	–	–	35	37	Z
	200	–	–	–	39	46	Z
	210	–	–	–	43	50	
	220	–	–	–	47	54	
	230	–	–	–	50	57	
	240	–	–	–	53	60	
	270	–	–	–	62	69	
	300	–	–	–	74	86	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)				Total decomp. time (min.)	Repetitive group
		15	12	9	6		
		Air		O_2			
18 metres	**60**	–	–	–	–	2	K
	65	–	–	–	1	3	L
	70	–	–	–	4	6	L
	80	–	–	–	7	9	N
	90	–	–	–	10	12	O
	100	–	–	–	15	17	Z
	110	–	–	–	21	23	Z
	120	–	–	–	26	28	Z
	130	–	–	–	31	33	Z
	140	–	–	–	35	37	Z
	150	–	–	–	41	48	Z
	160	–	–	–	48	55	Z
	170	–	–	–	53	60	
	180	–	–	–	59	66	
	190	–	–	–	64	71	
	200	–	–	–	68	80	
	210	–	–	–	73	85	
	220	–	–	–	77	89	
	230	–	–	–	82	94	
	240	–	–	–	88	100	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)				Total decomp. time (min.)	Repeti-tive group
		15	12	9	6		
		Air		O2			
21 metres	**45**	–	–	–	–	2	K
	50	–	–	–	1	3	K
	55	–	–	–	5	7	L
	60	–	–	–	8	10	M
	70	–	–	–	13	15	N
	80	–	–	–	17	19	O
	90	–	–	–	24	26	Z
	100	–	–	–	31	33	Z
	110	–	–	–	38	45	Z
	120	–	–	–	44	51	Z
	130	–	–	–	51	58	Z
	140	–	–	–	59	66	
	150	–	–	–	66	78	
	160	–	–	1	72	85	
	170	–	–	1	78	91	
	180	–	–	2	83	97	
	190	–	–	3	88	103	
	200	–	–	5	93	115	
	210	–	–	7	98	122	
	240	–	–	13	110	140	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)				Total decomp. time (min.)	Repeti-tive group
		15	12	9	6		
		Air		O2			
24 metres	**35**	–	–	–	–	3	J
	40	–	–	–	1	4	J
	45	–	–	–	5	8	K
	50	–	–	–	9	12	M
	55	–	–	–	13	16	M
	60	–	–	–	16	19	N
	70	–	–	–	22	25	O
	80	–	–	–	30	33	Z
	90	–	–	–	39	47	Z
	100	–	–	1	46	54	Z
	110	–	–	3	51	61	Z
	120	–	–	5	59	71	
	130	–	–	7	67	86	
	140	–	–	9	73	94	
	150	–	–	10	80	102	
	160	–	–	11	86	114	
	170	–	–	14	90	121	
	180 *	–	–	17	96	130	
	210	–	–	26	110	158	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)				Total decomp. time (min.)	Repetitive group
		15	12	9	6		
		Air		O_2			
27 metres	**30**	–	–	–	–	3	J
	35	–	–	–	2	5	J
	40	–	–	–	7	10	L
	45	–	–	–	12	15	M
	50	–	–	–	17	20	N
	55	–	–	–	21	24	O
	60	–	–	–	24	27	O
	70	–	–	–	32	35	Z
	80	–	–	3	40	51	Z
	90	–	–	7	46	61	Z
	100	–	–	10	53	71	
	110	–	–	13	61	87	
	120	–	2	14	70	99	
	130	–	5	14	79	111	
	140	–	8	14	87	127	
	150	–	11	17	94	140	
	160	–	13	20	101	152	
	170	–	15	23	106	167	
	180	–	16	26	112	177	
	240	–	42	34	159	268	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)				Total decomp. time (min.)	Repeti-tive group
		15	12	9	6		
		Air		O_2			
30 metres	**25**	–	–	–	–	3	H
	30	–	–	–	2	5	J
	35	–	–	–	8	11	L
	40	–	–	–	14	17	M
	45	–	–	–	19	22	N
	50	–	–	–	24	27	O
	55	–	–	–	28	31	Z
	60	–	–	–	33	36	Z
	70	–	–	6	39	53	Z
	80	–	–	11	45	64	Z
	90	–	2	14	53	82	
	100	–	9	14	66	102	
	110	–	14	14	76	117	
	120	–	19	14	85	136	
	150	3	26	23	109	184	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)						Total decomp. time (min.)	Repeti-tive group
		21	18	15	12	9	6		
		Air				O_2			
33 metres	**20**	–	–	–	–	–	–	4	H
	25	–	–	–	–	–	3	7	I
	30	–	–	–	–	–	7	11	K
	35	–	–	–	–	–	14	18	M
	40	–	–	–	–	–	20	24	N
	45	–	–	–	–	–	26	30	O
	50	–	–	–	–	–	32	36	Z
	55	–	–	–	–	3	33	44	Z
	60	–	–	–	–	7	36	51	Z
	70	–	–	–	–	14	42	64	Z
	80	–	–	–	9	14	54	90	
	90	–	–	–	18	14	68	113	
	95	–	–	–	25	14	79	131	
	100	–	–	–	25	14	79	131	
	110	–	–	5	26	14	91	154	
	120	–	–	10	26	18	101	173	
	180	–	3	23	47	34	159	299	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)						Total decomp. time (min.)	Repetitive group
		21	18	15	12	9	6		
		Air				O2			
36 metres	**15**	–	–	–	–	–	–	4	F
	20	–	–	–	–	–	2	6	H
	25	–	–	–	–	–	5	9	J
	30	–	–	–	–	–	13	17	L
	35	–	–	–	–	–	20	24	N
	40	–	–	–	–	1	26	31	O
	45	–	–	–	–	2	31	37	Z
	50	–	–	–	–	5	33	47	Z
	55	–	–	–	–	10	35	54	Z
	60	–	–	–	–	14	39	62	Z
	70	–	–	–	13	14	51	87	
	80	–	–	–	24	14	67	119	
	85	–	–	7	26	14	80	140	
	90	–	–	7	26	14	80	140	
	100	–	–	15	25	14	95	167	
	110	–	–	21	25	19	105	188	
	120	–	3	23	25	24	113	211	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)						Total decomp. time (min.)	Repeti-tive group
		21	18	15	12	9	6		
		Air				O_2			
39 metres	**10**	–	–	–	–	–	–	4	F
	15	–	–	–	–	–	2	6	G
	20	–	–	–	–	–	5	9	I
	25	–	–	–	–	–	9	13	K
	30	–	–	–	–	1	17	22	M
	35	–	–	–	–	3	23	30	O
	40	–	–	–	–	3	30	37	Z
	45	–	–	–	1	6	33	49	Z
	50	–	–	–	2	10	36	57	Z
	55	–	–	–	4	14	40	67	Z
	60	–	–	–	12	14	46	81	Z
	70	–	–	1	26	14	63	118	
	75	–	–	12	26	14	79	145	
	80	–	–	12	26	14	79	145	
	90	–	–	22	25	14	95	175	
	100	–	6	23	26	20	106	204	
	120	–	17	24	27	29	130	255	
	180	13	21	45	57	46	198	418	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)						Total decomp. time (min.)	Repetitive group
		21	18	15	12	9	6		
		Air				O2			
42 metres	**10**	–	–	–	–	–	–	5	E
	15	–	–	–	–	–	3	8	H
	20	–	–	–	–	–	7	12	J
	25	–	–	–	–	2	12	18	L
	30	–	–	–	–	4	19	27	N
	35	–	–	–	2	4	26	36	O
	40	–	–	–	4	4	33	50	Z
	45	–	–	–	5	9	36	59	Z
	50	–	–	–	8	14	39	70	Z
	55	–	–	1	15	15	45	85	Z
	60	–	–	2	23	14	56	109	
	65	–	–	14	25	15	74	142	
	70	–	–	14	25	15	74	142	
	80	–	2	24	25	15	91	176	
	90	–	12	23	26	19	107	211	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)						Total decomp. time (min.)	Repetitive group
		21	18	15	12	9	6		
		Air				O2			
45 metres	**5**	–	–	–	–	–	–	5	E
	10	–	–	–	–	–	1	6	F
	15	–	–	–	–	–	5	10	H
	20	–	–	–	–	1	8	14	K
	25	–	–	–	–	4	14	23	M
	30	–	–	–	4	4	22	35	O
	35	–	–	–	6	4	30	45	Z
	40	–	–	2	6	7	35	59	Z
	45	–	–	3	8	12	40	72	Z
	50	–	–	4	14	14	46	87	Z
	55	–	–	7	21	14	57	113	
	60	–	–	11	26	14	67	132	
	70	–	3	24	25	14	85	170	
	80	–	15	23	26	18	104	205	
	90	3	22	23	26	24	118	240	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)						Total decomp. time (min.)	Repetitive group
		21	18	15	12	9	6		
		Air				O$_2$			
48 metres	**5**	–	–	–	–	–	–	5	E
	10	–	–	–	–	–	2	7	F
	15	–	–	–	–	1	6	12	I
	20	–	–	–	1	2	10	18	L
	25	–	–	–	4	4	17	30	N
	30	–	–	2	6	4	26	43	Z
	35	–	–	4	6	4	34	58	Z
	40	–	–	6	6	11	38	71	Z
	45	–	2	5	11	14	45	86	Z
	50	–	2	8	19	15	55	113	
	55	–	3	11	26	14	67	135	
	60	–	6	17	25	15	77	154	
	70	–	15	23	26	15	99	197	
	80	6	21	24	25	23	114	237	

TUP Tables

Depth not deeper than	Max. bottom time (min.)	Time at stop depth (min)						Total decomp. time (min.)	Repeti-tive group
		21	18	15	12	9	6		
		Air				O_2			
51 metres	**5**	–	–	–	–	–	–	6	D
	10	–	–	–	–	–	3	9	G
	15	–	–	–	–	2	6	13	J
	20	–	–	–	3	3	12	23	M
	25	–	–	1	7	4	20	37	O
	30	–	–	5	7	3	30	50	Z
	35	–	2	6	6	8	37	69	Z
	40	–	4	6	9	12	44	85	Z
	45	–	5	7	16	14	53	110	Z
	50	1	5	11	23	14	66	134	
	55	2	7	16	26	14	77	156	
	60	2	11	21	26	14	88	181	
	70	7	19	24	25	20	109	228	
	80	17	22	23	26	27	128	267	

Prevention of Decompression Sickness

1. **Decompression.** Any ascent from the bottom to the surface entails decompression, in the term's true sense of reducing the ambient pressure. However, in diving terminology it is most common to reserve this term for the required stop time at the staged decompression stops. Hence, the term "no-decompression dive", strictly speaking an oxymoron, is being used to denote a dive that allows a direct ascent to the surface without stops.

2. **Table Safety.** A safe table is one that, when used correctly, has proven successful in terms of a low DCS incidence. Still, we must keep in mind that no table guarantees a 100 % success for all divers and all exposures even if the procedures are closely adhered to.

3. **Factors Increasing the Risk for Decompression Illness.** The tables address two parameters only, namely time and depth. We know that several other factors play a significant role in determining the decompression obligation. By being aware of these factors, we may use dive tables more wisely to plan and conduct safer dives. This chapter describes such factors that diving supervisors and divers should be aware of. If you comply with the recommendations in this chapter, you may further reduce the risk for decompression illness, based on the diver's individual factors and the characteristics of the dive.

4. **Adjustment of Decompression.** If there are circumstances increasing the risk for decompression illness, the decompression should be more conservative than prescribed by the tables. Especially this is true if multiple risk increasing factors are present and for dives with bottom times bordering the maximum allowed bottom time. In such cases the standard air decompression tables should be used more conservatively by decompressing according to a table time one or two steps longer than otherwise. For $SurDO_2$ dives, the oxygen breathing time in chamber should be extended as detailed below.

5. **Physical Work** is probably the one factor, in addition to time and depth, that has the largest influence on decompression requirement. Increased work causes an increase in blood circulation which leads to faster uptake of gas in the tissues. The sensation of breathlessness during part of the dive is a good indicator of the physical strain of the dive.

6. **Individual Factors.** Most divers and hyperbaric professionals assume that age, obesity, and a poor physical fitness all contribute to an increased risk of DCS. However, research in this field is not conclusive. We are still confident that these factors play a role, especially the age and obesity factors. Unfortunately, there is no published research indicating the magnitude of the extra risk. Until recently it was believed that women were more susceptible to DCS than men, but this has not been scientifically justified. Dive tables were originally being tested by young and fit military personnel, yet practice has shown that the tables provide good safety for most civilian divers as well. We recommend that divers who are overweight (BMI exceeding 30), older (above 50 years) or with poor physical fitness (not exercising regularly) to add a safety margin.

