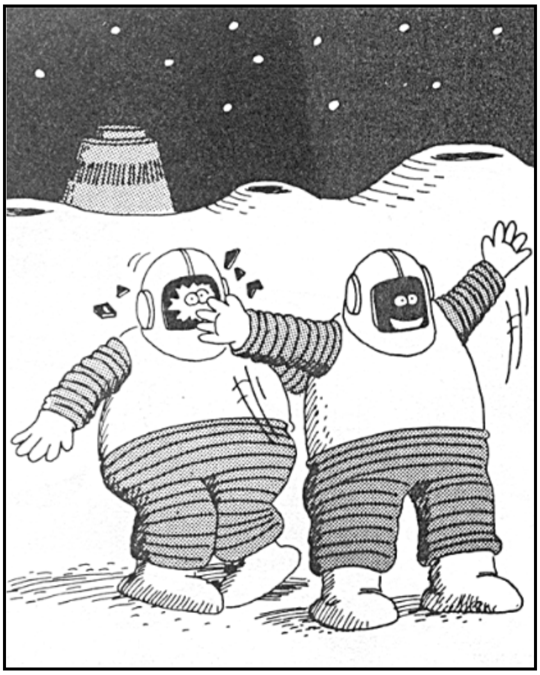
Section 5 — Manage Risk



"We've made it, Warren…The Moon!"[1]

[1] Copyright © The Far Side, Last Impressions, 2002, Larson. (Stolen and used without permission!)

i

CONTENTS

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

1 CHAPTER 1 – INTRODUCTION

INTRODUCTION

ADAS COMPETENCY

Manage risk associated with dive operations.

Apply risk controls for general diving risks.

Undertake site and task-specific risk assessment and select appropriate risk control measures.

Apply standard air, surface decompression and therapeutic tables in planning and conducting dive operations.

Undertake contingency planning.

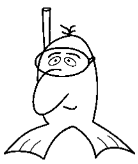
GENERAL

A huge component of the dive supervisor's job is managing the risk associated with diving. There are several components to managing risk for diving operations. The concept of risk can be applied to a range of things, such as business risk, contract risk, financial risk, insurance risk and OHS risk.

The employer is concerned with the full range of risk, and as the employer's representative at the dive site, you are to some extent also responsible for many components of risk – not just health and safety. A good dive supervisor will get the job done on time and on budget – this protects the employer from being exposed to business, contract and financial risk. A good dive supervisor looks after equipment and ensures records are kept accurately– this protects the employer from being exposed to insurance risk and legal liability risk. The way a dive supervisor achieves this is by thorough planning and appropriate supervision.

OHS RISK

However, our primary risk focus as a dive supervisor is to manage the health and safety risk of the dive operation. This consists of two types of risk. One is general diving risk. This is controlled primarily by technical training and knowledge. The other type of health and safety risk is specific to a particular dive operation and is related to planning and supervision.



The difference between these two types of risk is what differentiates the technical diver from the supervisor. A diver should have a good knowledge of how to manage the general component of risk. Experience consolidates and enhances this ability. However, do not confuse good technical knowledge of the general risks with the requirements for managing risk as a supervisor.

To manage the full range of risks of a dive operation properly needs good planning and supervision. Without a rigorous dive planning approach and application of good supervisory techniques, the safe and effective outcome of a dive operation depends solely on the technical skills and experience of the dive team. With luck, your team will live to see another day. If luck is not with you, lack of planning and supervision could have fatal consequences.

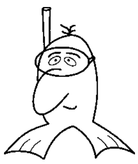
We have separated this chapter on managing risk into a section on general risk management, and then into these categories of general risk controls for the health and safety of the diver (section 3) and specific risk controls for hazard management related primarily to planning (sections 4, 5,6 and 7). We will look at detailed supervision aspects in later chapters.

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

2 CHAPTER 2 – MANAGING RISK

RISK MANAGEMENT STANDARD



There is a generic Risk Management Standard, AS/NZS4360, for managing all types of risk. The figure following shows the general concept of managing risk in a graphical manner. The steps are to identify risks, assess risks and control risks. At every step, there should be communication and consultation with all staff and, if necessary, with outside experts. The risk controls should be constantly monitored and reviewed for effectiveness. It is also important to monitor continuously the actual hazards or risks for any changes in circumstances that may increase the level of risk.

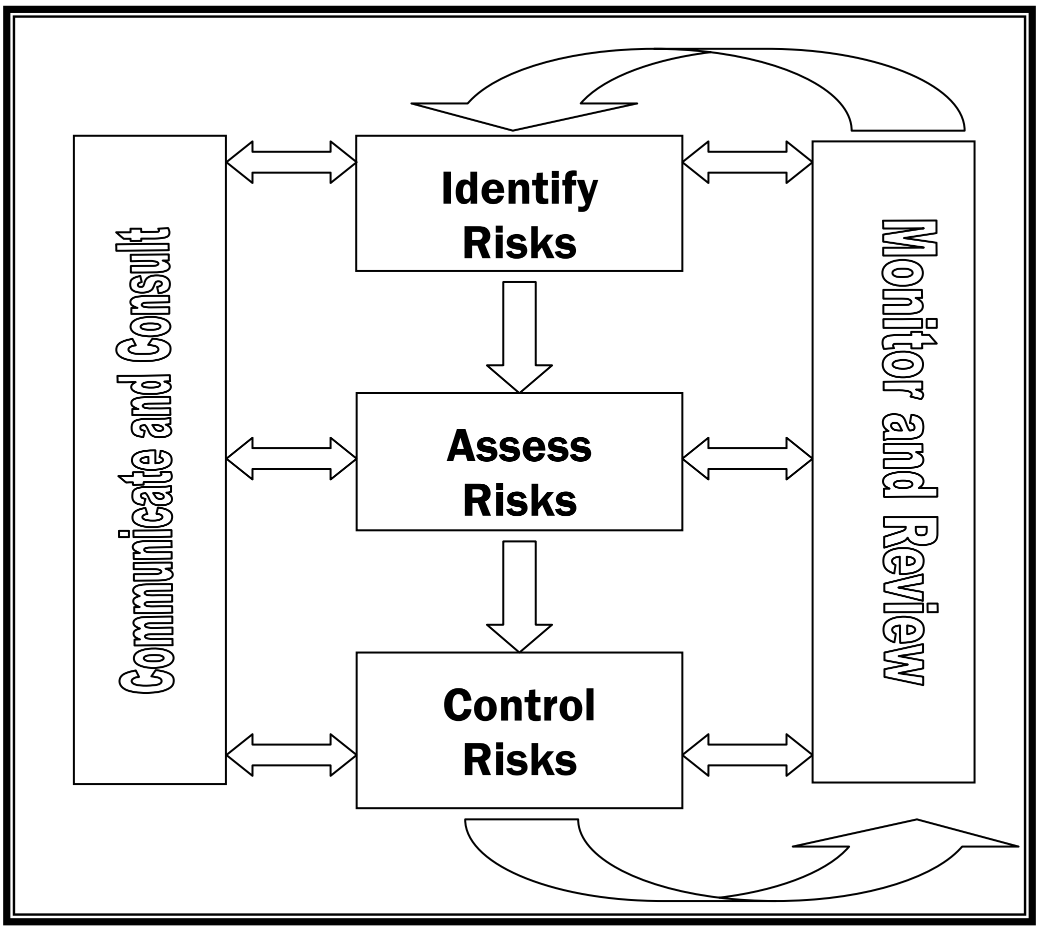
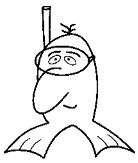


Figure 1: Managing Risk

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

OHS RISK/HAZARD IDENTIFICATION

GENERAL



In Australia, legislation adopts a risk management approach. In New Zealand, legislation adopts a hazard management approach[2]. We have used the terms risk and hazard interchangeably for identification for OHS risk.

There are a number of ways to identify risks or hazards[3]. Some of the methods you can use to do this are:

- ✔ talk to people familiar with the tasks,
- ✔ inspect the workplace (use a checklist, or do a "walk-through" inspection),
- ✔ examine incident or accident records (look at published statistics for other organisations as well),
- ✔ obtain expert advice or information,
- ✔ analyse the job or task,
- ✔ use formal analysis methods (see AS/NZS 3931), and
- ✔ brainstorm the hazard (use "what if?" questions).

OHS RISK/HAZARD ASSESSMENT

The simplest approach to analysing and evaluating risk generally involves obtaining subjective judgements on the consequence or impact of a particular hazard and the likelihood of it occurring from a variety of different people. Sometimes it is possible to obtain objective data such as injury statistics to give a quantitative measure of likelihood of injury or death.

The final risk assessment must be made by a "competent person". If you feel that you do not have sufficient knowledge to make an appropriate risk assessment, make sure that you consult someone who does – this may even be an outside consultant or industry expert.

OHS RISK/HAZARD CONTROL

After identifying a hazard and assessing the risk, you then need to come up with a range of options to control the risk or hazard. This usually involves either reducing the likelihood of the hazardous event occurring or reducing the consequence if the event occurs.

Once you have come up with a number of risk control options, you will need to make a decision on the best option or combination of options. This will usually be constrained by things such as cost, convenience, and time available. Sometimes it may be necessary to implement an interim set of controls – for example, in a situation where a design or engineering modification is needed which takes some time.

Controls can be categorised and ranked in order of preference. This is commonly known as the hierarchy of controls. There are a number of variations in how this is presented, generally

---

2 AS/NZS 4804:2001 p vii.

3 Source: Adapted from AS/NZS 4804:2001, p. 26.

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

with anything from three to six levels. However, the concept is the same, in that the preferred option is at the top of the hierarchy (elimination) and the least preferred option at the bottom of the hierarchy (personal protective equipment). See the figure "Hierarchy of controls" for the six-tier version of the hierarchy.

Figure 2: Hierarchy of Controls

When selecting risk controls, you attempt to select one that is closest to the top of the hierarchy, or use a combination of controls from different levels of the hierarchy. For example, when preparing to work near an outlet pipe from a dam where there is a suction hazard, you may select to combine the following risk controls:

✔ Engineering control – isolation valve to stop flow; put protective steel barrier in front of pipe inlet.

✔ Administrative control – tag and lock the valve; do not allow the diver to go within a certain distance of the pipe.

✔ Personal protective equipment – attach a lifeline to the diver.

Where the hazard is significant or the consequence severe, never rely on only one form of protection. If it is particularly hazardous to dive, consider the option of not diving at all.

Once you have selected the appropriate risk controls, re-do the risk assessment to ensure that the risk is reduced to an acceptable level and that no new hazards have been introduced. The concept of acceptable risk is somewhat subjective and depends on the current state of knowledge within the industry, and the cost and accessibility of risk control methods. The term ALARP – "as low as reasonably practicable" is often used in discussing the level of risk acceptable.

From a practical point of view, the dive supervisor manages risk on a daily basis by implementing risk controls that fall into the categories of supervision, planning, training, procedures and equipment.

3 CHAPTER 3 – GENERAL RISK CONTROLS FOR WORKING UNDERWATER

INTRODUCTION

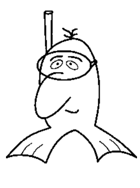
To manage the general aspects of risk for divers, you need to have a solid understanding of the risks of taking the human body into an underwater environment. This means applying the knowledge gained through having a sound understanding of physics and physiology to reduce the risk.

For this, you will need to know the risk control measures used to minimise the risks to the diver for the following situations:

- ✔ Increased pressure on body systems
- ✔ Changing volumes of gases under changing pressures and temperatures
- ✔ Increased heat transfer, sound transmission and poor visibility underwater

RISK CONTROL MEASURES FOR THE EFFECTS OF GAS BEHAVIOUR UNDERWATER

Virtually all the risks associated with the underwater environment are related to the behaviour of gases in changing pressures and their effects on body systems, and interruptions to the respiratory system and circulatory system (loss of air, inadequate oxygen in the blood stream, or inappropriate concentrations of breathing gases in the blood stream).



Risk control measures are shown in the table below, along with the required action by the dive supervisor to ensure that the risk control measures are applied.