7. **Cold Stress.** Typically, a diver will stay relatively warm during the bottom phase of a dive due to the workload. Then he may become cold during the subsequent inactive decompression phase. A cold decompression is less effective since the peripheral blood circulation is impaired. This will increase the risk for decompression illness.

8. **Recommended Adjustment of Decompression for Standard Air Decompression Dives.** To simplify the assessment of the individual risk factors, the table below may be used.

Score Risk factor	**1**	**2**
Workload	Low/Medium	High
Thermal comfort during decompression	Neutral/warm	Cold
Individual factors Age > 50 BMI > 30 Sedentary	0-1 individual factors	2-3 individual factors

By adding the scores for the various groups of risk factors you will achieve a total score ranging 3 to 6. The highest score will be achieved with a dive with a high workload, where the diver has been cold during decompression and has 2 or 3 of the individual risk factors. For score 5 we recommend that the decompression is adjusted according to a bottom time one step longer than the required. For score 6 we recommend decompression according to a bottom time two steps longer than prescribed.

9. **Adjustment of Table Bottom Times with SurDO$_2$.** Thermal comfort is not considered a risk factor given the fact that decompression mainly takes place in the recompression chamber.

Score Risk factor	**1**	**2**
Workload	Low/Medium	High
Individual factors Age > 50 BMI > 30 Sedentary	0-1 individual factors	2-3 individual factors

The total score will range 2 to 4. We recommend the addition of 15 min of extra oxygen breathing time on 12 m with score 4.

10. **Complying with the Recommendations in this Chapter.** We recommend that the decompression adjustments listed in this chapter should be followed to reduce the risk of DCS. We nevertheless consider that lack of compliance with the recommendations should not be considered a formal violation or “non-compliance”. The reason for this is that several factors are subjective (individual appreciation of workload and cold) that cannot be interpreted consistently. In addition, it is difficult to ascertain the effect these factors have on the DCS risk. Thirdly it is not always possible to know in advance the extent of workload and thermal comfort during the decompression phase while planning the dive. Please note that the Repetitive Group Designator should not be changed even if decompression is prolonged one or two steps as a precautionary measure. For long bottom times, extension of decompression may dictate decompression according to tabulated bottom times indicated as exceptional. There is no requirement to shorten the actual bottom time to avoid this.

11. **Acclimatization.** We have indications that repeated diving to the same depth over a long period of time actually *reduces* the susceptibility to DCS. This phenomenon is called "acclimatization". Acclimatization develops gradually over a few days and will be lost after a period without diving. Experience indicates that it is a good idea to avoid maximum bottom times the first day following a period of not diving.

12. **Fluid Balance.** The elimination of inert gas relies on a a proper fluid balance. Sufficient intake of water or mineral water prevents DCS. Dehydration may be caused by illness, a hangover or simply by inadequate fluid intake. Whatever the cause, dehydration will increase a diver's susceptibility to DCS. Some divers may tend to refrain from drinking prior to a dive to avoid the urinary discomfort particularly during long dives. We advice against this practice. Avoid coffee, tea (and of course alcohol!) before diving. With TUP and $SurDO_2$ the diver should drink before, during and after the chamber exposure. A rule of thumb is to drink sufficient to pass clear urine.

13. **Tobacco.** All tobacco products, both those that are being smoked/vaped and "snus"/chewing tobacco should be avoided both before and directly after a dive, because the nicotine and the carbon monoxide have negative influence on gas exchange and blood circulation.

14. **Alcohol, Drugs and Medication.** It should go without saying that diving under the influence of alcohol poses a multitude of risk factors. Among these are poor judgement, impaired co-ordination, exacerbation of nitrogen narcosis and the masking of DCI symptoms. Alcohol will typically induce dehydration of the body, and this is very likely to increase the risk of DCS. In a state of dehydration, blood will flow sluggishly, and the elimination of nitrogen will suffer. We advise against diving for at least 8 hours after alcoholic drinks have been consumed. Any other drug or medication that causes drowsiness and impaired judgement is also incompatible with safe diving.

15. **"Patent Foramen Ovale"** (PFO) is an incomplete closure of the septum separating the heart"s two upper chambers: the atria. This is a minor congenital defect found in about 30 % of the population. There are rarely any symptoms or consequences of this defect in daily life but in divers it raises the risk of DCS by a factor of 4-5. We currently do not advise routine screening for PFO but divers who have suffered from otherwise unexplained DCS are often tested during the medical check after the recompression treatment.

16. **The Effects of Physical Activity During the Decompression** are disputed. We believe in the benefit of light activities throughout the decompression phase, as opposed to the extremes of static inactivity or strenuous work. Avoid static loads or postures that restrict the free circulation of blood to any part of the body. For instance, do not grab the decompression line with one hand and keep that grip through the entire decompression and do not cross your legs while decompressing in a chamber. Further, it is advised to avoid strenuous activities for three hours after the dive. Divers participating in public emergency units (police, firefighting) should avoid routine training dives deeper than 20 m and Repetitive Group Designator exceeding H if physically demanding work tasks may be expected immediately after the dive.

17. **Repetitive Depth Excursions** (saw-tooth profile) during a dive should be avoided since it promotes the formation of bubbles and may increase DCS risk even for no-decompression dives. To limit the number of ascents it is a good idea to use a line or other means to lower tools to the diver rather than calling the diver up to collect them. One should consider the use of a dive computer as an additional measure for dives expected to include repetitive depth excursions.

18. **Depth Profile.** The tables are designed to provide a reasonable degree of safety for dives to a given depth for the maximum stated time. Whenever the depth varies it is preferable to do the deeper part first since this will further provide an increased safety margin against DCS.

19. **Safety Stop.** Even when a diver observes the correct ascent rate it is always a good idea to include a safety stop at 5 m for 3 min for no-decompression dives exceeding 9 m. However, omitting a safety stop should not be considered a violation of these tables. Further, we advise that the diver makes a brief stop to check the time half-way through the ascent. Then, if he finds himself ahead of schedule he can pause until back on schedule. For surface-controlled dives the tender will keep track of the time and will instruct the diver to stop while he checks the ascent rate.

20. **Deep Stops.** The ascent rate constitutes an important element of the decompression procedure. Data suggest that overly fast ascents promote neurological DCS, especially on deep dives. Hence, numerous divers all over the world have adopted the practice of including an extra, deep stop. The exact depth and time of these stops have not been standardized. If a deep stop is desired, we recommend it to last for 1-2 min at half the maximum depth or deeper. This stop should be included in the bottom time.

21. **Omitted Decompression.** Should a "low-on-air" situation or other emergency force the diver to skip part of the decompression he should skip the shallower part. In other words, follow the table until you must abort rather than speeding up the ascent or omitting deeper stops. See also the chapter Emergency Procedures.

22. **Surge** represents a nuisance and a hazard, especially at shallow stops. The diver may suffer motion sickness; he may get bumped against the hull of the vessel and even experience a pulmonary barotrauma. Decompression dives should be avoided in such conditions, especially when air is the only available breathing gas. Nitrox provides the option of using a deeper stop profile according to the Equivalent Air Depth principle unless $SurDO_2$ is an option. Should a diver using the standard air table be exposed to heavy surge while decompressing, his best option will be to do the 3 m stop time at 6 m, thus avoiding the stronger wave action close to the surface.

23. **Oxygen Breathing at Surface** is recommended whenever there is reason to suspect a higher risk of DCS and no other prescribed action applies to the situation. In practice this means an incident or conditions believed to promote DCI. In this situation, a period of 20 min oxygen breathing shortly after the dive is a recommended safety measure.

24. **Chamber Oxygen Breathing.** Hyperbaric oxygen is even more effective to reduce the risk of DCS. Recompress to 12 m for a maximum of two 30 min oxygen periods, each followed by a 5 min air break. Decompress on oxygen at a rate of 1 m/min. While prophylactic oxygen therapy is a useful tool it should not be used to justify a casual approach to decompression obligation, omitted decompression or DCS. One should never use post-dive oxygen breathing as part of a pre-planned or standard procedure.

25. **Limitation on Bottom Time.** Regulations from The Norwegian Labour Inspection authority as well as Norsok standards U-100 and U-103 have restrictions on bottom time. There is a distinction made between "Transfer Under Pressure" (TUP) and other decompression techniques such as in-water decompression or $SurDO_2$ (non-TUP). The bottom time limitations have been identified by bold horizontal lines in the present tables. "Maximum depth" should be interpreted as water depth when diving according to Norwegian Labour Inspection Authority, but Equivalent Air Depth when diving compliant with Norsok U-100 and U-103. "Bottom time" should be interpreted as actual bottom time. For repetitive dives the diver is allowed to decompress according to a longer table time than maximum bottom time listed in the tables below. The Norwegian Labour Inspection Authority has suggested changes to the inshore diving regulations. The proposal includes a suggestion to remove the bottom time limitations presently stipulated in the regulations. If this change should take place before the next edition of NDTT is released, we would recommend that all dives are planned with a bottom time not exceeding that indicated by an asterisk. This will ensure that the likelihood of contracting DCS is of the same order irrespective of mode of decompression. Any change in regulations will of course have precedence of this advice.

Maximum depth in metres	Maximum Bottom Time	
	TUP	Non-TUP
0-12	240	240
15	240	180
18	180	120
21	180	90
24	180	70
27	130	60
30	110	50

Maximum depth in metres	Maximum Bottom Time	
	TUP	Non-TUP
33	95	40
36	85	35
39	75	30
42	65	30
45	60	25
48	55	25
51	50	20

Procedures in the Event of Omitted Decompression or Uncontrolled Ascent

1. **An Uncontrolled Ascent Requires Prompt and Decisive Measures**, whether DCI is confirmed or not. The action being taken will depend on the location and the available resources. We advise all dive teams, professional as well as recreational, to bring a surface oxygen kit to any dive site. The capacity of the kit shall be sufficient for at least 30 min administration of oxygen and preferably 60 min based on a respiratory demand of 15 l/min. For dives planned with decompression stops, a chamber should be available at the dive site or in the immediate vicinity.

2. **Recompression and Surface Oxygen Breathing.** The procedures described in this chapter provide guidance for handling uncontrolled ascent and/or omitted decompression. If there is a recompression chamber is on site, the procedures may be simplified, and a decision taken to recompress in any situation with uncontrolled ascent or omitted decompression. If more than 10 min of decompression is omitted, the Treatment Table 5 should be given. For shorter periods of omitted decompression, 30 min of O_2 breathing at 12 m will be adequate (see next section). Surface oxygen breathing for 30 min after finished dive will provide additional protection if recompression is impossible. Recompression after omitted decompression is not to be considered as "treatment" but an emergency procedure. Contact diving physician for guidance related to omitted decompression and for guidance on minimum surface interval before next dive.

3. **Omitted Decompression or Uncontrolled Ascent – Oxygen on Site and Chamber Available.**
   - The diver develops symptoms of DCI: Recompress with Treatment Table 6 (TT 6). Contact the emergency medical dispatch service (113) and notify a diving accident.
     in the absence of any symptoms:
   - The dive is a SurDO_2 dive: Recompress as per Treatment Table 5 (TT 5). For other dives, act in agreement with the bullets listed below.
   - The bottom time allows direct ascent to surface: If the equipment is OK, descend and complete a safety stop. Observe for one hour at surface.
   - Omitted decompression at a staged decompression stop or working depth on a standard table decompression dive, with 10 min or less omitted decompression: Provided the diver remains without symptoms and his equipment is operational he should descend immediately and decompress according to a bottom time one interval longer than the originally required. Observe for one hour at surface. Should the diver be unable to descend he should be compressed to a depth of 12 m in a chamber. Provide O_2 on BIBS for 30 min. Decompress at a rate of 10 m/min while breathing air.
   - Omitted in-water decompression of 15 min and more: Recompress with TT 5.

4. **Chamber and/or Oxygen not Available on Site.** Staged decompression dives should not be conducted without the proper logistics. Nevertheless, for various reasons, an incident may take place under these circumstances. While it is impossible to devise proper procedures for every combination of mishap and deficient planning, we still have a few suggestions. Attempts to make the best of a bad situation come with a high degree of uncertainty. If a decision for in-water recompression is taken it is crucial that the diver descends as soon as possible.

5. **Procedure: Omitted Decompression or Uncontrolled Ascent in the Absence of a Recompression Chamber on Site.**
   - The diver develops symptoms of DCI: Provide surface oxygen breathing. Contact emergency medical dispatch service (113), notify diving accident.
   - The bottom time allows direct ascent to surface:
     Descend. Complete safety stop. Observe for one hour at surface.
   - Ascent from the bottom / work depth – no-stop limit exceeded:
     If the diver is OK and the equipment working: Descend and decompress according to a schedule one tabulated bottom time longer than originally prescribed. If the omitted decompression time is 15 min or longer or if the diver is unable to descent, then breathe oxygen at surface for 30 min. If omitted decompression is 15 min or longer then call a diving physician.