BROAD CATEGORY	RISK CONTROL MEASURE	ACTION BY DIVE SUPERVISOR
Training	Comprehensive training in diving techniques	Check qualifications and training of all dive personnel.
	Being medically fit to dive	Check medical fitness to dive certificates.
	Comprehensive first aid training of dive supervisor and divers	Ensure first aid training is current for self and others.
	Diver medical technicians on-site for certain dives	Ensure availability of trained diver medical technician if required on-site.

BROAD CATEGORY	RISK CONTROL MEASURE	ACTION BY DIVE SUPERVISOR
Equipment	Maintenance and care of equipment	Have regular maintenance schedules and have maintenance carried out by trained and qualified personnel.
	Use of compression chambers	During planning phase, ensure availability of compression chamber on-site if required. Ensure adequate access to compression chamber off-site.
Planning	Dive planning	Take care in collecting all relevant information on the dive requirements, the dive site, the possible hazards, the equipment requirements and the experience and qualifications of personnel. Write the dive plan down, including contingency plans, and communicate to all dive personnel.
	Planning dive depth and bottom time	Use reputable tables showing recommended decompression schedule.
	Maintaining adequate safety margins in breathing supplies and bottom times	Calculate breathing air supplies using maximum expected breathing rate and maintain conservative safety margin.
Supervision	Pre-dive and post-dive checks	Use adequate checklists, use properly and supervise correct use.
	Controlling depth of dive	Use reliable techniques to measure water depth prior to the dive and during the dive.
	Controlling rate of ascent and descent with constant breathing (no breath holding)	Use lazy shot or shot lines to control ascent (do not allow divers to use buoyancy vests or to ride the load when lifting). Use recommended ascent rates.
	Use of standby divers	Use standby divers as required by AS2299.1:1999.
	Not flying within 48 hours of diving	Reiterate during briefing and debriefing. Ask divers if they intend to fly after diving.
	Not diving under the influence of alcohol or narcotics	Do not allow alcohol on-site. Reiterate in briefings that no alcohol or narcotics to be used within 8 hours of diving. Ask and observe whether any diver has consumed any intoxicating substances within the previous 8 hours.

Figure 3: Table of risk controls for underwater environment

RISK CONTROL MEASURES FOR BUOYANCY

The following table shows the risk control measures for buoyancy issues and the actions required by the supervisor to ensure these risk control measures are applied.

BROAD CATEGORY	RISK CONTROL MEASURE	ACTION BY DIVE SUPERVISOR
Equipment	Weight belts	Ensure weight belts used are appropriate – correct weight and quick release.
Training	Buoyancy vest	Ensure adequate training in controlling the rate of ascent by dumping air from vest.
Training	No lifting using buoyancy vest as lifting mechanism	Ensure lifting device is separate from the diver and do not allow the diver to use buoyancy vest as lifting mechanism, even for small objects. (If they are dropped, ascent can become rapid and uncontrolled.)
Training, equipment, planning, supervision	Control rate of ascent when lifting	Ensure lifting devices using air are sized appropriately and have a means of letting air escape.

Figure 4: Table of risk controls for buoyancy

RISK CONTROL MEASURES - INCREASED HEAT TRANSFER, POOR VISIBILITY & SOUND

The following table shows the risk control measures for increased heat transfer, poor visibility and sound transmission and the actions required by the supervisor to ensure these risk control measures are applied.

BROAD CATEGORY	RISK CONTROL MEASURE	ACTION BY DIVE SUPERVISOR
Equipment, planning	Suitable protective suit	Take water temperature, depth and length of dive into account when selecting the suit to be worn by the diver. Ensure diver wears appropriate ancillary equipment such as a hood if applicable.
Planning, supervision	Controlling the length of the dive	Take the water temperature and the task requirements into account when planning the length of the dive.
Planning, supervision	Availability of shelter and warm clothing on surface	Ensure shelter and warm clothing is available on the surface and monitor its use.
Supervision	Briefing	Remind divers of the importance of staying warm when they can.

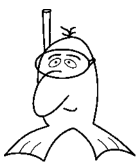
BROAD CATEGORY	RISK CONTROL MEASURE	ACTION BY DIVE SUPERVISOR
Planning, equipment	Underwater lighting	Ensure availability of both primary and secondary underwater lighting.
Planning, supervision	Time of day	For shallow dives, dive during daylight hours, and avoid night dives unless essential.
Planning	Eliminate unnecessary sources of noise	Wherever possible organise to eliminate unnecessary sources of noise – for example restrict private boating activity if possible.
Training, supervision	Divers not to be in water during detonation of explosives	Maintain overall supervision of explosives activity. Ensure all divers leave the water for detonation of explosives.

Figure 5: Table of risk controls for heat transfer, visibility and sound transmission

4 CHAPTER 4 – MANAGING RISK FOR A SPECIFIC DIVE OPERATION

INTRODUCTION

The second component of risk management is to manage the risks associated with a specific dive operation. This requires planning and supervision. The next four sections look at the planning aspects of managing risk. Overall dive planning, including the task aspects, is covered in the next chapter.



You need to identify and address the specific hazards present at a particular dive site and associated with a particular task. This means you need to be able to collect and organise information and make a judgement of what should be done to keep the risk as low as reasonably practicable. You need to be able to organise this information into a dive plan that clearly defines how the risks will be controlled and what will happen if anything goes wrong.

This includes being able to:

✔ undertake site and task-specific **risk assessment** and select appropriate **risk control** measures,

✔ use standard air, decompression and therapeutic tables appropriately, and

✔ undertake **contingency** planning.

Generally, the diving operations manual of the company will have documented procedures covering well-known or commonly used dive sites and common jobs. These should include both the risk assessments and the contingency or emergency plans.

In this instance, you will need to decide whether the job you are doing is the same, or whether there are some differences that change the risk. Even a small difference can make an enormous difference to the risk. Remember the o-ring on the space shuttle? An o-ring failed, which caused an explosion 73 seconds after lift-off in which seven people lost their lives. The cause of the explosion was determined to be an o-ring failure. Cold weather was a contributing factor.

What might have changed that could contribute to a problem at your dive site?

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

5 CHAPTER 5 – ADAS RISK ASSESSMENT TEMPLATE

INTRODUCTION

ADAS has developed a set of instructions for all staff and students during all dive operations. The ADAS template was specifically developed for diving and for use on a dive site. It offers ease of use and a clearly defined hazard identification and risk assessment method, which provides clear demarcation as to when a risk is unacceptable and needs further controls.

The risk assessment procedures outlined in the section are used by all ADAS staff and students during all diving operations. These risk assessment procedures form the basis of a simple to use risk assessment program that divers can apply in industry.

DEFINITIONS

HAZARD[5]

A hazard is something with the potential to harm and includes substances, machinery, methods of work and other aspects of work organisation.

RISK

Risk expresses the likelihood of that harm from a particular hazard and the consequences of that risk i.e. its severity.

RISK ASSESSMENT

Risk assessment may be defined as the identification of the hazards present in an undertaking and an estimate of the extent of the risks involved, taking into account whatever precautions are already being taken. It is essentially a three-stage process:

- ✔ identification of the hazards,
- ✔ evaluation of the risks, and

[5] Note that there are a number of definitions in common use. Although the wording varies slightly the principles are the same.

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

✔ measures to control the risks.

It should not be necessary to repeat the complete assessment if the job and circumstances are comparable. However, as diving is usually exposed to changeable environmental conditions, certain portions of the risk assessment will need to be reviewed immediately before and during each diving operation.

Risk assessment cannot be expected to cover risks that were not reasonably foreseeable[6].

EVALUATION

RISK ASSESSMENT

In a dive team, the worker most likely at risk is the diver and therefore the risk assessments relate directly to the in-water divers. **Separate risk assessment should be carried out for the surface workers**.

The evaluation of risks is done based on a probability of the occurrence multiplied by the severity of the occurrence. This is termed a risk rating.

PROBABILITY SCALE

RATING	PROBABILITY
6	Almost Certain – Usually occurs
5	Likely Frequent – expected, occurs repeatedly
4	Probable – not surprised, will occur several times
3	Possible – could occur sometimes
2	Remote – unlikely, though conceivable
1	Improbable – so unlikely, the probability is close to zero

SEVERITY SCALE

RATING	SEVERITY
6	Extreme – multiple deaths
5	High – death
4	Moderate – major injury
3	Low – over 3 day injury
2	Very Low – under 3 day injury
1	Not significant – no significant injury

On this basis, risk assessment will range from a score of 1 to a maximum score of 36.

6 When the likelihood of mishaps can be predicted they are foreseeable and employers have a duty to prevent them – Source: The General Duty of Care in Western Australian Workplaces, Worksafe WA Commission

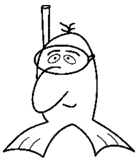
First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

RISK RATING TABLE

		HAZARD — SEVERITY					
RISK — PROBABILITY OF OCCURRENCE		6	5	4	3	2	1
	6	36	30	24	18	12	6
	5	30	25	20	15	10	5
	4	24	20	16	12	8	4
	3	18	15	12	9	6	3
	2	12	10	8	6	4	2
	1	6	5	4	3	2	1

RISK RATING



NOTE: If a Risk Assessment produces a risk rating of greater than 9 (area in white), **no diving will take place** until control measures are introduced to reduce the risk.

TYPES OF CONTROL

USE IN ORDER OF SEVERITY

TYPE OF CONTROL	DESCRIPTION
Elimination	Remove the hazard. Where this cannot be achieved, or where another control cannot be put in place that substantially reduces the risk, no diving will take place.
Substitution	Use alternative working method.
Separation[7]	Divers should be isolated from the hazard.
Design[8]	Design plant and procedures to minimize the risk.
Procedures and Training[9]	All divers must be thoroughly trained in work procedures that offer the greatest safety.
Personal protective equipment	Many items of diving equipment fall into the PPE category – mask, wetsuit, breathing equipment etc.

EXAMPLES OF CONTROL

TYPE OF CONTROL	DESCRIPTION
Suction	Elimination, close down the suction force.
Cold Water	Substitution, replace wetsuits for dry or hot water suits.

---

7 Also known as isolation

8 Also known as an engineering control

9 Training is an administrative control and is a requirement under OHS legislation

TYPE OF CONTROL	DESCRIPTION
Blue Green Algae	Separate the diver from the hazard with dry suit and lock on helmet. Use decontamination procedures.
Current	Design, harness and lifeline's, shelter, double exhaust valves, limited travel.
Cutting explosion	Training to ensure the diver avoids gas pockets.

STANDBY DIVER RISK ASSESSMENT

The following selection table for standby diver requirements is an example of a predetermined set of controls based on the risk rating.

CONTROLS	IN ORDER OF SEVERITY
36	Fully qualified and experienced standby diver in the water
30	Fully qualified and experienced standby diver on surface. One per diver
28	Fully qualified and experienced standby diver on surface. One per buddy pair
24	Trained and assessed standby diver with qualified experience standby @ 2min readiness per buddy pair
20	Trained and assessed standby diver with qualified experience standby @ 2min readiness for two buddy pairs working in same vicinity
16	Trained and assessed standby diver per buddy pair
12	In-water buddy pair plus surface standby at 1min readiness
8	In-water buddy pair only
3	No surface standby (AS2299)
RISK FACTORS	
Depth	0-10 (2) 10-20 (3) 20-30 (5) 30-50 (6)
Visibility	Nil (6) 1m (5) 2-5m (3) 5+ (2)
No direct access to buddy	6
No direct access to surface	6
Scuba only	4
Buddy not always within visibility	4
Entanglement potential	1 to 6
Work tasks	1 to 6
No in water buddy	6
Gross inexperience	6
No voice monitoring	6

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

METHOD
Multiply the highest scores to get total score e.g. nil vis in 50m = 6 x 6 =36 (highest score). Select appropriate control from control list. e.g. ideal conditions 0-10m – scuba – 5m + vis = 8 (in water buddy only)

HAZARD ISOLATION

Where hazards are not under the direct visual supervision of the dive supervisor they must be isolated. This isolation should, where possible, be completed in three ways; Visual, Mechanical, and Electrical. For example, an electric pump can have the fuses removed; a stop valve closed and can be tagged with a danger tag.

THE RISK ASSESSMENT

Location Date / / .

Structure

Job Description

ENVIRONMENTAL FACTORS	PROBABILITY	SEVERITY	COMMENTS AND CONTROLS
Wind			
Current/tide			
Visibility			
Maximum depth			
Water temperature			
Atmospheric temperature			
Time of day			
Underwater terrain			
Contaminants/biological hazards			
Entrapment hazards			
Isolation – remote sites			
Floating hazards			
Dangerous marine hazards			
Noise			
Sea state			
Sun/ice			
Altitude			

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

TASK RELATED FACTORS	PROBABILITY	SEVERITY	COMMENTS AND CONTROLS
Cutting			
Welding			
Dredging			
Explosives			
Inspection			
Overhead environments			
Cranes/winches/cables/rigging			
Airlifting			
Hydraulic/pneumatic tools			
Search patterns			
Reservoir cleaning			
Unstable structures			
Boat handling/unguarded propellers			
Shipping movement			
Manual handling			
Water pressure differentials/suction			
Entrapment			
Electric currents			
HP Jetting			
Sonar			
Entry and exit methods			
Sufficient trained personnel			
Lifeline entanglement			
Dive profiles			

HYPERBARIC/PHYSIOLOGICAL FACTORS	PROBABILITY	SEVERITY	COMMENTS AND CONTROLS
Barotrauma descent			
Barotrauma ascent			
Decompression illness			
Hypothermia			
Hyperthermia			
CO poisoning			
CO_2 poisoning			
Narcosis			
O_2 toxicity			
Drowning			
Exhaustion			
Cross infection			

PRE AND POST DIVE FACTORS	PROBABILITY	SEVERITY	COMMENTS AND CONTROLS
Pre-dive fitness			
Dehydration			
Drugs/alcohol			
Exercise			
Sleep deprivation			

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

6 CHAPTER 6 – ADAS JOB SAFETY ANALYSIS – JSA GUIDELINES

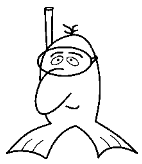
JOB SAFETY ANALYSIS

■ GENERAL

ADAS also has guidelines for undertaking a job safety analysis. A job safety analysis is simply another approach to undertaking a risk assessment and is particularly useful for large or complex tasks.

Job Safety Analysis (JSA) is a process where hazards associated with each step of a job are identified and control measures are put in place to minimise the risk to personnel, environment and property.

The hazard identification step shown below uses a more generic list of "prompts", than the one shown in the previous section, which was specific to diving operations. This list may be useful in considering components of a large job that are not specific to the dive site. For example, transport of equipment to the site.



■ STEPS OF A JSA

The steps in conducting a JSA are:

✔ Select the job to be analysed

✔ Break the job into logical steps

✔ Identify the hazards in each step

✔ Develop risk elimination or reduction measures for the hazards identified

✔ Record the JSA on the standard forms

✔ Review and update the JSA

■ DEVELOPING A JSA

When developing a JSA consider the following:

✔ What?

✔ Why?

First Edition — December 2003; Revision (0)

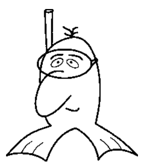
REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

- ✔ When?
- ✔ How?
- ✔ Where?
- ✔ Who?

For example:

- ✔ What exactly am I going to do? Identify and briefly describe the job.
- ✔ What materials will I be dealing with or handling? E.g. chemical, biological, weight, size?
- ✔ What tools and equipment will I be using?
- ✔ When will the job be done? Day/night, time of the year?
- ✔ How might the job affect other: people/activities/equipment?
- ✔ How the job might be affected by other: people/activities/equipment?
- ✔ Where will the job be done? At height, confined space, remote location?

THE STEPS OF A JSA



■ STEP 1 – WHAT TYPES OF JOBS SHOULD HAVE A JSA?

Selecting a job to be analysed:

- ✔ Jobs that have a history of, or a potential for injury or incidents
- ✔ Safety critical tasks
- ✔ New jobs
- ✔ Jobs that have changed
- ✔ Jobs when new personnel are performing the task

■ STEP 2 – BREAK THE JOB INTO LOGICAL STEPS

Identify simple steps and the sequence they are to be performed. Generally limit to less than ten steps.

■ STEP 3 – IDENTIFY THE HAZARDS IN EACH STEP

Consider the following physical hazards:

First Edition — December 2003; Revision (0)

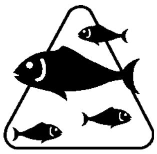
REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

PHYSICAL HAZARDS	PROBABILITY	SEVERITY	RISK RATING	COMMENTS AND CONTROLS
Pressure				
Electricity				
Chemicals				
Rotating equipment				
Vehicles				
Moving objects				
Height				
Depth				
Confined spaces				
Vibration				
Access				
Weather				
Hot/cold objects				
Noise				
Radiation				
Tools/equipment				
Weight of objects				
Bacteria				
Hydrocarbon / Gas release				
Other				

Consider the following mechanisms of injury:

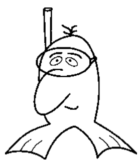
MECHANISM OF INJURY	PROBABILITY	SEVERITY	RISK RATING	COMMENTS AND CONTROLS
Struck by				
Caught in /on				
Strain / Overexertion				
Dropped objects				
Strike against				
Slip / Trip / Fall				
Inhalation				
Fire / Explosion				
Exposure to Gas / Heat / Fumes / Dust / Chemicals				
Other				

Consider other factors:



OTHER FACTORS	PROBABILITY	SEVERITY	RISK RATING	COMMENTS AND CONTROLS
Pollution to the environment				
Damage to equipment				
Human factors – i.e. competency, training, fitness, fatigue etc.				
Simultaneous operations				
Fellow employees				
Other				

■ STEP 4 – DEVELOP RISK ELIMINATION OR REDUCTION MEASURES



When determining risk reduction measures use the following "Hierarchy of Control"

- ✔ Elimination or substitution of the process/substance
- ✔ Engineering controls eg. Guards, mechanical aids
- ✔ Administrative controls, eg reducing exposure time, number of employees
- ✔ Personal Protective Equipment (PPE)

■ STEP 5 – RECORD THE JSA

Utilise the standard form under the headings:

- ✔ Step number
- ✔ Describe job steps
- ✔ Potential hazards
- ✔ Hazard management

■ STEP 6 – REVIEW AND UPDATE THE JSA

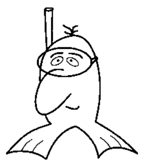
Review of the JSA should occur when:

- ✔ The task is completed
- ✔ Further hazards are identified
- ✔ The method of performing the tasks changes
- ✔ The task is undertaken again

7 CHAPTER 7 – STANDARD AIR, DECOMPRESSION AND THERAPEUTIC TABLES

WHY USE TABLES?

GENERAL



Tables have been developed as a method of controlling the risk associated with absorbing nitrogen into the blood at high pressures and then out-gassing at lower pressures. They are designed to give an easy way of deciding on appropriate and safe bottom times for the diver, or giving recommended decompression stops if the no decompression limit (NDL) is exceeded.

These are both different forms of risk control. Staying within the no decompression limit is effectively an elimination risk control – the hazard of bubbles in the bloodstream is eliminated (the amount of nitrogen absorbed should not be enough to cause bubble formation).

Decompression stops are effectively an administrative control – you are following a procedure to reduce the risk of bubbles forming (the amount of nitrogen absorbed is enough to introduce the hazard of bubble formation, but following strict procedures should reduce the risk).

Taken to the next level, surface decompression is, in a sense, the use of personal protective equipment (PPE). The diver ascends to the surface and is then encased in a piece of equipment (PPE) designed to re-pressurise his or her body and artificially reproduce the effects of doing in-water decompression stops.

It is an interesting case study on the importance of including some judgement on how the hierarchy of controls is applied. Strictly speaking, we would prefer a higher order control when selecting a risk control method. Personal protective equipment is at the bottom of the hierarchy. However, the risk of hypothermia or suffering psychological ill effects by staying in the water for an extended decompression stop may outweigh the risk of ascending to the surface and being at atmospheric pressure for a few minutes while being transferred to the chamber. By combining it with strict procedures (an administrative control), surface decompression becomes a viable option, with the risk assessed as sufficiently low to be safe.

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

MATHEMATICAL CONCEPTS

TABLES[10]

Diving tables are based on both mathematical decompression models and research into decompression illness or the actual formation of bubbles in the bloodstream in divers.

A diving table is only as good as the decompression model on which it is based. The DCIEM Tables are based on the model developed at the Defence and Civil Institute of Environmental Medicine in Toronto, Ontario, Canada. DCIEM — one of the world's leading aerospace and hyperbaric research centres — is a research establishment within the Department of National Defence.

Note that some tables are simply variations or derivations of the original tables developed by Haldane in the early 1900s. For an interesting discussion of the history and theory of decompression tables go to:

✔ http://www.mtsinai.org/pulmonary/books/scuba/sectionj.htm which has an online book by Lawrence Martin, M.D. Copyright 1997

There are various other tables in use, with a summary of some of the no decompression limits shown in the table below:

M	USN	DCIEM (1986)	Buehlmann	Bassett	BSAC '88	PADI RDP	NAUI
9	-	300	400	220	242	NA*	130
12	200	125	125	120	121	147	130
15	100	75	75	70	73	NA	80
18	60	50	51	50	50	56	55
21	50	35	35	40	36	NA	45
24	40	25	25	30	28	NA	35
27	30	20	20	25	22	NA	25
30	25	15	17	18	20	NA	22
33	20	12	14	15	15	NA	15
36	15	10	12	12	12	NA	12
39	10	8	10	10	10	NA	8
42	10	7	9	5	9	8	0

Figure 6: Comparison of tables * NA = No limit provided in tables for this depth increment.

If you look carefully through the table above and run along the rows for the various depths, you will notice that the US Navy No-Decompression Limit (NDL) is usually longer than the others are.

[10] This section based on modified extracts from The Underwater Centre Fremantle's course notes Pt 1-6.

The US Navy Tables were created to avoid DCI (not bubbles) in navy divers. It appears that the US Navy use its tables quite safely, but these navy divers, unlike many recreational divers, do not dive the tables to the limits nor do very much repetitive or multi-day diving. In addition, it has been reported that they add various safety factors to the tables.

Various researchers have used ultrasound to monitor divers diving to the US Navy No-Stop Limits. Some (Spencer, Bassett) have detected venous bubbles in about 30% of the divers tested and DCI in up to 8% of the divers. Therefore, if you dive to the US Navy limits, you will be quite likely to bubble and have a significant chance of getting DCI.

The Buehlmann (1986) and DCIEM Tables are both based on extensive research and experimentation. In the development of the DCIEM Tables, ultrasonic bubble detectors were used to monitor many of the experimental dives and the times have been chosen to minimise both DCI and bubbles.

The Bassett and PADI RDP limits evolved from ultrasound studies of a few divers diving to the US Navy NDLs (although PADI conducted a relatively large series of test dives to assess the extension of the limits to multi-level dives). The bottom times were systematically reduced until no bubbles were detected after the divers ascended to the surface at 18 m/minute.

It becomes obvious that the US Navy Tables should not be dived to the limit if bubbles and possibly DCI are to be avoided. The NDLs of the other tables are generally quite similar, which seems to indicate that they might be suitable for a diver in good condition. Presumably, the divers on which the tables were tested were reasonably fit and well before and during the test dives, so it is still advisable to reduce these NDLs to allow for predisposing factors to DCI.

In summary, DCIEM are the most conservative tables, especially at deeper depths, as they have been designed to avoid bubbles, not just symptoms.

EXPOSURE LIMITS FOR AIR AND NITROX DIVING[11]

As discussed, diving carries an inherent risk of decompression illness (DCI). The incidence of DCI drops if the length of time that a diver spends at any particular depth is limited. The depth/time limitations are reproduced in the Table below. Use of this table has resulted in a significant reduction in the incidence of DCI, and dive plans should incorporate these maximum time limits.