6. **In-water Recompression?** There is no consensus on how to best manage a case of DCI when neither oxygen nor an on-site chamber is available. Some will recommend in-water recompression, even when air is the only available breathing gas. In-water recompression remains a very controversial alternative and most diving medical experts oppose it. We choose to advise against in-water recompression for the following reasons:
   - The additional hyperbaric exposure will cause more nitrogen to be acquired, possibly exacerbating the problem when the diver surfaces for the second time.
   - It is hard to monitor a person under water and to take measures should his condition deteriorate.
   - The diver risks severe hypothermia.
   - The supply of breathing gas is likely to be limited.
   - Bad weather and wave action may create dangerous situations.

   It must be noted however, that some groups diving in remote areas with limited logistics have used in-water recompression successfully.

7. **Despite our Doubts and Concerns** we have chosen to present a standardized protocol for in-water recompression if such a procedure should be used. A standardized procedure may help reduce the risk of complications.

8. **Prerequisites for Considering In-Water Recompression:**
   - Enough breathing gas to complete the treatment
   - A sufficient thermal protection for the exposure
   - The diver must be fit for the exposure, physically as well as mentally
   - A standby diver should be prepared and means of communication (preferably speech) established
   - Reasonable sea state and weather conditions
   - Diving physician should be contacted and medical evacuation requested.
   - Preferably the area's depth and bottom topography should allow for the patient to rest on the bottom.

9. **The Following Plan May Be Used:**
   - Descend to 12 m for 30 min
   - Decompress by spending 10 min at each meter, up to and including the 3 m stop. Surface when the 3 m stop is completed.

   Hence, the total time for this treatment schedule is two hours.

10. **Light Activity Is Recommended Throughout the Treatment**, as opposed to hard work. The diver should be assisted when leaving the water, doffing his gear and putting on dry clothes. He should drink water and rest after the treatment. Even when the diver remains asymptomatic after the treatment, he should seek hyperbaric chamber treatment as soon as possible. Also, whenever oxygen becomes available while the diver is being treated, he should breathe oxygen as soon as he returns to the surface.

11. **In-water Recompression Should Certainly not Be Considered a Standard Treatment**, or even an approved emergency treatment. Therefore, this controversial approach will not be covered in other chapters.

Emergency Decompression

1. In extreme and unforeseen situations, the bottom time may be exceeded beyond what is tabulated. In such cases the dive supervisor may initiate the procedure for emergency decompression (see table below) pending contact with a diving physician. See further instructions in the sections below the table.

	Depth (m)			
	12	9	6	3
Decompression time (min)	5	5	10	30

2. This procedure has been designed for emergency situations when it is impossible to complete a correct, but long-lasting decompression. This will typically be the case with complications during the dive causing unforeseen extension of the bottom time. “Emergency decompression” is a method for immersed decompression according to an untested procedure. In all other situations without extensive omitted decompression the procedures described in section “Procedures in the Event of Omitted Decompression or Uncontrolled Ascent” should be followed.

3. Scientific and empirical data on the likelihood and consequence on severely omitted decompression are mainly absent. The procedures presented in this chapter have not been verified. They have been printed to support a final decision where no other and better documented procedures are available. The diving supervisor should in each situation consider the consequences of completing part of the decompression in water vs surfacing the diver for follow-up treatment by healthcare professionals.

4. Contact the emergency dispatch service (AMK, Tel 113) and rescue divers (Tel 110) whenever a diver must be decompressed according to these procedures. This action is essential to ensure support for surface rescue, first aid, medevac and final treatment. Ensure that you clearly state “diving accident”. The standby diver should accompany the affected diver whenever possible. First aid and oxygen equipment should be prepared. Plan for the practicalities related to evacuation and where the diver should stay at surface waiting for medevac. Prepare a pair of scissors or a knife to open the diving suit if so required and try to find a wool blanket or other insulating material to keep the diver warm.

5. There is a significant interindividual variation in tolerance for the omission of decompression. If the extent of omitted decompression can be estimated, we suggest considering the options such:
   -If there is a pressure chamber on site and the diver can be recompressed within 10 min the likelihood of severe symptoms will be low. The same is true if the length of omitted decompression is less than 30 min and the diver may be provided with oxygen during surface transport to an alternative recompression chamber. In

such cases, emergency decompression should only take place if all aspects related to the diver's safety is ensured.
-When the omitted decompression ranges 30 to 60 min DCS should be expected, and the diver should be recompressed as soon as possible but not later than 1 hour after finished dive. Oxygen should be given during the transport. Emergency decompression should be considered if "surface oxygen" is unavailable or transport to recompression chamber exceeds one hour.
-If omitted decompression exceeds 60 min, emergency decompression should be considered if the diver is unharmed and has normal level of consciousness, breathing and circulation. In the event of omitted decompression exceeding 60 min, long term health effects are likely. The likelihood of life-threatening cardiopulmonary DCS (chokes) will increase as omitted decompression time exceeds one hour.

6. If it is possible to provide oxygen-enriched air to the diver this should be done. Optimal pO_2 is 1.6 bar. Don´t give hyperoxic breathing gas exceeding a pO_2 of 1.9 bar.

7. The length of omitted decompression should be reduced to the extent possible. To what extent this is possible will depend on several specific parameters, and in the meantime preliminary actions should be initiated.

8. The length of decompression at 3 m should be adjusted to a specific risk assessment including background information of the dive profile, the diver's health, thermal comfort, availability of oxygen at surface and transport time to a recompression chamber. In the event of waves/swell the final part of decompression should take place at 6 m rather than 3 m.

9. Priority should be given to fast medevac with the diver breathing oxygen (FO_2=100%) for all cases when there has been a long period of omitted decompression. Medical examinations and other treatment should be restricted to a minimum to avoid delay. Provide intravenous fluid (Ringer, Saline) during transport to ensure optimal rehydration after the dive. Keep the diver comfortably warm.

10. A diver without symptoms should immediately be recompressed on Table 5 on arrival at the recompression facility. Consider Table 6 if omitted decompression exceeds 60 min even if the diver has no symptoms. If the diver develops symptoms before, during or after recompression, these should be followed up according to standard medical procedures.

11. A diver subjected to emergency decompression should be assessed by a diving physician before resuming diving.

Decompression Illness

1. **Decompression Illness (DCI)** is a term that covers a range of symptoms that arise when bubbles form in blood or tissue due to a too rapid decrease in ambient pressure. The definition of DCI itself and its proposed sub-categories remains somewhat unclear and controversial. The term "decompression illness" is typically used to cover decompression sickness (DCS) as well as Cerebral Arterial Gas Embolism (CAGE) and Arterial Gas Embolism (AGE).

2. The various diving communities have typically used "**the bends**" as the term for any kind of decompression sickness. One may also run into combinations as "skin bends" and "cerebral bends". We used to divide decompression sickness into these categories:
   - DCS type I – less serious case of decompression sickness
   - DCS type II – serious case of decompression sickness
   - CAGE (AGE) which is caused by lung barotrauma that discharges gas into the arterial bloodstream. This gas typically travels to the brain.

3. **The Type I and Type II Discrimination** is no longer used since it created a lot of confusion. It is better to describe a case of DCI by referring to symptoms and the parts of the body that are involved – for instance, neurological DCI, skin involvement, joint pain/involvement etc.

4. **DCS Is Caused by the Formation of Gas Bubbles** in the bloodstream and/or in the tissues. We used to believe that the blocking of blood flow was the primary mechanism. Today there is more focus on the injurious chain reactions caused by the bubbles. Blood platelets and white blood cells will aggregate on foreign objects (such as bubbles) and the inner lining of the blood vessels is injured causing tissue swelling (oedema). This will further cause an inflammatory reaction. These secondary reactions may develop slowly. An afflicted diver may experience an apparent recovery after the onset of symptoms followed by deterioration a few hours later. The treatment response is best if hyperbaric therapy is initiated early.

5. **The Symptoms of DCS** may manifest themselves during the decompression though usually during the first hours after a dive. As a rule of thumb, about 50 % of the cases will appear within the first hour and about 90 % within 6 hours after the dive.

6. **Cases of DCS Involving Skin and Lymph Only** ("skin bends" and "lymph bends) are the least serious kinds. The primary symptom of skin bends is itching, commonly associated with a transient rash. Skin bends seems to be more common after short and deep exposures rather than long and shallower ones. In most cases the itching will subside within the first 15 min post-dive. The aetiology of skin bends is believed to be the formation of subcutaneous gas bubbles. Mild cases with a temporary itching, burning sensation or a rash that resolves quickly will usually not warrant hyperbaric treatment. Persistent cases will need to be treated.

7. **Lymph Involvement** implies the blocking of lymph nodes and lymph vessels. The lymph vessels constitute the tissues' drainage system for excess fluid that will ultimately be returned to the blood circulation. When parts of the lymph system get blocked the adjacent tissues will swell. Usually this affects arms and chest but sometimes the thighs or the lower part of the abdomen and the crotch are involved. Blue or purplish discolouration of the skin may be present (marbling). Severe cases of DCS involving the lymph system may cause dehydration and circulatory collapse. The diver may suffer from weakness, nausea, cold sweat and a rapid heart rate/pulse – the same symptoms of shock due to circulatory insufficiency. Lymph involvement seems to be more common in divers using the surface decompression techniques.

8. **Joint Involvement** (the bends, pain only) may affect one or several joints. Shoulders, elbows, hips and knees are most commonly affected. Arms are involved more frequently than legs. Symptoms are typically strong, yet diffuse pain. The distribution is rarely symmetrical (not afflicting the corresponding joint of the opposite limb). The painful area is normally not tender and sensitive to touch. However, semi flexion of the joint tends to alleviate the pain. It is claimed that local physical compression of the affected area will alleviate pain, but this is not by supported scientifically.

9. **Gas Bubbles Trapped Inside Joint Capsules** have traditionally been proposed as the cause of pain. This is unlikely to be correct. It is more plausible that the offending bubbles are located inside nerves, at the base of tendons or inside the bone marrow. Any case of DCS causing joint pain should be treated with recompression.

10. **"Serious" DCS** includes:
    - Neurological DCS that can be subdivided into cerebral DCS and spinal DCS.
    - DCS of the inner ear (vestibular and cochlear DCS).
    - Chokes

11. **Permanent Damage.** All experience indicates that serious DCS carries a great risk of permanent damage (sequela). There are indications that even less serious cases may cause permanent damage. Thus, it is important that all members of the dive team are well versed in recognizing the various symptoms of DCS and the necessity for prompt action once DCS is suspected.

12. **Fatigue.** During the recent years there has been an increasing focus on post-dive fatigue. Fatigue may be the only apparent symptom of DCS, and it is hard to distinguish between fatigue caused by decompression stress from other causes (e.g. a strenuous dive). When in doubt, contact a diving physician.

13. **Cerebral DCS** is caused by gas bubbles in the brain. The symptoms are many folds, depending on which part of the brain is affected. The most common symptoms are fatigue, headache, nausea, vertigo and balance disturbances. In serious cases vision, consciousness, muscle strength and sense of touch may be impaired. In cases leading to numbness or paralysis, one side of the body will typically be affected. These are the same kind of symptoms as those of a common stroke in the elderly.

14. **Spinal DCS** is caused by bubbles in the spinal cord. The most common symptoms are numbness or pins-and-needles affecting legs or arms. Usually only one leg or one arm is involved but a transverse paralysis is not uncommon. Spinal symptoms will never cause a total paralysis of one side of the body from head to toe, this being the distinctive characteristic of cerebral involvement. Some divers report chest pain as the first symptom. When spinal DCS causes paralysis, the legs are most affected. The paralysis may also impair bladder and bowel functions, but these dysfunctions will tend to go unnoticed for a while.

15. **Vestibular and Cochlear DCS** is caused by bubbles lodged in the inner ear in the organs sensing balance and hearing. The most common symptoms are vertigo, loss of balance, nausea/vomiting and occasionally hearing impairment or tinnitus. Vestibular involvement may also be caused by isobaric counter-diffusion – that is, the switch from a slowly diffusing breathing gas (e.g. air) to a faster diffusing one (e.g. helium) without increasing the ambient pressure.

16. **Chokes** is a rare but very serious condition. It takes place when the major blood vessels of the heart and lungs get clogged with copious amounts of bubbles. The most common symptoms are chest pain, coughing and laboured breathing. Cyanosis may result due to insufficient oxygenation. Chokes may result from gross violations of the decompression requirements as an "explosive" decompression from great depths. Immediate recompression is required to avoid death from circulatory collapse.