When breathing oxy-nitrogen mixtures with oxygen percentages higher than in natural air, the equivalent air depth should be established. This equivalent air depth should be used to establish bottom time limits.

The table below shows the maximum bottom time limitations for surface decompression (SD), in-water decompression and transfer under pressure (TUP) decompression diving.

In addition the table provides a comparison of no-decompression times, maximum bottom times in the normal air diving range (for dives above the limiting line), and total decompression times for both air and SurD diving. These are provided to assist supervisors planning diving operations. This table is not to be used instead of the recognised, published tables.

[11] Extract from *Commercial Diving Projects Offshore*, Diving at Work Regulations 1997, *Approved Code of Practice*, published by HSE Books.

Depth of Dive		Times in minutes or minutes::seconds									
		Maximum Bottom time limits (minutes) – Based on HSE / IMCA / DMAC Requirements		No Decompression Limits		Limiting Line Times (Maximum Normal Air Diving Range)		Total Decompression Times Air Diving for Dives up to the Maximum Bottom Time Limits		Total Decompression Times SurD O_2 Air Diving for Dives up to the Maximum Bottom Time Limits	
Metres	**Feet**	**TUP**	**SurD & In-water**	**USN**	**DCIEM**	**USN**	**DCIEM**	**USN**	**DCIEM**	**Modified USN**	**DCIEM**
12	**40**	240	**240**	200	150	270	180	12::20	26*	-	-
15	**50**	240	**180**	100	75	200	140	30::40	40*	-	-
18	**60**	180	**120**	60	50	120	120	28::00	36	-	38
21	**70**	180	**90**	50	35	100	100	25::20	37	50::20	38
24	**80**	180	**70**	40	25	80	80	25::40	37	49::40	38
27	**90**	130	**60**	30	20	70	60	28::00	41	50::00	45
30	**100**	110	**50**	25	15	60	55	29::20	41	50::20	42
33	**110**	95	**40**	20	12	50	55	26::40	37	48::40	40
36	**120**	85	**35**	15	10	40	50	34::00	38	53::00	41
39	**130**	75	**30**	10	8	40	45	25::20	37	49::20	41
42	**140**	65	**30**	10	7	30	45	30::40	46	52::40	48
45	**150**	50	**25**	5	7	30	40	26::00	40	51::00	44
48	**160**	55	**25**	5	6	25	35	20::40	49	54::20	50
51	**170**	50	**20**	5	6	25	35	24::40	38	51::40	

* These dives are below the limiting line on DCIEM tables and would therefore be unacceptable during diving operations.

> **Note:** Bottom time is the total elapsed time from when the diver is exposed to a pressure greater than atmospheric:
>
> ✔ when leaving the surface with an open device,
>
> ✔ on the start of pressurisation when a closed device is employed in the observation mode, and
>
> ✔ to the time (next whole minute) that the diver begins decompression (measured in minutes).

REFERENCE

See also DMAC 21: Guidance on the duration of saturation exposures and surface intervals between saturations Rev. 1.

DIVE COMPUTERS[12]

Multi-level diving is challenging to deal with using tables. To be able to calculate appropriate dive times, scientists developed algorithms that take into account changes in nitrogen uptake with continuous changes in depth. These algorithms were mainly theoretical models until the microchip revolution made them accessible and workable in a hand-held computer. When the algorithm is programmed into a computer that also senses depth (a simple depth gauge) and measures time, you have a "dive computer".

Using measurements of depth and time at depth, the computer calculates the nitrogen saturation and de-saturation of each compartment, and rapidly converts this information into a digital readout for the diver. Keeping track of multi-level diving is no problem for the computer. At the same time the computer performs other functions, such as tracking rate of ascent. Not all dive computers function alike, but most are able to provide the following information:

✔ During the dive

- ☞ Depth,
- ☞ Number of the dive (first, second, etc.),
- ☞ Time elapsed since dive began,
- ☞ How many minutes may be spent at current depth before a decompression stop becomes mandatory,
- ☞ Speed of ascent, and some type of message flashed if it is too fast, and
- ☞ Water temperature.

✔ After the dive

- ☞ Maximum depth reached,
- ☞ Length of time that can be spent at various depths on the next dive, and
- ☞ When it will be safe to fly (time to de-saturation.

Unlike printed tables, dive computers keep track of where you have been and for how long and thus give an accurate display of your dive profile.

So which is better? Some argue that the printed tables are safer because they assume an average depth greater than actually achieved on most dives, and therefore provide a greater margin of safety. This is true in theory. However, even if you went to the exact depth intended, the chance for making human error in calculating a repetitive dive is high. Finding the right designated letter group, determining surface interval, keeping an accurate record, etc., all leave much room for making mistakes. Even assuming you accomplished a square-wave dive, you are unlikely to match a computer for computation and record keeping.

Thus, repetitive, multi-level or deep diving should be safer with a properly used computer than with printed tables. This statement does not mean computers are "better" than tables. Computers make it easier for the typical recreational diver to keep track of the dive, and to stay within safe limits while, in many instances, also increasing bottom time.

For commercial divers, who have a properly trained and competent surface team monitoring their movements, diving based on tables is still the preferred method. Computers provide an excellent source of back up information for the diver, as long as they are used and maintained properly.

---

[12] This section on dive computers based on extracts from http://www.mtsinai.org/pulmonary/books/scuba/sectionj.htm accessed December 2002, *Scuba Diving Explained*, by Lawrence Martin M.D., 1997.

There is further information on the policy of the South Pacific Underwater Medicine Society (SPUMS) at http://www.spums.org.au/SPUMS_Policy_Dive_Computers.htm[13]

AIR DECOMPRESSION TABLES

BACKGROUND

When compressed air is breathed at depth, the inert nitrogen diffuses into the various tissues of the body. Nitrogen uptake by the body continues, at different rates for the various tissues, as long as the partial pressure of the inspired nitrogen is higher than the partial pressure of the gas absorbed in the tissues. The amount of nitrogen absorbed increases with the partial pressure of the inspired nitrogen (depth) and the duration of the exposure (bottom time).

When the diver ascends, the process is reversed as the nitrogen partial pressure in the tissues exceeds that in the circulatory and respiratory systems. The pressure gradient from the tissues of the blood and lungs must be carefully controlled to prevent a rapid diffusion of nitrogen. If the pressure gradient is uncontrolled, bubbles of nitrogen gas form in the tissues and blood, which can result in the development of decompression illness.

To prevent the development of decompression illness, special decompression tables have been established. These tables take into consideration the amount of nitrogen absorbed by the body at various depths for given periods. They also consider allowable pressure gradients, which can exist without excessive bubble formation, and the different gas elimination rates associated with various body tissues.

The set of air decompression tables presented here has been developed for Canadian Forces diving by the Experimental Diving Unit of the Defence and Civil Institute of Environmental Medicine (DCIEM). They are identical to those contained in the Canadian Forces Diving Manual. These tables provide a more conservative approach to decompression procedures than those currently published by the United States Navy and the Royal Navy, and are the Tables recommended by AS/NZS2299.1.1999.

DESCRIPTION OF DECOMPRESSION TABLES

STANDARD AIR DECOMPRESSION TABLE (METRES)

The DCIEM Air Diving Tables consist of the following tables:

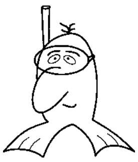
- ✔ Table 1 Standard Air Decompression
- ✔ Table 1S Short Standard Air Decompression
- ✔ Table 3 Surface Decompression with Oxygen
- ✔ Table 4A Repetitive Factors/Surface intervals
- ✔ Table 4B No-Decompression Repetitive Diving
- ✔ Table 5 Depth Corrections for Diving at Altitude

[13] (accessed December 2000)

GENERAL POINTS

This section consists of parts of Appendix F of AS/NZS2299.1:1999 Decompression Tables for Diving[14]. ADAS has chosen the "DCIEM Decompression Tables for Diving" for use during air diving operations to 50 metres.

USE OF TABLES



It is important to note that while the depths referred to in this text are given in metres (m) followed by the corresponding imperial depths in feet (ft) in parentheses, these imperial depths are approximations only and are not interchangeable as far as the decompression requirements in the tables are concerned.

The depth segments in Tables 1 and 3 are divided into two sections by a limiting line. This limiting line corresponds to the line dividing the "Normal air range" and "Exceptional exposure range" in the Figure below. In the shaded areas below each limiting line on the tables, highlight dive profiles that are in the "Exceptional exposure range".

Repetitive groups in Tables 1 and 3 are shown for dives within the "Normal air range" only, and are not shown for dives within the "Exceptional exposure range", since repetitive diving is not recommended in this range.

Although these procedures cover diving only to a depth of 50m (164ft), decompression schedules for depths up to 72m (240ft) have been included to allow for altitude corrections.

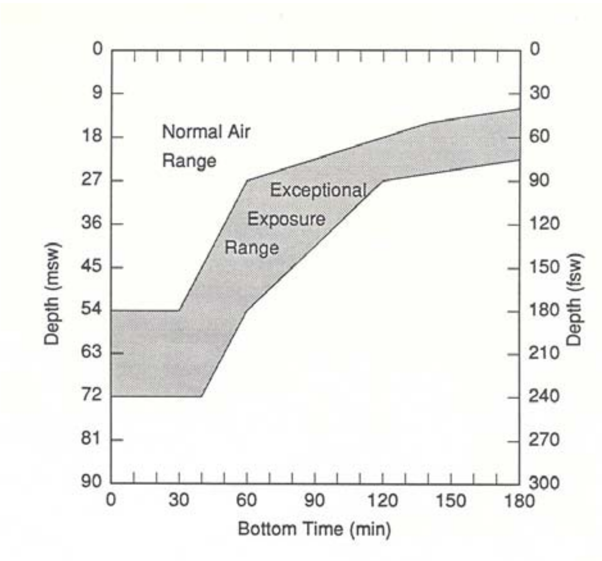


Figure 7: DCIEM Air Diving Limits

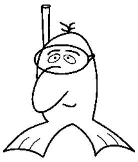
DEFINITIONS

The tables in this section may only be used in accordance with the following definitions.

> **NOTE:** Supervisors need to be aware that some variations exist in definitions between US Navy and DCIEM Tables i.e. stop times.

---

[14] Taken from the Appendix F of AS/NZS2299.1:1999 DCIEM Decompression Tables for Diving.



✔ ***Ascent rate***; a specified rate of travel that the diver has to maintain up to and between decompression stops. For these tables, the ascent rate is from 18 ±3m/minutes (from 60 ±10ft/minutes).

✔ ***Bottom time (BT)***; the total elapsed time from when a diver leaves the surface to the time (next whole minute) at which ascent is commenced, measured in minutes.

✔ ***Decompression schedule***; a specific decompression procedure for a given combination of depth and bottom time as listed in a decompression table; it is normally described as maximum depth (metres (m) or feet (ft))/bottom time (minutes).

✔ ***Decompression stop***; a specific length of time that a diver has to spend at a specified depth to allow for the elimination of sufficient inert gas from the body to allow safe ascent to the next decompression stop or the surface.

✔ ***Depth***; the maximum depth attained, measured in metres (m) or feet (ft).

✔ ***Descent rate***; the maximum rate of travel allowed descending to the bottom. For these tables, the descent rate is 18m (60ft)/minutes maximum.

✔ ***Effective bottom time (EBT)***; for repetitive diving, the calculated bottom time for decompression purposes taking into consideration the residual nitrogen from the previous dive(s).

✔ ***Effective depth (ED)***; for a dive at altitude, the depth of an equivalent dive at sea level.

✔ ***No-decompression (No-D) limit***; the maximum bottom time that allows a direct ascent to the surface without requiring decompression stops.

✔ ***Point of interruption***; the time at which normal decompression was interrupted as a result of an emergency procedure, i.e. loss of breathing air, Oxygen symptom. Once the situation allows the return to normal decompression procedures, the table is to be re-entered where the interruption occurred.

✔ ***Repetitive dive***; any dive that has a repetitive factor greater than 1.0.

✔ ***Repetitive factor (RF)***; a figure, used for repetitive diving, determined by the repetitive group and the length of the surface interval after a dive.

✔ ***Repetitive group (RG)***; a letter that relates directly to the amount of residual nitrogen in a diver's body immediately on surfacing from a dive.

✔ ***Residual nitrogen***; nitrogen in excess of normal conditions, and which is still dissolved in a diver's tissues after the surface has been reached.

✔ ***Stop time***; the tabulated decompression stop time, this includes the travelling time to that stop at 18 ±3m/minutes (60 ±10ft/minutes).

✔ ***Surface interval (SI)***; the time that a diver has spent on the surface following a dive; beginning as soon as the diver surfaces and ending as soon as the diver starts the descent for the next dive.

✔ ***Surface interval—Surface Decompression with Oxygen***; when using Table 3 (Surface decompression with oxygen—SurD O_2), this is the time from the diver leaving the 9m (30ft) water stop (or the bottom if no stop required) to arriving at the 12m (40ft) compression chamber stop. The maximum time allowed is 7 minutes.

STANDARD AIR DECOMPRESSION (IN-WATER DECO)

INTRODUCTION

The Standard Air Decompression tables are contained in the Table 1. Users of these tables are cautioned that they have only been validated by manned experiments to the limit of the “Normal air range”.

PROCEDURE

The procedure for Standard Air Decompression is as follows:

✔ Descend at 18m/minutes (60ft/minutes) or slower.

✔ Ascend at 18 ±3m/minutes (60 ±10ft/minutes) to the indicated stops and remain at each stop for the stop time. (The tabulated stop time for each stop includes the ascent time to that stop at 18m/minutes [60ft/minutes]).

EXAMPLE

Determine the decompression schedule required for a dive to 32m (104ft) and a bottom time of 22 minutes.

PROCEDURE

✔ Enter Table 1 at the exact or next greater depth than 32m (104ft); select 33m (110ft).

✔ Using the 33m (110ft) schedule, proceed to the “Bottom time” column and find the time listed that is equal to or subsequently greater than 22 minutes, select 25 minutes.

✔ Proceed horizontally across the table at the 33m (110ft)/25 minutes level to find the decompression stops and the “Repetitive group” (RG) designator prescribed for this dive, as follows:

- ☞ 6 minutes stop at 6m (20ft)
- ☞ 10 minutes stop at 3m (10ft)
- ☞ “Repetitive group” on surfacing — G

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

T1 Table 1 - Standard Air Decompression

IMPORTANT NOTE

The DCIEM Table 1 – Standard Air Decompression Table provided in this text has been included for training purposes only. It should not be relied upon to conduct diving operations as errors may appear in the table or the table may be out of date. Only the full version of the tables, as published by DCIEM, or published in AS/NZS2299.1:1999 should be used.

T1

DCIEM Air Decompression Table

Depth m *(ft)*	Bottom time	Stop Times (min) at different depths, m *(ft)*										Decomp. Time (min)	Repet. group
		30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	6 *(20)*	3 *(10)*		
6 *(20)*	30	-	-	-	-	-	-	-	-	-	-	1	A
	60	-	-	-	-	-	-	-	-	-	-	1	B
	90	-	-	-	-	-	-	-	-	-	-	1	C
	120	-	-	-	-	-	-	-	-	-	-	1	D
	150	-	-	-	-	-	-	-	-	-	-	1	E
	180	-	-	-	-	-	-	-	-	-	-	1	F
	240	-	-	-	-	-	-	-	-	-	-	1	G
	300	-	-	-	-	-	-	-	-	-	-	1	H
	360	-	-	-	-	-	-	-	-	-	-	1	I
	420	-	-	-	-	-	-	-	-	-	-	1	J
	480	-	-	-	-	-	-	-	-	-	-	1	K
	600	-	-	-	-	-	-	-	-	-	-	1	L
	720	-	-	-	-	-	-	-	-	-	-	1	M
9 *(30)*	30	-	-	-	-	-	-	-	-	-	-	1	A
	60	-	-	-	-	-	-	-	-	-	-	1	C
	90	-	-	-	-	-	-	-	-	-	-	1	D
	120	-	-	-	-	-	-	-	-	-	-	1	F
	150	-	-	-	-	-	-	-	-	-	-	1	G
	180	-	-	-	-	-	-	-	-	-	-	1	H
	210	-	-	-	-	-	-	-	-	-	-	1	J
	240	-	-	-	-	-	-	-	-	-	-	1	K
	270	-	-	-	-	-	-	-	-	-	-	1	L
	300	-	-	-	-	-	-	-	-	-	-	1	M
	330	-	-	-	-	-	-	-	-	-	3	3	N
	360	-	-	-	-	-	-	-	-	-	5	5	O
	400	-	-	-	-	-	-	-	-	-	7	7	
	420	-	-	-	-	-	-	-	-	-	10	10	
	450	-	-	-	-	-	-	-	-	-	15	15	
	480	-	-	-	-	-	-	-	-	-	20	20	

T1

DCIEM Air Decompression Table

Depth m *(ft)*	Bottom time	Stop Times (min) at different depths, m *(ft)*										Decomp. Time (min)	Repet. group
		30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	6 *(20)*	3 *(10)*		
12 (40)	20	-	-	-	-	-	-	-	-	-	-	1	A
	30	-	-	-	-	-	-	-	-	-	-	1	B
	60	-	-	-	-	-	-	-	-	-	-	1	D
	90	-	-	-	-	-	-	-	-	-	-	1	G
	120	-	-	-	-	-	-	-	-	-	-	1	H
	150	-	-	-	-	-	-	-	-	-	-	1	J
	180	-	-	-	-	-	-	-	-	-	5	5	M
	200	-	-	-	-	-	-	-	-	-	10	10	
	210	-	-	-	-	-	-	-	-	-	15	15	
	220	-	-	-	-	-	-	-	-	-	19	19	
	240	-	-	-	-	-	-	-	-	-	26	26	
	270	-	-	-	-	-	-	-	-	-	35	35	
	300	-	-	-	-	-	-	-	-	-	44	44	
	330	-	-	-	-	-	-	-	-	-	53	53	
	360	-	-	-	-	-	-	-	-	-	62	62	
15 (50)	10	-	-	-	-	-	-	-	-	-	-	1	A
	20	-	-	-	-	-	-	-	-	-	-	1	B
	30	-	-	-	-	-	-	-	-	-	-	1	C
	40	-	-	-	-	-	-	-	-	-	-	1	D
	50	-	-	-	-	-	-	-	-	-	-	1	E
	60	-	-	-	-	-	-	-	-	-	-	1	F
	75	-	-	-	-	-	-	-	-	-	-	1	G
	100	-	-	-	-	-	-	-	-	-	5	5	I
	120	-	-	-	-	-	-	-	-	-	10	10	K
	125	-	-	-	-	-	-	-	-	-	13	13	K
	130	-	-	-	-	-	-	-	-	-	16	16	L
	140	-	-	-	-	-	-	-	-	-	21	21	M
	150	-	-	-	-	-	-	-	-	-	26	26	
	160	-	-	-	-	-	-	-	-	-	31	31	
	170	-	-	-	-	-	-	-	-	-	35	35	
	180	-	-	-	-	-	-	-	-	-	40	40	
	200	-	-	-	-	-	-	-	-	-	50	50	
	220	-	-	-	-	-	-	-	-	-	59	59	
	240	-	-	-	-	-	-	-	-	-	70	70	
	260	-	-	-	-	-	-	-	-	-	81	81	
	280	-	-	-	-	-	-	-	-	-	91	91	

T1

DCIEM Air Decompression Table

Depth m *(ft)*	Bottom time	Stop Times (min) at different depths, m *(ft)* 30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	6 *(20)*	3 *(10)*	Decomp. Time (min)	Repet. group
18 ***(60)***	10	-	-	-	-	-	-	-	-	-	-	1	A
	20	-	-	-	-	-	-	-	-	-	-	1	B
	30	-	-	-	-	-	-	-	-	-	-	1	D
	40	-	-	-	-	-	-	-	-	-	-	1	E
	50	-	-	-	-	-	-	-	-	-	-	1	F
	60	-	-	-	-	-	-	-	-	-	5	5	G
	80	-	-	-	-	-	-	-	-	-	10	10	I
	90	-	-	-	-	-	-	-	-	-	16	16	J
	100	-	-	-	-	-	-	-	-	-	24	24	K
	110	-	-	-	-	-	-	-	-	-	30	30	L
	120	-	-	-	-	-	-	-	-	-	36	36	M
	130	-	-	-	-	-	-	-	-	2	40	42	
	140	-	-	-	-	-	-	-	-	2	46	48	
	150	-	-	-	-	-	-	-	-	3	52	55	
	160	-	-	-	-	-	-	-	-	3	59	62	
	170	-	-	-	-	-	-	-	-	4	65	69	
	180	-	-	-	-	-	-	-	-	4	73	77	
	190									5	80	85	
	200	-	-	-	-	-	-	-	-	7	87	94	
	210	-	-	-	-	-	-	-	-	13	91	104	
	220	-	-	-	-	-	-	-	-	17	97	114	
	230	-	-	-	-	-	-	-	-	21	103	124	
	240	-	-	-	-	-	-	-	-	24	109	133	
21 ***(70)***	10	-	-	-	-	-	-	-	-	-	-	1	A
	20	-	-	-	-	-	-	-	-	-	-	1	C
	25	-	-	-	-	-	-	-	-	-	-	1	D
	30	-	-	-	-	-	-	-	-	-	-	1	D
	35	-	-	-	-	-	-	-	-	-	-	1	E
	40	-	-	-	-	-	-	-	-	-	5	5	F
	50	-	-	-	-	-	-	-	-	-	10	10	G
	60	-	-	-	-	-	-	-	-	-	12	12	H
	70	-	-	-	-	-	-	-	-	3	17	20	J
	80	-	-	-	-	-	-	-	-	4	25	29	K
	90	-	-	-	-	-	-	-	-	5	32	37	M
	100	-	-	-	-	-	-	-	-	6	39	45	N
	110	-	-	-	-	-	-	-	-	7	46	53	
	120	-	-	-	-	-	-	-	-	7	54	61	
	130	-	-	-	-	-	-	-	-	8	62	70	
	140	-	-	-	-	-	-	-	-	9	71	80	
	150	-	-	-	-	-	-	-	-	15	77	92	
	160	-	-	-	-	-	-	-	-	20	85	105	
	170	-	-	-	-	-	-	-	-	25	93	118	
	180	-	-	-	-	-	-	-	-	29	101	130	
	190	-	-	-	-	-	-	-	-	34	109	143	
	200	-	-	-	-	-	-	-	-	38	117	155	