Barotrauma

1. **Barotrauma** is a term that covers various injuries caused by the direct effect of a pressure differential. Any air-filled cavity of the body will be subject to pressure damage if it fails to communicate freely with the exterior during changes in ambient pressure. Pulmonary hyperinflation injury is the most serious kind of barotrauma. Luckily, this is an uncommon occurrence. Far more common are the various barotraumas of descent affecting ears and the sinuses, commonly known as "squeeze".

2. **Pulmonary Hyperinflation Injury** (burst lung) may result from undue expansion and stretching as the air expands during an ascent. Normally a diver will exhale excess air automatically, but a panic-stricken diver may tend to hold his breath during an emergency ascent. Some pulmonary conditions may weaken the strength and the elasticity of the lung tissue (thin-walled bullae) while others may increase the airway resistance and compromise the person's ability to exhale efficiently (asthma).

3. **Pulmonary Hyperinflation Injuries** can be divided in three categories:
   - Alveolar rupture
   - Mediastinal emphysema
   - Pneumothorax

   The common cause of all these injuries is stretching and rupture of the lung tissue with air entering the chest cavity or into ruptured blood vessels. Air embolism may result as a secondary condition, in which case air that has entered the bloodstream will be transported to other parts of the body (mainly the brain).

4. **Alveolar Rupture** means damage to the alveoli without any significant amount of air entering the chest cavity. An x-ray will fail to detect any air outside the airways in this case. Whenever a diver suffers from air embolism (ref. para. 8) after a dive and there is no detectable lung damage, we assume a case of alveolar rupture. One may experience weak or transient symptoms resembling those of pneumothorax (ref. para. 6) but in most cases, there are no symptoms whatsoever. Alveolar rupture *per se* is innocuous and does not require treatment. However, any sign of air embolism warrants immediate hyperbaric treatment due to the danger of secondary effects.

5. **Mediastinal Emphysema** takes place when air that has leaked through minor ruptures of the lung is collected in the central region of the chest cavity (mediastinum). This involves the region along the oesophagus, the trachea and around the heart. Moderate chest pain upon inspiration is the most common symptom of this condition. Coughing may be another symptom as well as a "metallic" voice distortion due to pressure on the larynx or its associated nerves. The air being trapped may move upwards and reach subcutaneous regions of the throat and shoulder area. If so, the area involved will be swollen and feels like powdery snow when touched. Mediastinal and/or subcutaneous emphysema will usually not require surgery. Such patients are admitted to hospital for oxygen breathing as this will accelerate reabsorption of free gas.

6. **Pneumothorax** (collapsed lung) will result when the pleural membrane is stretched beyond its limits and ruptures. When the pleural membrane is punctured the negative pressure surrounding the lungs will be relieved and cause the lung to collapse. Luckily, in most cases there is not total but rather a partial collapse involving one or several lobes. The most common symptoms are chest pain upon inspiration, possibly including coughing. When pneumothorax is suspected the patient should be hospitalized for an X-ray test and further treatment. Minor cases will be treated by administration of oxygen to speed up the reabsorption of the air pocket. More severe cases are treated surgically by insertion of a tube connected to a suction unit. The negative pressure created will re-expand the collapsed part of the lung. A case of pneumothorax will **never** be treated with recompression since the condition may actually worsen during the ensuing decompression i.e. as gas in the plural space expands.

7. Theoretically, a case of pneumothorax may be complicated by a flap-valve effect of the rupture. If so, the flap opens upon each inspiration and closes upon expiration. This will lead to the air pocket growing each time the diver draws his breath. The condition is called tension pneumothorax and it can be life-threatening. The diver will suffer from growing chest pain, cough and shortness of breath. The skin will turn pale and bluish (cyanosis) due to lack of oxygen. The condition can be alleviated by puncturing the chest cavity with a cannula. Tension pneumothorax, while being potentially fatal, is extremely rare. The majority of cases with the above-mentioned symptoms suffer from lung oedema rather than tension pneumothorax.

8. **Air Embolism.** Cerebral arterial gas embolism, (CAGE) may result as a secondary complication to all the lung injuries described above. In most cases the lung injury fails to be diagnosed unless the diver is being treated for air embolism. Whenever a lung rupture involves blood vessels, air may enter the bloodstream and be transported to other parts of the body. While this air may end up in any organ the most serious condition takes place when the air ends up in the brain. Symptoms will be manifest as soon as the diver surfaces. Usually they include headache, nausea, vertigo, visual disturbances or loss of consciousness. Partial or complete paralysis of one side of the body may also result. In practice, air embolism may be hard to distinguish from neurological DCS. However, while symptoms of air embolism will be evident upon surfacing DCS will usually take at least 5 min to develop. Further, air embolism does not relate to the exposure while the risk of DCS certainly does. The dive history will give a good indication and differentiation. In any event, it is largely of academic interest to try to distinguish between the two since first aid as well as proper treatment will be identical.

Treatment of Decompression Sickness and Air Embolism

1. **Whenever a Diving Related Injury is Suspected** medical personnel should be contacted as soon as possible. Immediately phone the national emergency dispatch service (Norway: 113) in all cases of suspected and verified cases of diving related injuries or illnesses.

2. **Examination of the injured diver** should never be allowed to delay oxygen administration or hyperbaric treatment (see below). However, there will usually be time for assessment while one is awaiting transport or preparing the chamber. In any event, it is crucial to continuously monitor vital signs, i.e. the patient's breathing, pulse and state of consciousness. A patient whose level of consciousness is affected should be placed in the recovery position to secure open airways (head tilted slightly back).

3. **First Aid.** Patients suffering from decompression sickness or air embolism seek immediate hyperbaric treatment. However, while the patient awaits the ultimate treatment it is important that he receives oxygen and drinks enough water. It is recommended to log the patient's symptoms, including all possible changes over time and the details of preliminary treatment given. In the past various drugs used to be recommended (e.g. acetyl salicylic acid/"Aspirin"). Recent research indicates that such medication is ineffective, hence it is no longer recommended.

4. **Administration of oxygen** should start as soon as possible. We recommend demand valve systems rather than constant flow for two reasons – they ensure that 100 % oxygen is inspired, and they conserve the limited supply of gas. Alternatively, systems with a reservoir bag may be used. Provide sufficient flow to keep the reservoir bag filled. Free flow systems without reservoir are less suited. When the only option is a non-reservoir constant flow system the flow selector should be set at 12 – 15 l/min. The administration of oxygen should be continuous until the patient reaches the hyperbaric facility since surface oxygen breathing carries no risk of oxygen seizures.

5. **Hydration.** Patients suffering from DCI tend to be dehydrated. Conscious patients should be offered something to drink, and they will typically need at least one litre to restore their fluid balance. A practical indicator is to keep drinking until one produces colourless urine. Water, juice or any soft drink will be good choices while coffee, tea or alcoholic beverages should be avoided. Patients who are not fully conscious should not be offered anything to drink due to the risk of inhaling fluid. Intravenous fluid administration is the only safe way to hydrate semi-conscious patients.

6. **Preparing for Medevac.** The patient should bring his dive log, depth gauge and/or dive computer. Breathing gas cylinders will normally not go with the patient. But the valves should be closed to secure the remaining gas as a sample in case breathing gas contamination may be an issue. Then, if there is reason to suspect carbon monoxide poisoning this may be confirmed or ruled out by a subsequent analysis of the breathing gas. Another issue is whether the diver's buddy should accompany him to the hyperbaric facility; this should be assessed by the emergency dispatch service. The main rule is to include an asymptomatic buddy whenever both have violated the decompression tables. Conversely, when no procedures have been violated there is no reason to treat the buddy of a diver with DCI.

7. **Mode of Transport.** The choice of transport will depend on location, topography, the urgency of the situation and the available options. The persons in charge of the medevac, always including a diving physician, will make that decision in co-operation with the team's dive supervisor. Whenever air evacuation is chosen the altitude (or, cabin altitude when the aircraft is pressurized) should stay below 300 m (1000 ft). Under no circumstances should a diver suffering from DCI be taken above an altitude of 500 m (1,500 ft).

8. **The Hyperbaric Chamber** must be of a dual lock design to allow the transfer of chamber attendants without decompressing the main compartment. Further, a treatment chamber needs an oxygen system with masks. It shall have an overboard dump to avoid expired oxygen in the chamber atmosphere; otherwise, the oxygen level inside the chamber will rise and cause a fire hazard. Further, if the chamber is going to be used for Treatment Table 6A or 6He schedules it will have to be fitted with mixed gas BIBS lines (nitrox or heliox) in addition to the oxygen. Portable one-man chambers are not suited for treating DCI.

9. **The Choice of Treatment Table (TT).** There used to be a multitude of treatment tables which caused the choice to be difficult and inconsistent. This was compounded by the fact that there were no absolute criteria. We now recommend that all DCS/gas embolism patients be recompressed to a depth of 18 m and start breathing oxygen. Then the diving physician will assess the situation and decide which further actions to take. Unless there are special complications the usual choice will be to complete TT 6.

10. **Life-threatening Symptoms.** By life-threatening symptoms, we refer to serious symptoms manifesting shortly after a dive (within 10 min). For instance, a diver may surface unconscious, or he may experience rapidly progressing paralyses. Even in such cases the first step will be to start a TT 6. If the condition deteriorates at a chamber depth of 18 m or the diver fails to improve after having spent 10-20 min at 18 m, further compression will be considered. If so, the alternatives are TT 6A or 6He, providing that the chamber has mixed gas supply. Any decision to utilize TT 6A or TT 6He should be referred to a diving physician since the risk of running into complications will be higher. Further, there is inconclusive evidence on the effectiveness of these schedules.

11. **Table Extensions.** Serious cases of DCI (neurological, vestibular) that do not resolve within the three first oxygen periods at 18 m may warrant an extension of TT 6. If so, a qualified diving physician may order additional oxygen periods at 18 m and/or at 9 m.

12. **Complications during Recompression Therapy.** The most usual complication is barotrauma leading to ear and sinus pain. This will rarely warrant any treatment beyond the administration of decongestant nasal spray and mild analgesics. A quite different complication is the risk of oxygen seizures during TT 6. This occurs in one out of one thousand treatments.

13. **Acute Oxygen Toxicity.** In case a patient suffers from oxygen seizures during the chamber treatment the immediate action is to remove the breathing mask. Then the diving physician in charge will decide how to proceed. As far as the treatment itself is concerned the odds for success are better if the original plan is followed. Still, the diving physician may advise against any further exposure to pure oxygen. Provided the treatment is resumed we recommend an anti-convulsant medication (such as Midazolam®, Stesolid® or other brand) to prevent recurrent seizures. If medication is given by persons without appropriate medical training, the drugs should preferably be administered by nasal spray or oromucosal solution. Suppositories or enema are less practical. When seizures occur at 18 m the oxygen treatment will usually be resumed at a shallower depth. Should it be impossible to consult the diving physician the oxygen treatment must be aborted. If so, enter TT 1 at 18 m and run this schedule to the surface. This will entail a remaining decompression time of 5 hrs, 51 min. Although a "technically correct" procedure, this is not a good solution. Thus, we once again emphasize the importance of establishing and maintaining contact with a diving physician throughout the hyperbaric treatment.

14. **Failed Oxygen Supply.** Whenever the oxygen supply fails the patient will necessarily breathe chamber air at the current depth. Provided the oxygen supply is re-established within 15 min the oxygen breathing is resumed, and the treatment schedule proceeds as planned, adding oxygen time to make up for the unintended break. If the oxygen supply cannot be re-established within 15 min the contingency plan is to switch to TT 1. If so, TT 1 will be entered at the current depth and followed to the surface.

15. **Atelectasis.** Oxygen breathing may cause small areas of the lung to collapse (atelectasis) if the ventilation of these areas is compromised by any reason. For all practical purposes, this is not a significant problem, but may cause short lasting chest pain when the areas are re-expanded during a deep inspiration. To avoid this, we advise a regular (every 5-10 min) a deep inspiration when breathing 100 % O_2 during SurDO_2 or hyperbaric oxygen treatment.

16. **Chamber Attendant.** A chamber attendant should always accompany a patient during a hyperbaric treatment, mainly to be of assistance in case the patient convulses. In Norway there has recently been a focus on the risk of developing DCI when serving as a chamber attendant. The current procedures render this risk small, provided the guidelines are followed. The chamber attendant should have a minimum surface interval of 18h after a chamber exposure before a no-decompression dive is started. A minimum of 24h surface interval is needed for a staged decompression dive.

17. **Trailing Treatments** are often required for DCI. Usually, this means one session each day or perhaps two sessions per day in serious cases. The total number of treatments will rarely exceed five or six. The efficiency of the various Treatment Tables is poorly documented, and the differences seem to be small between the various alternatives. In Norway, HBO 14/90, 14/60 and TT 5 are the most used choices. In any event, the selection of tables as well as the number of treatments will be decided by a diving physician.