T1

DCIEM Air Decompression Table

Depth m *(ft)*	Bottom time	Stop Times (min) at different depths, m *(ft)*										Decomp. Time (min)	Repet. group
		30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	6 *(20)*	3 *(10)*		
24 ***(80)***	10	-	-	-	-	-	-	-	-	-	-	2	A
	15	-	-	-	-	-	-	-	-	-	-	2	C
	20	-	-	-	-	-	-	-	-	-	-	2	D
	25	-	-	-	-	-	-	-	-	-	-	2	E
	30	-	-	-	-	-	-	-	-	-	5	5	F
	40	-	-	-	-	-	-	-	-	-	11	11	G
	50	-	-	-	-	-	-	-	-	4	11	15	H
	55	-	-	-	-	-	-	-	-	5	15	20	I
	60	-	-	-	-	-	-	-	-	6	21	27	J
	65	-	-	-	-	-	-	-	-	7	25	32	J
	70	-	-	-	-	-	-	-	-	7	30	37	K
	75	-	-	-	-	-	-	-	-	8	34	42	L
	80	-	-	-	-	-	-	-	-	9	37	46	M
	85	-	-	-	-	-	-	-	-	9	42	51	
	90	-	-	-	-	-	-	-	-	10	46	56	
	95	-	-	-	-	-	-	-	-	11	50	61	
	100	-	-	-	-	-	-	-	-	11	55	66	
	110	-	-	-	-	-	-	-	2	12	64	78	
	120	-	-	-	-	-	-	-	3	18	72	93	
	130	-	-	-	-	-	-	-	4	23	82	109	
	140	-	-	-	-	-	-	-	4	28	93	125	
	150	-	-	-	-	-	-	-	5	33	104	142	
	160	-	-	-	-	-	-	-	5	39	114	158	
27 ***(90)***	5	-	-	-	-	-	-	-	-	-	-	2	A
	10	-	-	-	-	-	-	-	-	-	-	2	B
	15	-	-	-	-	-	-	-	-	-	-	2	C
	20	-	-	-	-	-	-	-	-	-	-	2	D
	25	-	-	-	-	-	-	-	-	-	7	7	E
	30	-	-	-	-	-	-	-	-	2	9	11	F
	40	-	-	-	-	-	-	-	-	6	10	16	H
	45	-	-	-	-	-	-	-	-	7	14	21	I
	50	-	-	-	-	-	-	-	-	8	20	28	J
	55	-	-	-	-	-	-	-	-	9	26	35	K
	60	-	-	-	-	-	-	-	2	8	31	41	L
	65	-	-	-	-	-	-	-	3	8	36	47	
	70	-	-	-	-	-	-	-	3	9	40	52	
	75	-	-	-	-	-	-	-	4	9	46	59	
	80	-	-	-	-	-	-	-	4	10	51	65	
	85	-	-	-	-	-	-	-	5	10	56	71	
	90	-	-	-	-	-	-	-	5	14	60	79	
	95	-	-	-	-	-	-	-	6	17	64	87	
	100	-	-	-	-	-	-	-	6	20	70	96	
	110	-	-	-	-	-	-	-	7	26	82	115	
	120	-	-	-	-	-	-	-	8	31	95	134	

T1

DCIEM Air Decompression Table

Depth m *(ft)*	Bottom time	Stop Times (min) at different depths, m *(ft)*										Decomp. Time (min)	Repet. group
		30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	6 *(20)*	3 *(10)*		
30 ***(100)***	5	-	-	-	-	-	-	-	-	-	-	2	A
	10	-	-	-	-	-	-	-	-	-	-	2	B
	15	-	-	-	-	-	-	-	-	-	-	2	D
	20	-	-	-	-	-	-	-	-	-	8	8	E
	25	-	-	-	-	-	-	-	-	3	9	12	F
	30	-	-	-	-	-	-	-	-	5	10	15	G
	35	-	-	-	-	-	-	-	-	7	11	18	H
	40	-	-	-	-	-	-	-	-	9	16	25	I
	45	-	-	-	-	-	-	-	3	8	23	34	J
	50	-	-	-	-	-	-	-	4	8	29	41	K
	55	-	-	-	-	-	-	-	5	9	34	48	L
	60	-	-	-	-	-	-	-	6	9	40	55	
	65	-	-	-	-	-	-	-	6	10	46	62	
	70	-	-	-	-	-	-	-	7	10	52	69	
	75	-	-	-	-	-	-	-	8	14	56	78	
	80	-	-	-	-	-	-	-	8	18	61	87	
	85	-	-	-	-	-	-	-	9	21	67	97	
	90	-	-	-	-	-	-	2	8	24	75	109	
	95	-	-	-	-	-	-	3	8	27	82	120	
	100	-	-	-	-	-	-	3	8	31	90	132	
	105	-	-	-	-	-	-	3	9	34	98	144	
	110	-	-	-	-	-	-	4	8	38	106	156	
33 ***(110)***	5	-	-	-	-	-	-	-	-	-	-	2	A
	10	-	-	-	-	-	-	-	-	-	-	2	B
	12	-	-	-	-	-	-	-	-	-	-	2	C
	15	-	-	-	-	-	-	-	-	-	5	5	D
	20	-	-	-	-	-	-	-	-	3	9	12	F
	25	-	-	-	-	-	-	-	-	6	10	16	G
	30	-	-	-	-	-	-	-	-	9	10	19	H
	35	-	-	-	-	-	-	-	3	8	16	27	I
	40	-	-	-	-	-	-	-	5	8	24	37	J
	45	-	-	-	-	-	-	-	6	9	31	46	K
	50	-	-	-	-	-	-	-	7	9	38	54	M
	55	-	-	-	-	-	-	-	8	10	44	62	N
	60	-	-	-	-	-	-	2	7	10	51	70	
	65	-	-	-	-	-	-	3	7	15	55	80	
	70	-	-	-	-	-	-	4	7	19	62	92	
	75	-	-	-	-	-	-	4	8	23	68	103	
	80	-	-	-	-	-	-	5	8	26	77	116	
	85	-	-	-	-	-	-	5	9	30	86	130	
	90	-	-	-	-	-	-	6	9	34	95	144	
	95	-	-	-	-	-	-	6	9	38	105	158	
	100	-	-	-	-	-	-	7	9	42	114	172	
	105	-	-	-	-	-	-	7	12	45	123	187	
	110	-	-	-	-	-	-	8	15	48	130	201	

T1

DCIEM Air Decompression Table

Depth m *(ft)*	Bottom time	Stop Times (min) at different depths, m *(ft)*										Decomp. Time (min)	Repet. group
		30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	6 *(20)*	3 *(10)*		
36 ***(120)***	5	-	-	-	-	-	-	-	-	-	-	2	A
	10	-	-	-	-	-	-	-	-	-	-	2	C
	15	-	-	-	-	-	-	-	-	-	10	10	D
	20	-	-	-	-	-	-	-	-	6	9	15	F
	25	-	-	-	-	-	-	-	-	9	10	19	G
	30	-	-	-	-	-	-	-	4	8	14	26	I
	35	-	-	-	-	-	-	-	6	8	24	38	J
	40	-	-	-	-	-	-	-	8	8	32	48	K
	45	-	-	-	-	-	-	3	6	10	38	57	M
	50	-	-	-	-	-	-	4	7	10	46	67	N
	55	-	-	-	-	-	-	5	7	13	53	78	
	60	-	-	-	-	-	-	6	7	18	59	90	
	65	-	-	-	-	-	-	6	8	22	66	102	
	70	-	-	-	-	-	-	7	8	27	75	117	
	75	-	-	-	-	-	-	8	8	31	86	133	
	80	-	-	-	-	-	2	6	9	35	97	149	
	85	-	-	-	-	-	3	6	10	40	107	166	
	90	-	-	-	-	-	3	7	13	42	118	183	
	95	-	-	-	-	-	4	6	16	46	128	200	
	100	-	-	-	-	-	4	7	19	50	136	216	
39 ***(130)***	5	-	-	-	-	-	-	-	-	-	-	2	A
	8	-	-	-	-	-	-	-	-	-	-	2	B
	10	-	-	-	-	-	-	-	-	-	5	5	C
	15	-	-	-	-	-	-	-	-	4	8	12	E
	20	-	-	-	-	-	-	-	-	8	10	18	G
	25	-	-	-	-	-	-	-	5	7	11	23	H
	30	-	-	-	-	-	-	-	7	8	22	37	J
	35	-	-	-	-	-	-	3	6	9	30	48	K
	40	-	-	-	-	-	-	4	7	9	39	59	M
	45	-	-	-	-	-	-	6	7	10	47	70	N
	50	-	-	-	-	-	-	7	7	15	53	82	
	55	-	-	-	-	-	2	6	8	20	61	97	
	60	-	-	-	-	-	3	6	8	25	70	112	
	65	-	-	-	-	-	4	6	8	30	82	130	
	70	-	-	-	-	-	4	7	9	34	94	148	
	75	-	-	-	-	-	5	6	11	39	106	167	
	80	-	-	-	-	-	5	7	14	42	118	186	
	85	-	-	-	-	-	6	7	17	47	129	206	
	90	-	-	-	-	-	6	8	20	52	138	224	

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

T1

DCIEM Air Decompression Table

Depth m *(ft)*	Bottom time	Stop Times (min) at different depths, m *(ft)*										Decomp. Time (min)	Repet. group
		30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	6 *(20)*	3 *(10)*		
42 *(140)*	7	-	-	-	-	-	-	-	-	-	-	2	B
	10	-	-	-	-	-	-	-	-	-	7	7	D
	15	-	-	-	-	-	-	-	-	6	9	15	F
	20	-	-	-	-	-	-	-	4	7	10	21	G
	25	-	-	-	-	-	-	-	7	8	17	32	I
	30	-	-	-	-	-	-	4	6	8	28	46	K
	35	-	-	-	-	-	-	5	7	9	37	58	L
	40	-	-	-	-	-	-	7	7	10	46	70	N
	45	-	-	-	-	-	3	5	8	16	53	85	O
	50	-	-	-	-	-	4	6	8	21	62	101	
	55	-	-	-	-	-	5	6	8	27	73	119	
	60	-	-	-	-	-	6	6	9	32	86	139	
	65	-	-	-	-	-	6	7	10	37	99	159	
	70	-	-	-	-	-	7	7	14	40	114	182	
	75	-	-	-	-	3	5	7	18	45	126	204	
	80	-	-	-	-	3	6	7	21	51	137	225	
	85	-	-	-	-	4	5	8	25	57	146	245	
	90			-	-	4	6	8	28	65	152	263	
45 *(150)*	7	-	-	-	-	-	-	-	-	-	-	3	B
	10	-	-	-	-	-	-	-	-	-	9	9	D
	15	-	-	-	-	-	-	-	-	8	9	17	F
	20	-	-	-	-	-	-	-	6	7	11	24	H
	25	-	-	-	-	-	-	4	5	8	23	40	J
	30	-	-	-	-	-	-	6	6	9	34	55	K
	35	-	-	-	-	-	3	5	7	10	44	69	M
	40	-	-	-	-	-	4	6	7	15	52	84	O
	45	-	-	-	-	-	5	6	8	21	61	101	
	50	-	-	-	-	-	6	7	8	27	73	121	
	55	-	-	-	-	3	5	6	9	33	88	144	
	60	-	-	-	-	3	5	7	12	38	103	168	
	65	-	-	-	-	4	5	8	16	42	119	194	
	70	-	-	-	-	5	5	8	20	48	132	218	
	75	-	-	-	-	5	6	8	24	55	142	240	
	80	-	-	-	-	6	6	8	28	63	150	261	
48 *(160)*	6	-	-	-	-	-	-	-	-	-	-	3	B
	10	-	-	-	-	-	-	-	-	-	11	11	D
	15	-	-	-	-	-	-	-	4	6	10	20	G
	20	-	-	-	-	-	-	-	8	8	14	30	H
	25	-	-	-	-	-	-	6	6	8	29	49	K
	30	-	-	-	-	-	3	5	7	9	40	64	M
	35	-	-	-	-	-	5	5	8	13	49	80	N
	40	-	-	-	-	-	6	6	8	20	59	99	
	45	-	-	-	-	3	5	6	9	26	72	121	
	50	-	-	-	-	4	5	7	9	33	88	146	
	55	-	-	-	-	5	5	7	13	38	105	173	
	60	-	-	-	-	6	5	8	17	43	122	201	
	65	-	-	-	-	7	5	8	22	50	135	227	
	70	-	-	-	3	4	6	8	26	58	146	251	