18. **Treatment Table 1** is no longer recommended since the oxygen tables have proved to be far more effective. The main reason for including it is that it represents a contingency plan if the oxygen supply fails. For surface decompression this will imply entering table 1 at 12 m. The remaining time at 12 m may be adjusted by subtracting the time that has been spent at 12 m already. As soon as the diver has spent 30 min at 12 m, the time before switching to table 1 included, the chamber may be moved to 9 m. TT 1 may also be used as a contingency plan for hyperbaric treatment – in short, whenever oxygen breathing has to be discontinued for medical or logistical reasons.

19. **Treatment Table 5** is primarily used for cases of omitted decompression with no symptoms of DCI. If so, the chamber run will be considered as an operative procedure rather than being a treatment. Table 5 may also be used for follow-up treatment sessions or in special cases when the diagnosis is uncertain. Earlier it was common to recommend the use of TT 5 for less serious cases. Dive teams would then treat "less serious" cases on-site without involving medical expertise. This is no longer recommended since cases that appear to be benign may very well include neurological involvement that goes undetected.

20. **Treatment Table 6** is the standard choice for all cases of decompression sickness and cerebral arterial gas embolism. If the patient does not respond well during the first oxygen period at 18 m one may switch to TT 6A or 6He.

21. **Treatment Table 6A** used to be the recommended choice for treating cerebral arterial gas embolism. However, research as well as experience indicate no significant advantage over TT 6 and the risk of complications is higher. Thus, we do not recommend the use of TT 6A unless a patient suffering severe DCI fails to respond during the first oxygen period of a table 6 treatment. TT 5A is suited for cases where one wants to finish a TT 6A run as quickly as possible, for instance in cases where decompression sickness or cerebral arterial gas embolism has been ruled out during a treatment.

22. **Treatment Table 6He** is based on the experience of COMEX and the Israeli Navy. They claim that this table produces better results in treating neurological DCI, but this remains to be verified. Opinions vary on when to use TT 6He – the primary indications are neurological DCI that does not respond to standard treatment and uncontrolled ascents from great depths, especially when helium is involved. A table 6He treatment should never be considered unless it is ordered by a qualified diving physician.

Hyperbaric Oxygen Treatment of Non-Diving Related Disorders

1. **Hyperbaric Oxygen Treatment (HBO).** A multitude of conditions and injuries may benefit from oxygen administration at an elevated ambient pressure. In Norway, Haukeland University Hospital has the national responsibility for elective (planned) HBO treatment and provide such treatment in their hospital chambers. In addition, the hospital provides multi-regional treatment capacity for acute HBO treatment. Similar emergency HBO-treatment is provided by hospitals in Tromsø and Oslo. However, some patients with non-diving related conditions are still being treated in civilian and Navy chambers that are not under the direct auspices of the hospital. For this reason, we have chosen to include a presentation of the most commonly used treatment tables. It may serve as a reference for operative and technical personnel in charge of HBO treatment.

2. **Chamber Modifications.** Chambers that will be used for HBO treatment of non-divers may need modifications and adaptations. This should be worked out in co-operation with the hospital and the physicians to oversee the treatment. We will present some general guidelines.

3. **Oxygen Supply.** The chamber should be equipped with at least one extra outlet for oxygen inside. This should be fitted with a flow metre providing a range of 0-20 l/min and that allows connection to a bag ventilator (resuscitator). The patient's expiratory gas must be led out of the chamber. This requires a special set-up in connection with the exhaust (overboard dump).

4. **Medical Suction** must be available to clean the airways of critically ill patients during the treatment. A compressed air driven ejector suction is best suited, but a mechanical unit driven by a foot pump will work too.

5. **Medical Equipment.** Electrically powered medical equipment must be tested and approved for hyperbaric use to avoid fire and explosion hazards. Most of the equipment commonly used for diagnosis and treatment will work as intended when in the hyperbaric environment but anything involving closed, air-filled spaces may be destroyed or cause damage. Medical personnel planning to operate equipment inside the chamber must be aware of these issues. Some of the commonly used pieces of equipment that must be pressure compensated are the drip chamber of intravenous infusion kits, the cuff of a tracheal tube (The expansion bag in the lower part of the air tube) and the pressure cuff of infusion bags. These must all be equalized when the chamber pressure is adjusted – that is, addition of air during compression and venting of excess air during decompression.

6. **Hygiene and the Control of Contaminated Waste.** The risk of being exposed to body fluids (vomit, blood, urine, faecal matter) is increased during a chamber treatment. When disposable medical equipment such as syringes are used, these should be put in a plastic bottle after use. However, *do not cap the bottle* since this will cause pressure equalisation problems. A roll of paper towel, disposable gloves and a plastic bag for garbage are other useful paraphernalia. The chamber must be cleaned inside when the chamber treatment is finished. Use disposable gloves and remove any visible stains with a sheet of paper towel. Surfaces as the chamber floor, seats and bunks should be cleaned with standard household detergents. Areas that have been contaminated with body fluids, on the other hand, must be disinfected. Clean the areas in question with soap and water before applying any disinfectants. Take care to remove any soap residue since these may otherwise interfere with proper disinfection. 70 % ethanol or Virkon® is the best suited disinfectant but it may be hard to obtain. A good alternative is concentrated chlorine solutions (e.g. Klorin®) (1 cap of Klorin in 0.5l water). In any event, it is important to ventilate the chamber properly after disinfecting it to ensure clean, odourless air when the chamber is used next time.

7. **Gas Producing Soft tissue infections, carbon monoxide intoxication, chronic wounds and radiation injuries of bone and soft tissues** are the most common indications for HBO treatment in addition to diving related injuries. The reader is adviced to search relevant literature to learn more.

8. **Maximum allowed bottom time.** HBO Tables 14/60, 14/90, 20/60 and 20/90 stipulate maximum allowed bottom times. These time limitations are enforced to protect the chamber attendant from decompression sickness. If chamber attendant is switched, treatment time may be extended.

Diagnostics

1. This chapter provides guidelines for diagnosis and first aid by non-medically trained personnel at the dive site. The information provided can greatly assist the diving physician to make the right decisions.

2. **Handling of an Unconscious Victim** is described in a later flowchart on cardiopulmonary resuscitation.

3. **Handling of a Conscious Patient.** The first thing you should do in your further examination is to get an overview of the medical history and learn this:

    - **Medical history.** Ask the patient whether he/she suffers from any chronic conditions and whether the current situation may be linked to previous incidents. Ask for diabetes, epilepsy and cardiac disease. Current or recent use of medication? There is no need to focus on details – the main point is to gain information on conditions that may be responsible for the incident.
    - **The case at hand.** Establish exactly what the patient was doing, focusing on type of work and dive profile. Obviously, when a diver suffers an external trauma the dive particulars are less significant – however, workload and profile are important facts whenever decompression illness is suspected. Obtain information to rule out or confirm external injuries, accidents under water, diving gear malfunction, high workload and strong currents. **Which** were the initial symptoms? **When** did they manifest? **How** did the symptoms develop? Try to obtain a precise timeline of events, the first appearance of symptoms and the further development of symptoms. By linking the onset of symptoms to the phase of the dive or incident during the dive one will be able to diagnose the case correctly and assess its severity.

4. **Are There Signs of Trauma?** Try to obtain as much information as possible and provide an accurate description of your findings. Do not try to make a diagnosis, since this will be the responsibility of professional medical personnel – your job is to provide the facts and observations upon which they will base their conclusions.

5. **Summary – Dive and Development of Symptoms.** It would be useful if you could submit this information (see checklist on page 118) to any health providers you contact.

6. **Examination Checklist.** The examination checklist, found on page 120 and onwards, is intended as a guideline for the examination of diving-related injuries. From serial 6 it is less suited for general injuries such as fractures, wounds and traumas caused by dynamic force. Use your best judgement and include the tests that seem relevant. In any event, the first five tests will apply to any kind of injury. Take down your findings and pass the information on to the medevac personnel.

Selecting Correct Treatment Table

Flowchart for Treatment of Decompression Sickness and Arterial Gas Embolism

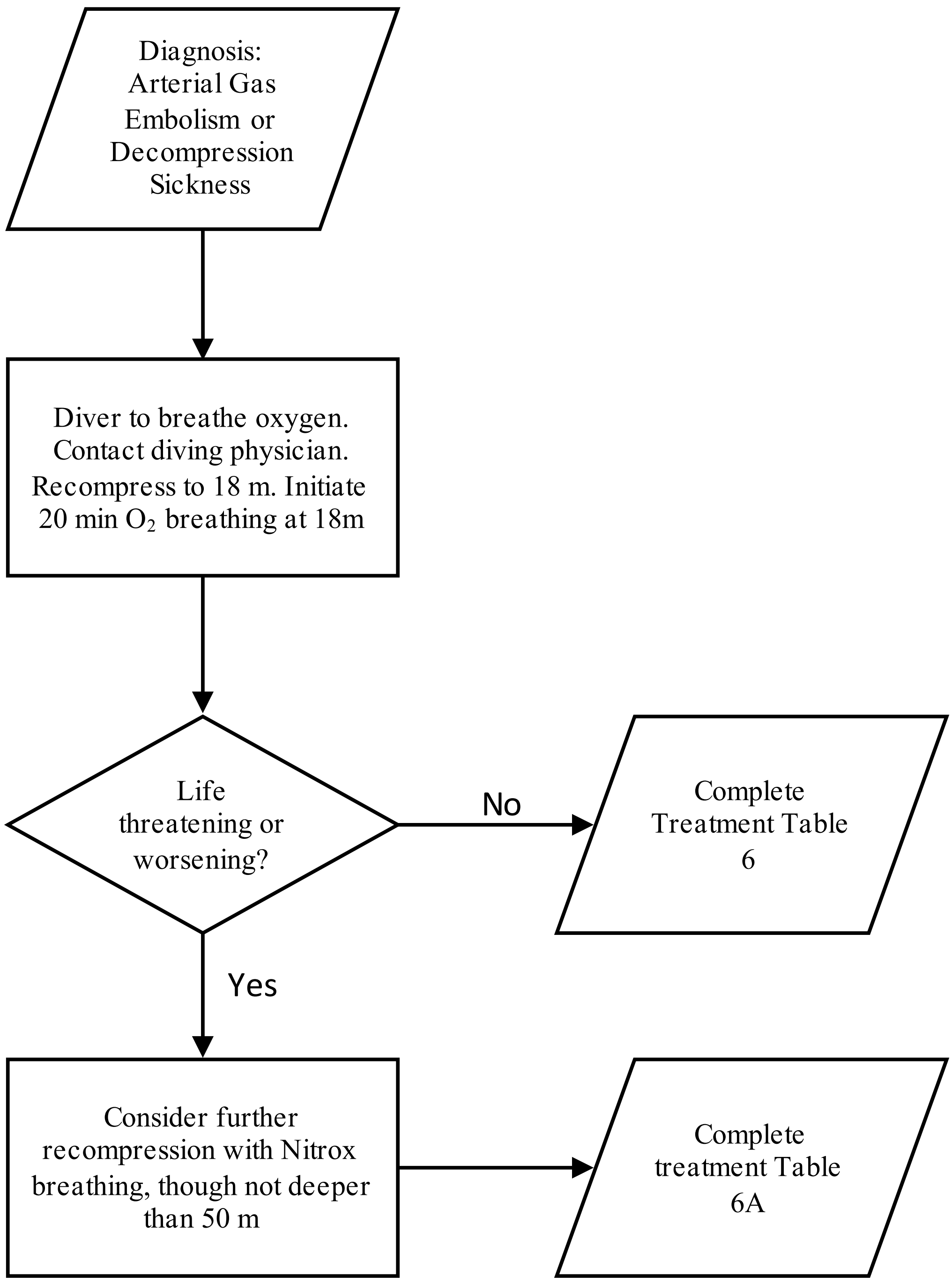
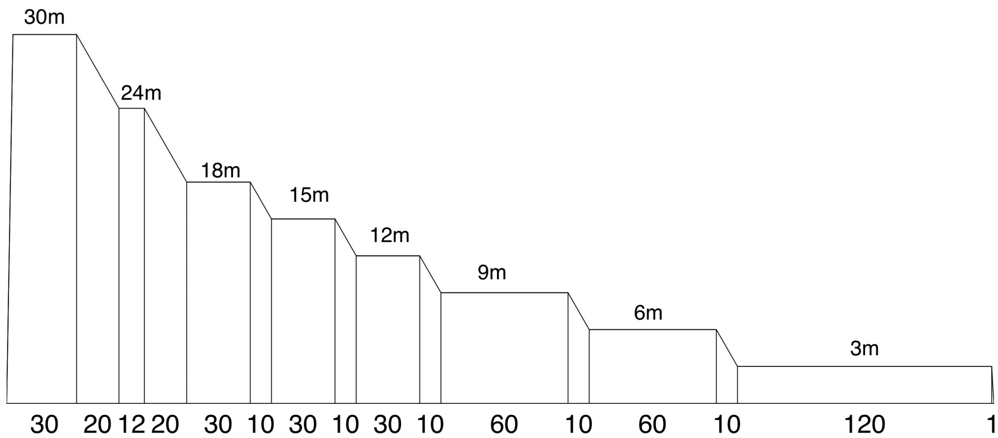


Table 1



Compression and decompression

Rate of compression at will.