T1

DCIEM Air Decompression Table

Depth m *(ft)*	Bottom time	Stop Times (min) at different depths, m *(ft)*										Decomp. Time (min)	Repet. group
		30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	6 *(20)*	3 *(10)*		
51 (170)	6	-	-	-	-	-	-	-	-	-	-	3	B
	10	-	-	-	-	-	-	-	-	5	8	13	D
	15	-	-	-	-	-	-	-	5	7	10	22	G
	20	-	-	-	-	-	-	5	5	8	20	38	I
	25	-	-	-	-	-	3	5	6	9	33	56	K
	30	-	-	-	-	-	5	5	7	10	46	73	M
	35	-	-	-	-	3	4	6	8	18	55	94	O
	40	-	-	-	-	4	5	6	8	26	68	117	
	45	-	-	-	-	5	5	7	9	32	85	143	
	50	-	-	-	-	6	6	7	13	37	105	174	
	55	-	-	-	3	4	6	7	18	44	122	204	
	60	-	-	-	4	4	6	8	23	51	137	233	
	65	-	-	-	5	4	6	9	27	61	148	260	
	70	-	-	-	5	5	6	12	30	72	155	285	
54 (180)	5	-	-	-	-	-	-	-	-	-	-	3	B
	10	-	-	-	-	-	-	-	-	6	9	15	E
	15	-	-	-	-	-	-	-	7	7	11	25	H
	20	-	-	-	-	-	-	6	6	8	25	45	J
	25	-	-	-	-	-	5	5	7	9	39	65	M
	30	-	-	-	-	3	4	6	7	15	50	85	O
	35	-	-	-	-	5	4	6	8	23	62	108	
	40	-	-	-	-	6	5	7	9	30	80	137	
	45	-	-	-	4	4	5	7	13	36	101	170	
	50	-	-	-	4	5	5	8	18	42	121	203	
	55	-	-	-	5	5	6	8	23	51	137	235	
	60	-	-	-	6	5	6	9	28	61	149	264	
57 (190)	5	-	-	-	-	-	-	-	-	-	-	3	
	10	-	-	-	-	-	-	-	-	8	9	17	
	15	-	-	-	-	-	-	4	5	7	11	27	
	20	-	-	-	-	-	4	4	6	9	29	52	
	25	-	-	-	-	-	7	5	7	10	44	73	
	30	-	-	-	-	5	7	6	8	19	55	97	
	35	-	-	-	3	4	5	6	9	27	72	126	
	40	-	-	-	4	4	5	7	11	35	93	159	
	45	-	-	-	5	5	5	8	17	41	116	197	
	50	-	-	3	3	5	6	8	22	50	135	232	
	55	-	-	4	3	5	7	9	27	61	149	265	
60 (200)	5	-	-	-	-	-	-	-	-	-	-	4	
	10	-	-	-	-	-	-	-	-	10	9	19	
	15	-	-	-	-	-	-	5	6	8	16	35	
	20	-	-	-	-	-	5	5	6	10	33	59	
	25	-	-	-	-	5	4	5	7	14	48	83	
	30	-	-	-	3	4	4	6	9	23	62	111	
	35	-	-	-	5	4	5	6	10	32	84	146	
	40	-	-	-	6	4	6	7	15	38	109	185	
	45	-	-	4	3	5	6	8	21	47	131	225	
	50	-	-	5	4	4	7	9	27	58	147	261	

T1

DCIEM Air Decompression Table

Depth m *(ft)*	Bottom time	Stop Times (min) at different depths, m *(ft)* 30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	6 *(20)*	3 *(10)*	Decomp. Time (min)	Repet. group
63 (210)	5	-	-	-	-	-	-	-	-	-	5	5	
	10	-	-	-	-	-	-	-	5	6	10	21	
	15	-	-	-	-	-	-	7	6	8	20	41	
	20	-	-	-	-	-	7	5	7	9	39	67	
	25	-	-	-	-	6	4	6	8	17	52	93	
	30	-	-	-	5	4	4	7	8	28	71	127	
	35	-	-	3	3	4	6	7	12	35	97	167	
	40	-	-	4	4	4	6	8	19	43	123	211	
	45	-	-	5	4	5	6	9	25	54	142	250	
	50	-	3	3	4	6	6	13	29	70	154	288	
66 (220)	5	-	-	-	-	-	-	-	-	-	7	7	
	10	-	-	-	-	-	-	-	7	6	10	23	
	156	-	-	-	-	-	4	5	5	9	24	47	
	20	-	-	-	-	5	4	5	7	10	43	74	
	25	-	-	-	4	4	4	6	8	21	58	105	
	30	-	-	3	3	4	5	7	9	32	81	144	
	35	-	-	5	3	4	6	7	16	39	110	190	
	40	-	3	3	4	4	7	8	23	49	135	236	
	45	-	4	3	4	5	7	11	28	65	151	278	
69 (230)	5	-	-	-	-	-	-	-	-	-	8	8	
	10	-	-	-	-	-	-	-	8	7	10	25	
	15	-	-	-	-	-	6	4	6	9	28	53	
	20	-	-	-	-	6	4	6	7	12	47	82	
	25	-	-	-	6	3	5	6	9	24	65	118	
	30	-	-	5	3	4	5	7	12	35	93	164	
	35	-	3	3	4	4	6	8	19	44	123	214	
	40	-	5	3	4	5	6	9	27	57	146	262	
72 (240)	5	-	-	-	-	-	-	-	-	-	9	9	
	10	-	-	-	-	-	-	4	5	7	11	27	
	15	-	-	-	-	-	7	5	6	9	32	59	
	20	-	-	-	4	4	4	5	8	16	50	91	
	25	-	-	4	3	4	5	6	9	28	73	132	
	30	-	-	6	3	5	5	8	15	37	106	185	
	35	-	5	3	4	4	6	9	23	49	135	238	
	40	3	3	3	4	6	6	13	28	67	153	286	

T1s Table 1S - Short Standard Air Decompression

TABLE 1S: SHORT STANDARD AIR DECOMPRESSION (METRES)

Depth (msw)	No-Decompression Bottom Times (min)				Decompression Required Bottom Times (min)			
6	30 A 60 B 90 C 120 D	150 E 180 F 240 G 300 H	360 I 420 J 480 K 600 L	720 M ∞				
9	30 A 45 B 60 C 90 D	100 E 120 F 150 G 180 H	190 I 210 J 240 K 270 L	300 M	330 N 360 O	400	420	480
12	22 A 30 B 40 C	60 D 70 E 80 F	90 G 120 H 130 I	150 J	160 K 170 L 180 M	200	210	220
15	18 A 25 B	30 C 40 D	50 E 60 F	75 G	90 H 100 I	110 J 120 K	128 L	137 M
18	14 A 20 B	25 C 30 D	40 E	50 F	60 G	70 H 80 I	88 J	95 K
Decompression Time in minutes at		3 msw			5	10	15	20
21	12 A 15 B	20 C	25 D	35 E	40 F	53 H	65 I	68 J
24	10 A 13 B	15 C	20 D	25 E	30 F	37 G	50 H	54 I
27	9 A	12 B	15 C	20 D	24 E	28 F	35 G	44 I
30	7 A	10 B	12 C	15 D	18 D	22 F	30 G	37 H
33		6 A	10 B	12 C	15 D	18 E	24 G	31 H
36		6 A	8 B	10 C	12 D	15 E	19 F	25 G
39			5 A	8 B	10 C	13 D	17 F	21 G
42			5 A	7 B	9 C	12 D	14 F	18 G
45			4 A	7 B	8 C	10 D	13 F	16 G
Decompression Time in minutes at		6 msw			-	-	5	10
		3 msw			5	10	10	10

First Edition – December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

SURFACE DECOMPRESSION WITH OXYGEN (SURD O_2)

INTRODUCTION

The surface decompression with oxygen (SurD O_2) table is contained in Table 3. These tables have only been validated by manned experiments to the limits of the "exceptional exposure range".

PROCEDURE

The procedure for surface decompression with oxygen (SurD O_2) is as follows:

✔ Ascend and decompress normally (see Table 3) to the 9m (30ft) stop (or to the surface if no in-water stop is shown).

✔ Remain at the 9m (30ft) stop for the stop time (remembering that the stop time includes ascent to the 9m (30ft) stop at 18 ±3m/minutes (60 ±10ft/minutes).

✔ Ascend to the surface and recompress on Oxygen to 12m (40ft) in the compression chamber; the surface interval of a surface decompression with oxygen must not exceed 7 minutes.

NOTE: The maximum surface interval, Surface Decompression with Oxygen, of 7 minutes was chosen to enhance the operability of the procedure and to reduce the chances of omitted decompression during operations. Extensive experimentation using the full 7 minutes has proven this procedure safe. In operational use, the surface interval, Surface Decompression with Oxygen, should be kept to a minimum.

✔ Remain on Oxygen at 12m (40ft) for the tabulated stop time with 5 minutes air breaks after every 30 minutes on Oxygen.

NOTE: The asterisks following the stop times for "Chamber on Oxygen" in Table 3 represent the number of air breaks. The tabulated 12m (40ft) stop times are for Oxygen only, while the "Total decompression time" column includes the air breaks. If no asterisk follows a tabulated 30 minutes "Chamber on Oxygen" stop time, no air break is taken prior to ascent on Oxygen. If only one asterisk follows a tabulated 60 minutes "Chamber on Oxygen" stop time, no second air break is taken prior to ascent on Oxygen.

✔ Ascend to the surface on Oxygen.

NOTE: A time of 1 minute for this "ascent" has been added to the "Total decompression time" column as an example only.

EXAMPLE

Determine the decompression schedule for a dive to 36m (120ft) with duration of 75 minutes.

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

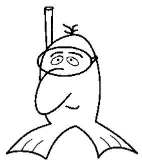
PROCEDURE

Enter Table 3 at the exact or next greater depth than 36m (120ft); select 36m (120ft).

Using the 36m (120ft) schedule, proceed to the “Bottom time” column and find the time listed which is equal to or subsequently greater than 75 minutes, select 75 minutes.

Proceed horizontally across the table at the 36m (120ft)/75 minutes level to find the decompression stops and stop times as follows: Table 3 calls for

- ✔ 8 minutes stop at 12m
- ✔ 8 minutes stop at 9m
- ✔ Time from 9m in-water to 12m compression chamber stop on surface is maximum 7 minutes
- ✔ 80 minutes stop at 12m on Oxygen
- ✔ 70minutes (including 2 × 5 minutes air breaks)
- ✔ No repetitive group (exceptional exposure dive)



> **NOTE:** Repetitive diving can also be conducted using Surface Decompression with Oxygen, as shown by repetitive groups in Tables 4A and 4B for dives within the “Normal air range”; however, these Repetitive groups may be different from those in Tables 1, 1S and 3.

SUPERVISORS ARE NOT TO PLAN REPETITIVE DIVES

■ OXYGEN RELATED PROBLEMS DURING SURFACE DECOMPRESSION WITH OXYGEN

LOSS OF OXYGEN

For loss of Oxygen, switch diver to standard air decompression (Table 1) and commence decompression at the 12m (40ft) stop.

> **NOTE:** Previous Oxygen time is “good” time and is subtracted from 12m (40ft), 9m (30ft), 6 m (20ft) and 3m (10ft) stops as appropriate.

EXAMPLE

Dive 42m (140ft), Bottom time 30 minutes: Table 3 calls for 30 minutes Surface Decompression with Oxygen.

SITUATION

After 24 minutes on Oxygen in compression chamber, Oxygen is lost.

PROCEDURE

At 42m, Table 1 calls for;

12m — 4 minutes stop

9m — 5 minutes stop

6m — 8 minutes stop

3m — 28 minutes stop

The 24 minutes spent on Oxygen satisfied the 12m, 9m and 6m stops, and 6 minutes of the 3m stop; therefore, ascend to 3m and complete decompression by remaining on air at 3m for 22 minutes.

MINOR SYMPTOMS OF OXYGEN TOXICITY

For minor symptoms of Oxygen toxicity, the procedure is as follows:

Take diver off Oxygen.

After symptoms have gone, either;

- ☞ leave diver on air for an additional 15 minutes and then resume Oxygen from the time of interruption; or
- ☞ switch diver to the Standard Air Decompression Table 1 and complete decompression on air.

If Oxygen breathing is resumed and Oxygen symptoms recur, switch the diver to the Standard Air Decompression Table 1 and complete the decompression on air.

EXAMPLE

Dive 36m (120ft), Bottom time 75 minutes: Table 3 call for 70 minutes Surface Decompression with Oxygen plus two 5 minutes air breaks.

SITUATION

After 11 minutes on Oxygen in compression chamber, the diver develops symptoms of Oxygen toxicity.

PROCEDURE

Take the diver off Oxygen.

Wait until the diver stabilizes, then wait a further 15 minutes.

Resume Oxygen breathing from point of interruption (see Note).

> **NOTE:** If diver took 4 minutes to stabilize, then the 12m (40ft) compression chamber stop would be 11 + 4 (stabilize) + 15 (wait) + 19 (remainder of first Oxygen period) + 5 (air break) + 30 (second Oxygen period) + 5 (air break) + 10 (remaining Oxygen required) = 99 minutes.