Time at 30 m includes time of descent.

Decompression rate between stops is 0.3 m/min.

Patient

To breathe air during the treatment.

Chamber attendant

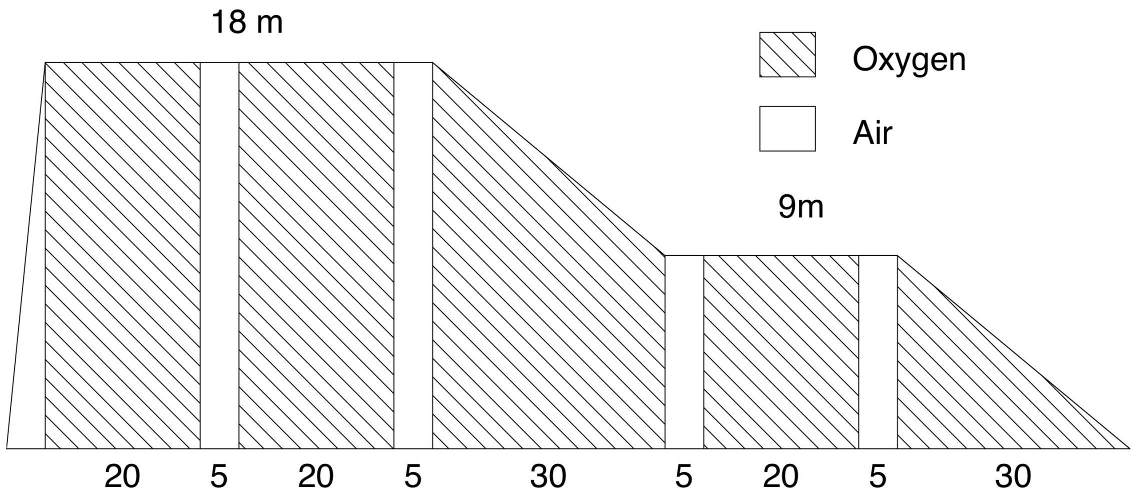
To breathe air during the treatment.

Extension

No extensions

Depth in metres	Time in minutes	Breathing gas	Running time h : min.
30	30	Air	0 : 30
30 - 24	20	Air	0 : 50
24	12	Air	1 : 02
24 - 18	20	Air	1 : 22
18	30	Air	1 : 52
18 - 15	10	Air	2 : 02
15	30	Air	2 : 32
15 - 12	10	Air	2 : 42
12	30	Air	3 : 12
12 - 9	10	Air	3 : 22
9	60	Air	4 : 22
9 - 6	10	Air	4 : 32
6	60	Air	5 : 32
6 - 3	10	Air	5 : 42
3	120	Air	7 : 42
3 - 0	1	Air	7 : 43

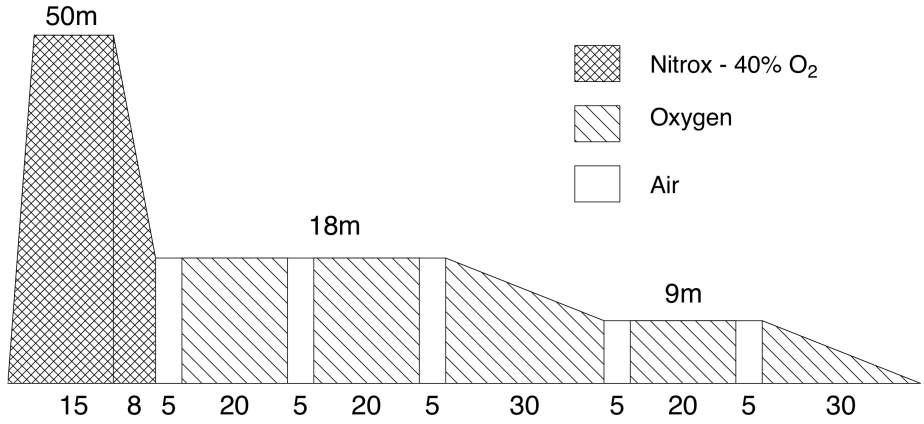
Table 5



Compression and decompression
Rate of compression at will.
Decompression rate 0.3 m/min.
Patient
Breathing gas: Optional chamber gas or BIBS O_2 during compression. Time on O_2 running from arrival 18 m.
Chamber attendant
Breathes O_2 on BIBS during decompression from 9 m to surface.
If repetitive dive to breathe O_2 on BIBS from last O_2 breathing period identical to the patient.
Extensions
A maximum of two additional O_2-periods at 9 m allowed.

Depth in metres	Time in minutes	Breathing gas	Running time h : min.
0 - 18	–	Air/O2	–
18	20	Oxygen	0 : 20
18	5	Air	0 : 25
18	20	Oxygen	0 : 45
18	5	Air	0 : 50
18 - 9	30	Oxygen	1 : 20
9	5	Air	1 : 25
9	20	Oxygen	1 : 45
9	5	Air	1 : 50
9 - 0	30	Oxygen	2 : 20

Table 5A



Depth in metres	Time in minutes	Breathing gas	Running time h : min.
0 - 50	-	Nitrox	-
50	15	Nitrox	0 : 15
50 - 18	8 *	Nitrox	0 : 23
18	5	Air	0 : 28
18	20	Oxygen	0 : 48
18	5	Air	0 : 53
18	20	Oxygen	1 : 13
18	5	Air	1 : 18
18 - 9	30	Oxygen	1 : 48
9	5	Air	1 : 53
9	20	Oxygen	2 : 13
9	5	Air	2 : 18
9 - 0	30	Oxygen	2 : 48

Compression and decompression

This treatment table is to be used on the order of a physician only.

Compression to 50 m should be rapid. Time at 50 m includes time for compression.

Decompression rate from 50 to 18 m, is 4 m/min. From 18 to 9 and from 9 to 0 the rate is 0.3 m/min.

Patient

To breathe Nitrox with 40 % O_2 and O_2 on BIBS as shown.

Chamber attendant

To breathe Nitrox 40 at 50 m and during decompression to 18 m. (No air breaks.)

To breathe O_2 on BIBS identical to the patient from the last O_2-breathing period at 9 m.

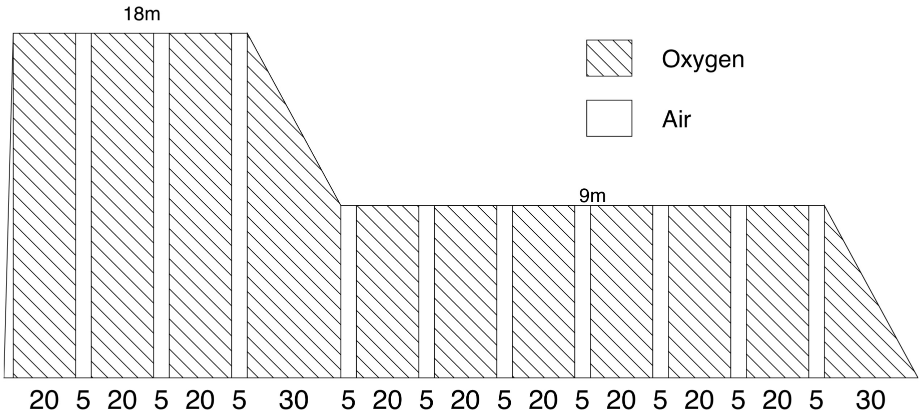
If repeated dive and/or extension of treatment table, he should breathe O_2 on BIBS identical to the patient during decompression from 18 m and further on.

Extension

No extensions.

* If the breathing gas at 50 m is air, the decompression rate is 1 m/min, and there is no 5 min air stop on arrival 18 m.

Table 6



Compression and decompression

Rate of compression at will.

Decompression rate 0.3 m/min.

Patient

Breathing gas: Optional chamber gas or BIBS O_2 during compression.

Time on O_2 running from arrival 18 m.

Chamber attendant

To breathe O_2 on BIBS identical to the patient from last O_2-period at 9 m.

If extended with more than one O_2 period at 18 m **or** more than three O_2 periods at 9 m the attendant should breathe O_2 on BIBS identical to the patient from the second last O_2 period at 9 m.

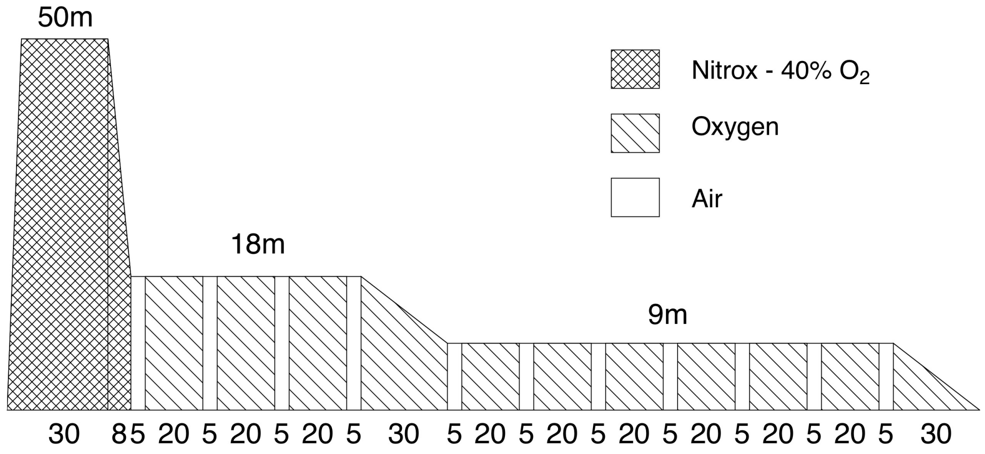
If repeated dive, the attendant breathes O_2 on BIBS identical to the patient from the third last O_2 period at 9 m.

Extensions

A maximum of two O_2 periods at 18 m and/or a maximum of six O_2-periods at 9 m.

Depth in metres	Time in minutes	Breathing gas	Running time h : min.
0 - 18	–	Air / O_2	–
18	20	Oxygen	0 : 20
18	5	Air	0 : 25
18	20	Oxygen	0 : 45
18	5	Air	0 : 50
18	20	Oxygen	1 : 10
18	5	Air	1 : 15
18 - 9	30	Oxygen	1 : 45
9	5	Air	1 : 50
9	20	Oxygen	2 : 10
9	5	Air	2 : 15
9	20	Oxygen	2 : 35
9	5	Air	2 : 40
9	20	Oxygen	3 : 00
9	5	Air	3 : 05
9	20	Oxygen	3 : 25
9	5	Air	3 : 30
9	20	Oxygen	3 : 50
9	5	Air	3 : 55
9	20	Oxygen	4 : 15
9	5	Air	4 : 20
9 - 0	30	Oxygen	4 : 50

Table 6A



Compression and decompression

This treatment table is to be used on the order of a physician only.

Compression to 50 m should be rapid. Time at 50 m includes time for compression.

Decompression rate from 50 to 18 m, is 4 m/min. From 18 to 9 and from 9 to 0 the rate is 0.3 m/min.

Patient

To breathe Nitrox with 40 % O_2 and O_2 on BIBS as shown.

Chamber attendant

To breathe Nitrox 40 at 50 m and during decompression to 18 m, 5 min air break after 20 min at 50 m.

To breathe BIBS O_2 identical to the patient from the third last O_2-period at 9 m.

If repeated dive and/or extensions to breathe BIBS O_2 identical to the patient from the fourth last O_2-period at 9 m.

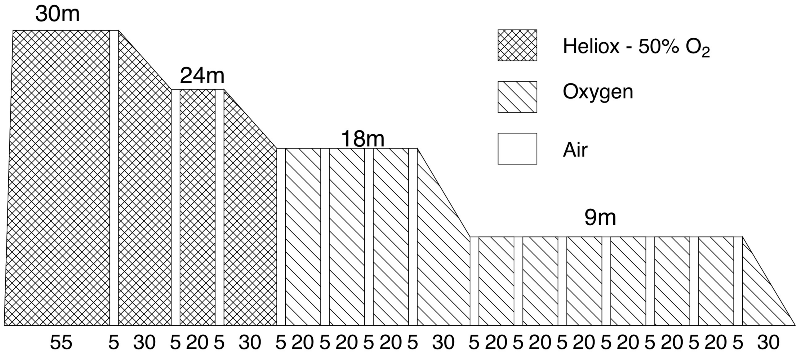
Extensions

A maximum of two O_2-periods at 18 m and/ or a maximum of six O_2-periods at 9 m.

* If the breathing gas at 50 m is air, the decompression rate is 1 m/min, and there is no 5 min air stop on arrival 18 m.

Depth in metres	Time in minutes	Breathing gas	Running time h : min.
0 - 50	-	Nitrox	-
50	30	Nitrox	0 : 30
50 - 18	8 *	Nitrox	0 : 38
18	5	Air	0 : 43
18	20	Oxygen	1 : 03
18	5	Air	1 : 08
18	20	Oxygen	1 : 28
18	5	Air	1 : 33
18	20	Oxygen	1 : 53
18	5	Air	1 : 58
18 - 9	30	Oxygen	2 : 28
9	5	Air	2 : 33
9	20	Oxygen	2 : 53
9	5	Air	2 : 58
9	20	Oxygen	3 : 18
9	5	Air	3 : 23
9	20	Oxygen	3 : 43
9	5	Air	3 : 48
9	20	Oxygen	4 : 08
9	5	Air	4 : 13
9	20	Oxygen	4 : 33
9	5	Air	4 : 38
9	20	Oxygen	4 : 58
9	5	Air	5 : 03
9 - 0	30	Oxygen	5 : 33

Table 6He



Compression and decompression

This treatment table is to be used on the order of a physician only.

Compression to 30 m at will. Time at 30 m includes time for compression.

Decompression from 30 to 24 m and from 24 m to 18 m is 0.2 m/min, otherwise 0.3 m/min.

Patient

Optional to breathe BIBS Heliox or chamber air during compression to 30 m.

Chamber attendant

To breathe O_2 on BIBS identical to the patient from arrival 9 m.

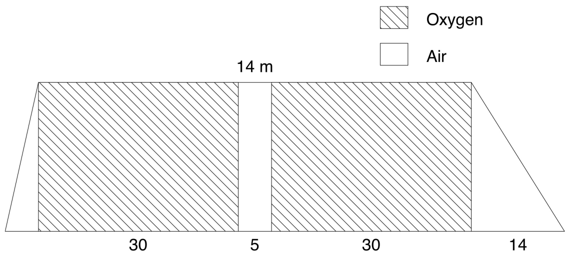
Identical procedure if repeated dive and/or table extensions.

Extensions

A maximum of one O_2-period at 18 m and a maximum of three O_2-periods at 9 m.

Depth (metres)	Time (min)	Breathing gas	Run. time h : min.
0 - 30	-	Heliox	-
30	55	Heliox	0 : 55
30	5	Air	1 : 00
30 - 24	30	Heliox	1 : 30
24	5	Air	1 : 35
24	20	Heliox	1 : 55
24	5	Air	2 : 00
24 -18	30	Heliox	2 : 30
18	5	Air	2 : 35
18	20	Oxygen	2 : 55
18	5	Air	3 : 00
18	20	Oxygen	3 : 20
18	5	Air	3 : 25
18	20	Oxygen	3 : 45
18	5	Air	3 : 50
18 - 9	30	Oxygen	4 : 20
9	5	Air	4 : 25
9	20	Oxygen	4 : 45
9	5	Air	4 : 50
9	20	Oxygen	5 : 10
9	5	Air	5 : 15
9	20	Oxygen	5 : 35
9	5	Air	5 : 40
9	20	Oxygen	6 : 00
9	5	Air	6 : 05
9	20	Oxygen	6 : 25
9	5	Air	6 : 30
9	20	Oxygen	6 : 50
9	5	Air	6 : 55
9 - 0	30	Oxygen	7 : 25

HBO-Table 14/60



Compression and decompression

Compression rate at will.

Decompression rate 1 m/min.

If 14 m is not approached within 20 min, the first O_2 period is shortened accordingly. Maximum allowed bottom time 85 min.

Patient

Optional breathing O_2 on BIBS or chamber air during compression

Time on BIBS O_2 running from time of arrival at 14 m.

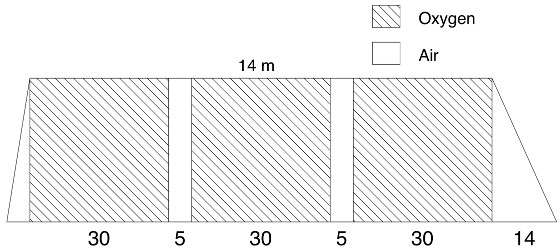
Chamber attendant

To breathe O_2 on BIBS during decompression.

Extensions

Not allowed.

HBO-Table 14/90



Compression and decompression

Compression rate at will.

Decompression rate 1 m/min.

If 14 m is not approached within 15 min, the first O_2 period is shortened accordingly. Maximum allowed bottom time 115 min.

Patient

Optional breathing O_2 on BIBS or chamber air during compression

Time on BIBS O_2 running from time of arrival at 14 m.

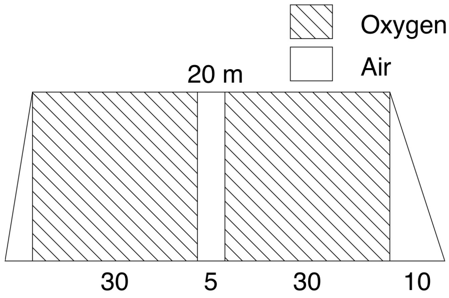
Chamber attendant

To breathe O_2 on BIBS during the last 15 min at 14 m and during decompression.

Extensions

Not allowed.

HBO-Table 20/60



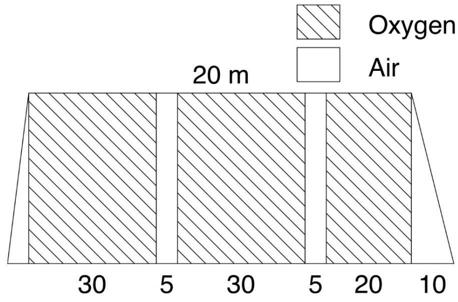
Compression and decompression
Compression rate at will. Decompression rate 2 m/min.

Patient
Optional breathing O_2 on BIBS or chamber air during compression
Time on BIBS O_2 running from time of arrival at 20 m.
Conscious patients should be given prophylactic medication to avoid oxygen induced seizures.
Sedated patients can breathe oxygen continuously (no air break required).

Chamber attendant
To breathe O_2 on BIBS during the last 10 min at 20 m and during decompression.
If repeated dive, the chamber attendant should breathe O_2 on BIBS during the last 20 min at 20 m and during decompression.

Extensions
Not allowed. Maximum allowed bottom time 70 min including compression.

HBO-table 20/90



Compression and decompression
Compression rate at will.
Decompression rate 2 m/min.

Patient
Optional breathing O_2 on BIBS or chamber air during compression.
Conscious patients should be given prophylactic medication to avoid oxygen induced seizures.
Sedated patients can breathe oxygen continuously (no air break required).

Chamber attendant
To breathe O_2 on BIBS during the last 20 min at 20 m, and during decompression.
If repeated dive the chamber attendant should breathe O_2 on BIBS during the last 30 min at 20 m and during decompression.

Extensions
Not allowed.
Maximum allowed bottom time is 90 min including compression

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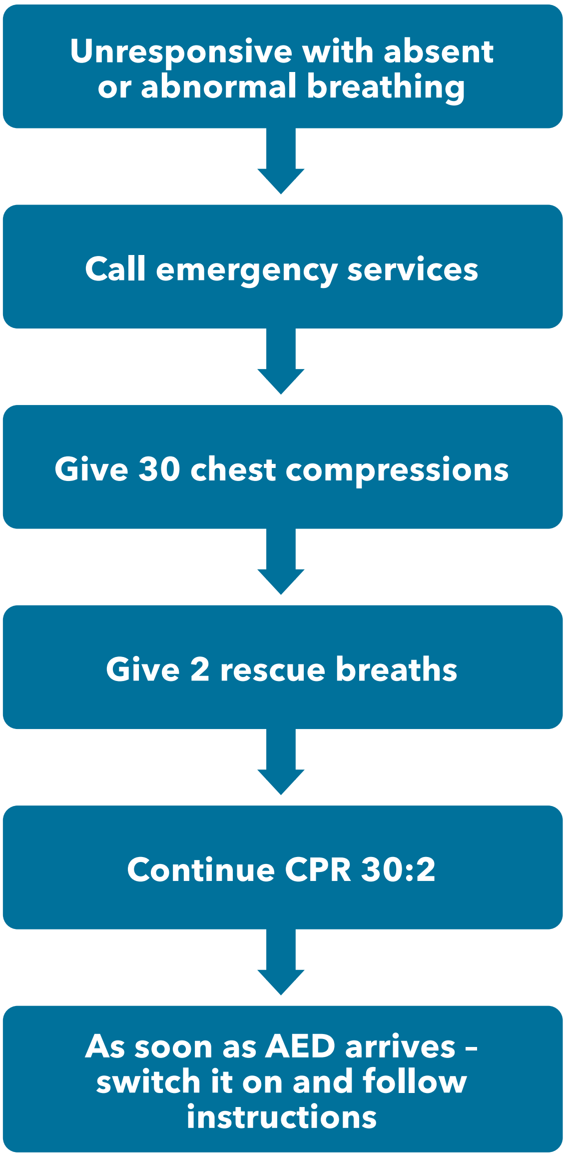
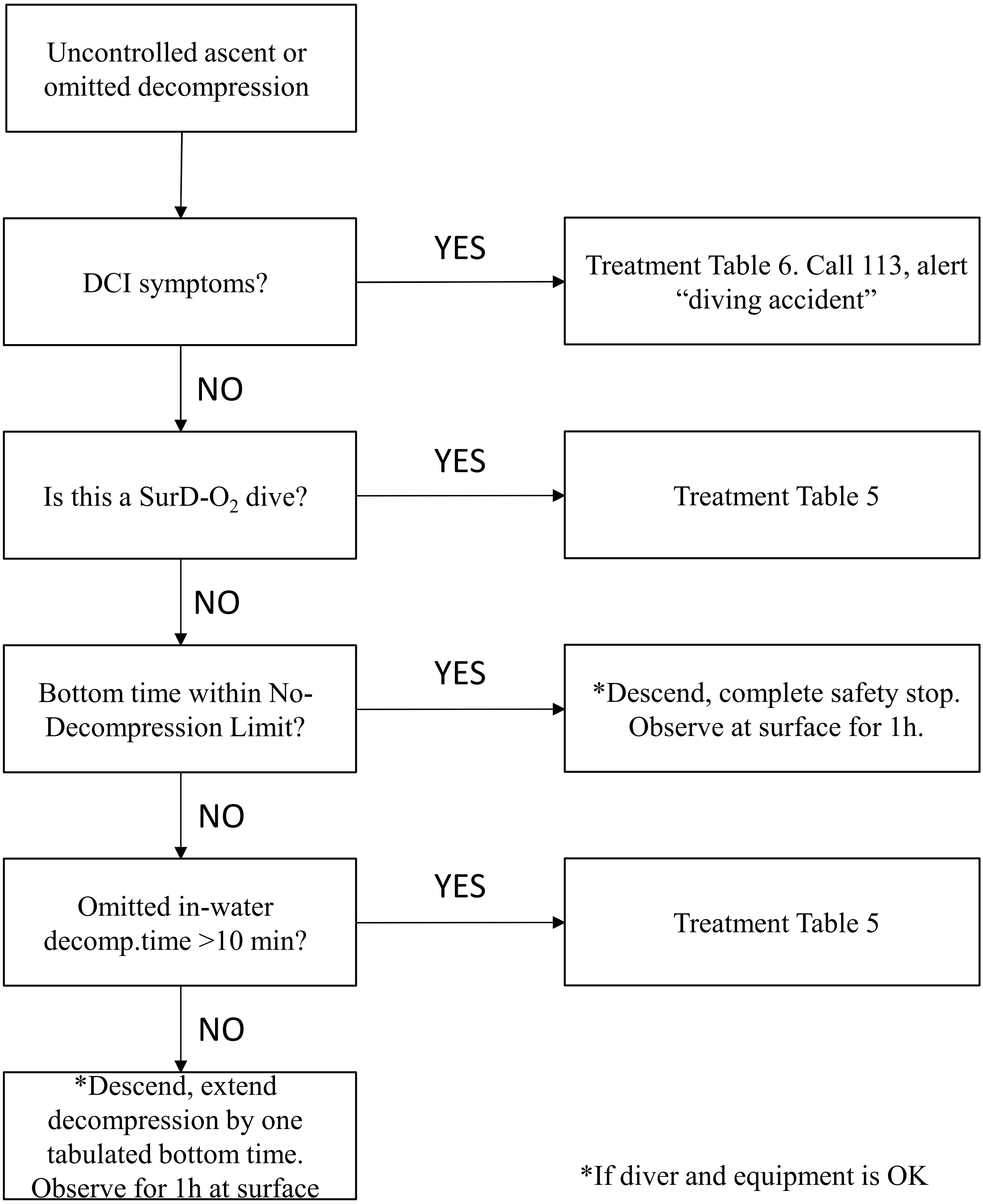


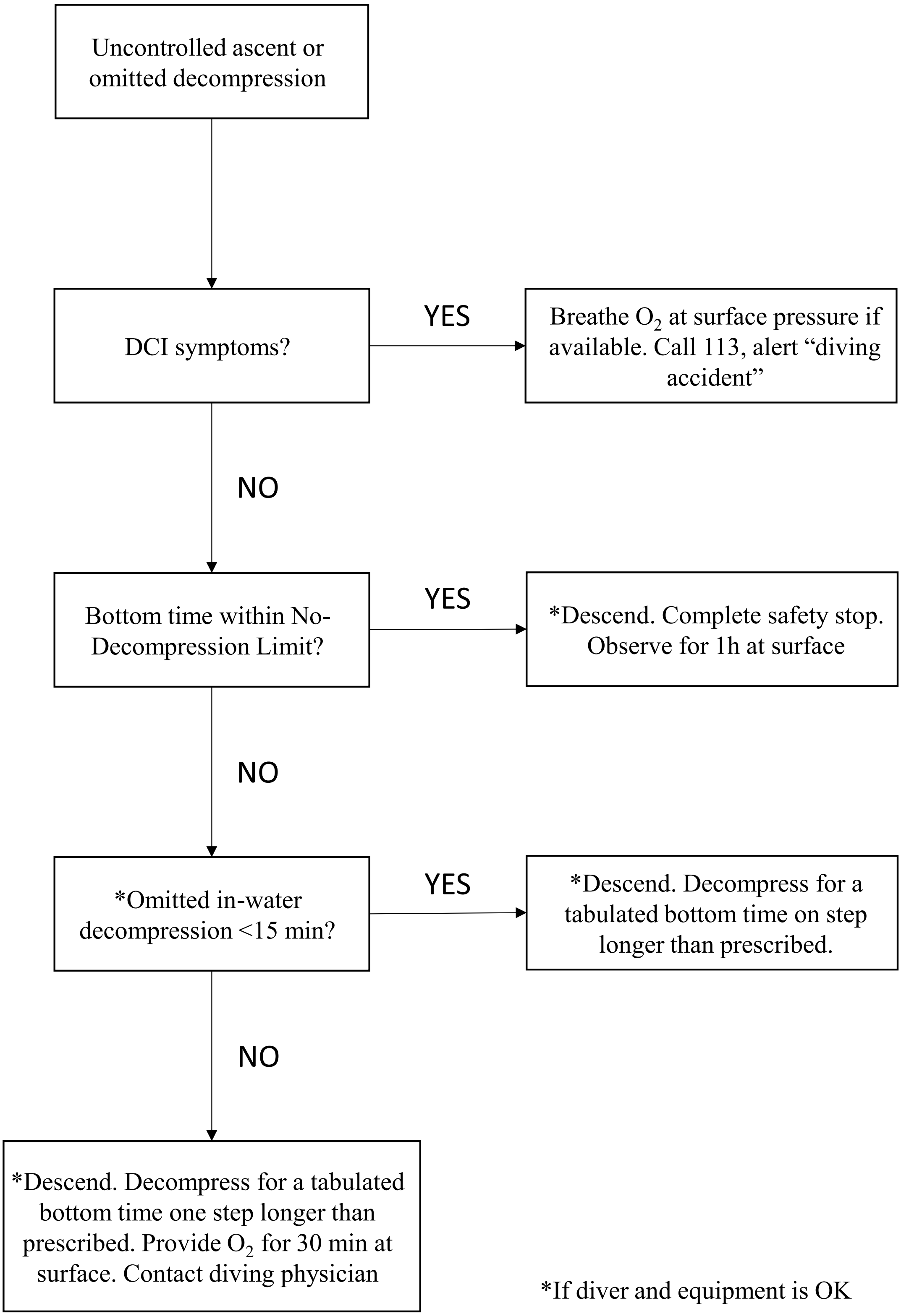
Emergency Procedures – Omitted Decompression or Uncontrolled Ascent

Chamber and oxygen available on dive site



Emergency Procedures – Omitted Decompression or Uncontrolled ascent

Chamber or oxygen not available on dive site



*If diver and equipment is OK

Form – Dive and Development of Symptoms

Patient name/DOB/phone number:		
Fill in data concerning ***the last dive*** the patient completed		
Date:	Time (hh:min) for start of dive	
Max depth (m):	Decompression stops (depth/time)	
Total dive time (min):	Safety stop (Yes/No)?	Date for last alcohol consumption before the last dive:
Breathing gas (Air/Nitrox/Heliox)		Was a dive computer used? If Yes – did it present any warnings?
Technical problems (cold, physical strain, equalization problems, uncontrolled ascent)?		
Date, time and flight leg for the first flight after the last dive:		How long time (hh:min) did it go after the last dive before the first symptoms appeared?
Describe the symptoms and how they developed. Was oxygen provided and did it affect the symptoms?		

If the diver has done multiple dives the last three days, then please provide details in agreement with the bold form on the preceding page. If time allows, it would be useful if you could state dive experience (number of years with diving, total number of dives, number of dives last 12 months) and other factors you may believe that could contribute to the symptoms. Other illnesses? Use of medication? Have you ever experienced anything like this previously?

Examination Checklist

Description
If there are multiple questions for the same subject and anyone is not "OK" then detail on the last page.
1-6: Give priority to this in cases of serious accidents or injuries
7-9: Usually completed only once and is most relevant when the medical history or symptoms call for follow-up.
10-18: Neurological examination to disclose neurological injuries (spinal or cerebral DCS). These examinations may be necessary to repeat while waiting for medical evacuation or during recompression treatment).

<table>
<tr><th rowspan="2">No</th><th rowspan="2">Topic</th><th rowspan="2">Description</th><th colspan="2">OK</th></tr>
<tr><th>Yes</th><th>No</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Level of consciousness</td><td colspan="3">Repeat this assessment every 5.-10. min until other instruction is given by health professionals.</td></tr>
<tr><td>Does the patient speak spontaneously, and does he respond appropriately when spoken to?</td><td></td><td></td></tr>
<tr><td>If the patient does not speak spontaneously or respond when talked to: Pinch a fingernail. Does he/she react to pain?</td><td></td><td></td></tr>
<tr><td>2</td><td>Airways</td><td>If the diver doesn't respond when spoken to: Assess airways: Loosen neck dam. Ensure that no other object is tightening the neck. Extending the neck and protrude the cheek. Visually inspect the mouth for foreign bodies.</td><td></td><td></td></tr>
<tr><td rowspan="5">3</td><td rowspan="5">Breathing/ respiration</td><td colspan="3">Repeat this examination every 5.-10. min until other instruction is given by health professionals.</td></tr>
<tr><td>Is the patient breathing?</td><td></td><td></td></tr>
<tr><td>Is the breathing rate 10-30 /min?</td><td></td><td></td></tr>
<tr><td>Is he breathing regularly?</td><td></td><td></td></tr>
<tr><td>Is the depth of breathing (assess chest movement) normal?</td><td></td><td></td></tr>
<tr><td rowspan="4">4</td><td rowspan="4">Pulse (circulation)</td><td colspan="3">Repeat this examination every 5.-10. min until other instruction is given by health professionals.
Initially search for pulse in the wrist. If you can"t find it search in front of the oblique neck muscle</td></tr>
<tr><td>Is the pulse 50-80?
Frequency</td><td></td><td></td></tr>
<tr><td>Do you feel the pulse with normal strength?</td><td></td><td></td></tr>
<tr><td>Is it regular?</td><td></td><td></td></tr>
<tr><td>5</td><td>External injuries</td><td>Wounds/lesions? Bleeding? Discolouration of skin/ bruises? (Check "no" if any findings here)</td><td></td><td></td></tr>
<tr><td>6</td><td></td><td colspan="3">May be difficult to assess outdoor, particularly if a diving suit is worn.</td></tr>
</table>

No	Topic	Description	OK	
			Yes	No
	Skin temperature and colour	Is the skin temperature normal?		
		Is skin colour normal?		
7	Rashes	Describe the pattern, body distribution and colour of the rash. Are areas of the skin raised or appear marbled? ("Marbling" shows as thin blue lines forming a pattern). Use your mobile telephone and take pictures but avoid getting too close – the images frequently get too blurry then.		
8	Pain	Describe any pain and learn the exact location and extent of local pain. Is the pain made worse by applying external pressure?		
9	Joint pain	Does the pain increase or diminish when the joint is flexed or held in certain positions? Ask the patient whether any area is tender for direct pressure.		
10	Gait	Have the patient walk and turn with his eyes open and look for any usual gait or imbalance. Ask him to walk on his heels and then toes. Look for weakness. Is the diver able to walk on a straight line heel to toe without sidesteps?		
11	Muscle strength	Check for normal muscle strength by comparing handshake and resist the movements (shoulders, elbow, wrist, hip, knee, ankle). Look for any differences in strength between opposing limbs.		
12	Speed	Have the patient beat his chest as quickly as possible for 5-10 sec. Let him/her beat his thigh as quickly as possibly – alternating with the palm and back of the hand. You want to look for speed, equal performance and fluency of movement.		
13	Co-ordination	Have the patient close his eyes and then move one hand to touch the tip of his nose with his index finger (he/she should be able to find the nose tip). A similar co-ordination test may be performed by trying to make the heel touch the opposite knee and follow the (tibia) bone with a smooth movement. Repeat on the opposite change.		

No	Topic	Description	OK	
			Yes	No
14	Balance	Be prepared to support the patient so he doesn't fall during this examination! Let him stand upright, feet together, arms along the side, open eyes. Look for poor balance or unusual swaying and especially, a tendency to lean or to one side or topple. Repeat with closed eyes. Is he swaying significantly more with closed eyes?		
15	Skin sensitivity	Check for skin sensitivity by touching the patient in various areas of the feet, arms, body and face. Touch on both sides and ask for different sensation (left versus right). Look for differences at various levels (head to toe).		
16	Vision	Do both pupils appear to be of similar size? Cover one eye and ask the patient whether he can see clearly (use a small object at 5-6 m distance); then cover the other eye and repeat the test. Ask the patient to follow your finger as you slowly move it in a "H" pattern in front of him. Check for fluent, parallel eye movements as the patient fixes his eyes on the moving finger. Double vision or any uncontrolled movements (nystagmus) in any direction?		
17	Hearing	Place yourself behind the patient and lightly scrub two of your fingers outside the patient's ear. Does he hear this approximately equally?		
18	Fistula-test	Only if the diver is complaining of vertigo, tinnitus or reduced hearing. Place yourself in front of him. Ask him to equalize carefully. Do the symptoms worsen? Can you observe uncontrolled or jerky eye movements (Nystagmus)?		

Write date, time and findings below. For serious accidents you should make a note of level of consciousness, pulse and respiratory rate every 5-10 min.

Phone list

Name	Phone no.

Notes

Notes

Procedures In the Case of Omitted Decompression or Uncontrolled Ascent

EQUIPMENT	INCIDENT	ACTION
Recompression chamber	DCS symptoms	TT 6, Call 113, alert "diving accident"
	Uncontrolled ascent, no-decompression dive or omitted staged in-water decompression stop, ***SurD-O_2***	TT 5
	Uncontrolled ascent, no-decompression dive, ***Standard air table***	Descend, complete safety stop, observe for 1h at surface
	Omitted staged in-water decompression <15 min, ***Standard air table***	Descend, extend decompression with one bottom time longer than required. Observe for 1h at surface.
	Omitted in-water decompression >= 15 min, **Standard air table**	TT 5
Oxygen	DCS symptoms	Breathe O_2, call 113, alert "diving accident"
	Uncontrolled ascent, no-decompression dive	Descend, complete a safety stop. Observe for 1h at surface
	Omitted staged in-water decompression <15 min	Descend, extend decompression with one bottom time longer than required. Observe for 1 h at surface.
	Omitted staged in-water decompression >=15 min	Descend, extend decompression with one bottom time longer than required. Breathe O_2 for 30 min at surface. Contact diving physician
Nothing	DCS symptoms	Call 113. Alert "diving accident".
	Uncontrolled ascent after no-decompression dive or <15 min omitted in-water decompression	Descend, extend decompression with one bottom time longer than required (alternatively complete a safety stop if this was a no-decompression dive). Observe for 1h at surface
	Uncontrolled ascent >=15 min omitted in-water decompression	Call 113. Alert "diving accident", request contact with a diving physician.

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