In this case, however, the 10 (remaining Oxygen required) may be added to the 19 (remainder of first Oxygen period) thus precluding the need for the final 5 minutes air break. The 12m

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

(40ft) compression stop would then become 11 + 4 (stabilize) + 15 (wait) + 29 (first Oxygen period) + 5 (air break) + 30 (second Oxygen period) = 94 minutes.

Further, since treatment may resume with 30 minutes Oxygen periods, it may be convenient, in some cases, to complete the treatment with the shortest Oxygen period. In this case, this would simply mean that the first Oxygen period would become 30 minutes, and the second Oxygen period 29 minutes.

SERIOUS, INCAPACITATING SYMPTOMS OF CNS OXYGEN TOXICITY

For serious, incapacitating symptoms of Central Nervous System (CNS) Oxygen toxicity, the procedure is as follows:

Take diver off Oxygen and stabilize.

Switch to Standard Air Decompression Table 1 and complete decompression on air.

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

T3 Table 3 – Surface Decompression Using Oxygen

IMPORTANT NOTE

The DCIEM Table 3 – Surface Decompression Using Oxygen provided in this text has been included for training purposes only. It should not be relied upon to conduct diving operations as errors may appear in the table or the table may be out of date. Only the full version of the tables, as published by DCIEM, or published in AS/NZS2299.1:1999 should be used.

T3

DCIEM Surface Decompression Using Oxygen Table

Depth m *(ft)*	Bottom time	Stop time (min) at different depths, m (ft): 30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	Surface Interval	Chamber on O_2 12m/(40ft)	Total decomp. time (min)	Repet. group
18 *(60)*	50	-	-	-	-	-	-	-	-	**MUST NOT EXCEED 7 min**	-	1	F
	70	-	-	-	-	-	-	-	-		10	18	H
	80	-	-	-	-	-	-	-	-		16	24	H
	90	-	-	-	-	-	-	-	-		20	28	I
	100	-	-	-	-	-	-	-	-		24	32	J
	110	-	-	-	-	-	-	-	-		28	36	K
	120	-	-	-	-	-	-	-	-		30	38	K
	130	-	-	-	-	-	-	-	-		32*	45	
	140	-	-	-	-	-	-	-	-		38*	51	
	150	-	-	-	-	-	-	-	-		42*	55	
	160	-	-	-	-	-	-	-	-		46*	59	
	170	-	-	-	-	-	-	-	-		50*	65	
	180	-	-	-	-	-	-	-	-		54*	68	
	190	-	-	-	-	-	-	-	-		57*	70	
	200	-	-	-	-	-	-	-	-		60*	73	
	210	-	-	-	-	-	-	-	-		63**	81	
	220	-	-	-	-	-	-	-	-		69**	87	
	230	-	-	-	-	-	-	-	-		73**	92	
	240	-	-	-	-	-	-	-	-		77**	95	

NOTE: Asterisk (*) indicates the number of 5 minutes air breaks

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

T3

DCIEM Surface Decompression Using Oxygen Table

Depth m (ft)	Bottom time	Stop time (min) at different depths, m (ft) 30 (100)	27 (90)	24 (80)	21 (70)	18 (60)	15 (50)	12 (40)	9 (30)	Surface Interval	Chamber on O_2 12m/(40ft)	Total decomp. time (min)	Repet. group
21 (70)	35	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	1	E
	50	-	-	-	-	-	-	-	-		6	14	H
	60	-	-	-	-	-	-	-	-		15	23	H
	70	-	-	-	-	-	-	-	-		21	29	I
	80	-	-	-	-	-	-	-	-		26	34	J
	90	-	-	-	-	-	-	-	-		30	38	K
	100	-	-	-	-	-	-	-	-		34*	47	K
	110	-	-	-	-	-	-	-	-		40*	53	
	120	-	-	-	-	-	-	-	-		45*	58	
	130	-	-	-	-	-	-	-	-		50*	63	
	140	-	-	-	-	-	-	-	-		55*	68	
	150	-	-	-	-	-	-	-	-		59*	72	
	160	-	-	-	-	-	-	-	-		63**	81	
	170	-	-	-	-	-	-	-	-		71**	89	
	180	-	-	-	-	-	-	-	-		76**	94	
	190	-	-	-	-	-	-	-	-		81**	99	
	200	-	-	-	-	-	-	-	1		85**	104	
24 (80)	25	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	2	E
	45	-	-	-	-	-	-	-	-		12	20	H
	50	-	-	-	-	-	-	-	-		17	25	H
	55	-	-	-	-	-	-	-	-		21	29	H
	60	-	-	-	-	-	-	-	-		24	32	I
	70	-	-	-	-	-	-	-	-		30	38	J
	80	-	-	-	-	-	-	-	-		35*	48	K
	90	-	-	-	-	-	-	-	-		42*	55	
	100	-	-	-	-	-	-	-	2		47*	62	
	110	-	-	-	-	-	-	-	2		53*	68	
	120	-	-	-	-	-	-	-	3		58*	74	
	130	-	-	-	-	-	-	-	4		62**	84	
	140	-	-	-	-	-	-	-	4		72**	94	
	150	-	-	-	-	-	-	-	5		78**	101	
	160	-	-	-	-	-	-	-	5		84**	107	
27 (90)	20	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	2	D
	35	-	-	-	-	-	-	-	-		8	16	G
	40	-	-	-	-	-	-	-	-		16	24	G
	45	-	-	-	-	-	-	-	-		21	29	H
	50	-	-	-	-	-	-	-	-		25	33	H
	55	-	-	-	-	-	-	-	1		28	37	I
	60	-	-	-	-	-	-	-	2		30*	45	J
	70	-	-	-	-	-	-	-	3		37*	53	
	80	-	-	-	-	-	-	-	4		45*	62	
	90	-	-	-	-	-	-	-	5		52*	70	
	100	-	-	-	-	-	-	-	6		58*	77	
	110	-	-	-	-	-	-	-	7		65**	90	
	120	-	-	-	-	-	-	-	8		74**	100	

NOTE: Asterisk (*) indicates the number of 5 minutes air breaks

T3

DCIEM Surface Decompression Using Oxygen Table

Depth m (ft)	Bottom time	Stop time (min) at different depths, m (ft) 30 (100)	27 (90)	24 (80)	21 (70)	18 (60)	15 (50)	12 (40)	9 (30)	Surface Interval	Chamber on O_2 12m/(40ft)	Total decomp. time (min)	Repet. group
30 (100)	15	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	2	D
	30	-	-	-	-	-	-	-	-		8	16	G
	35	-	-	-	-	-	-	-	-		17	25	G
	40	-	-	-	-	-	-	-	2		22	32	H
	45	-	-	-	-	-	-	-	3		27	38	I
	50	-	-	-	-	-	-	-	4		30	42	I
	55	-	-	-	-	-	-	-	5		31*	49	J
	60	-	-	-	-	-	-	-	6		37*	56	
	70	-	-	-	-	-	-	-	7		46*	66	
	80	-	-	-	-	-	-	-	8		54*	75	
	90	-	-	-	-	-	-	2	8		60*	83	
	100	-	-	-	-	-	-	3	8		72**	101	
	110	-	-	-	-	-	-	4	8		81**	111	
33 (110)	12	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	2	C
	25	-	-	-	-	-	-	-	-		7	15	G
	30	-	-	-	-	-	-	-	2		16	28	G
	35	-	-	-	-	-	-	-	3		22	33	H
	40	-	-	-	-	-	-	-	5		27	40	I
	45	-	-	-	-	-	-	-	6		30*	49	J
	50	-	-	-	-	-	-	-	7		35*	55	K
	55	-	-	-	-	-	-	-	8		40*	61	K
	60	-	-	-	-	-	-	2	7		45*	67	
	65	-	-	-	-	-	-	3	7		50*	73	
	70	-	-	-	-	-	-	4	7		54*	78	
	75	-	-	-	-	-	-	4	8		59*	84	
	80	-	-	-	-	-	-	5	8		60**	91	
	85	-	-	-	-	-	-	5	9		69**	101	
	90	-	-	-	-	-	-	6	9		75**	108	
	95	-	-	-	-	-	-	6	9		80**	113	
	100	-	-	-	-	-	-	7	9		85**	119	
	105	-	-	-	-	-	-	7	12		89**	126	
	110	-	-	-	-	-	-	8	15		93***	139	

NOTE: Asterisk (*) indicates the number of 5 minutes air breaks

T3

DCIEM Surface Decompression Using Oxygen Table

Depth m *(ft)*	Bottom time	Stop time (min) at different depths, m (ft) 30 *(100)*	27 *(90)*	24 *(80)*	21 *(70)*	18 *(60)*	15 *(50)*	12 *(40)*	9 *(30)*	Surface Interval	Chamber on O_2 12m/(40ft)	Total decomp. time (min)	Repet. group
36 ***(120)***	10	-	-	-	-	-	-	-	-	**MUST NOT EXCEED 7 min**	-	2	C
	20	-	-	-	-	-	-	-	-		7	15	F
	25	-	-	-	-	-	-	-	2		13	23	G
	30	-	-	-	-	-	-	-	4		21	33	G
	35	-	-	-	-	-	-	-	6		27	41	H
	40	-	-	-	-	-	-	-	8		30*	51	I
	45	-	-	-	-	-	-	3	6		36*	58	J
	50	-	-	-	-	-	-	4	7		42*	66	K
	55	-	-	-	-	-	-	5	7		48*	73	
	60	-	-	-	-	-	-	6	7		53*	79	
	65	-	-	-	-	-	-	6	8		58*	85	
	70	-	-	-	-	-	-	7	8		60**	93	
	75	-	-	-	-	-	-	8	8		70**	104	
	80	-	-	-	-	-	2	6	9		76**	111	
	85	-	-	-	-	-	3	6	10		82**	119	
	90	-	-	-	-	-	3	7	13		87**	128	
	95	-	-	-	-	-	4	6	16		90**	134	
	100	-	-	-	-	-	4	7	19		100***	153	
39 ***(130)***	8	-	-	-	-	-	-	-	-	**MUST NOT EXCEED 7 min**	-	2	B
	20	-	-	-	-	-	-	-	-		8	16	G
	25	-	-	-	-	-	-	-	5		18	31	G
	30	-	-	-	-	-	-	-	7		26	41	H
	35	-	-	-	-	-	-	3	6		30*	52	I
	40	-	-	-	-	-	-	4	7		36*	60	J
	45	-	-	-	-	-	-	6	7		43*	69	K
	50	-	-	-	-	-	-	7	7		49*	76	
	55	-	-	-	-	-	2	6	8		54*	83	
	60	-	-	-	-	-	3	6	8		60*	90	
	65	-	-	-	-	-	4	6	8		67**	103	
	70	-	-	-	-	-	4	7	9		75**	113	
	75	-	-	-	-	-	5	6	11		81**	121	
	80	-	-	-	-	-	5	7	14		87**	131	
	85	-	-	-	-	-	6	7	17		90***	143	
	90	-	-	-	-	-	6	8	20		101***	158	

NOTE: Asterisk (*) indicates the number of 5 minutes air breaks

T3

DCIEM Surface Decompression Using Oxygen Table

Depth m (ft)	Bottom time	Stop time (min) at different depths, m (ft)								Surface Interval	Chamber on O_2 12m/(40ft)	Total decomp. time (min)	Repet. group
		30 (100)	27 (90)	24 (80)	21 (70)	18 (60)	15 (50)	12 (40)	9 (30)				
42 (140)	7	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	3	B
	15	-	-	-	-	-	-	-	-		7	15	F
	20	-	-	-	-	-	-	-	4		12	24	G
	25	-	-	-	-	-	-	-	7		23	38	H
	30	-	-	-	-	-	-	4	6		30	48	I
	35	-	-	-	-	-	-	5	7		34*	59	J
	40	-	-	-	-	-	-	7	7		42*	69	K
	45					-	3	5	8		49*	78	M
	50	-	-	-	-	-	4	6	8		55*	86	
	55	-	-	-	-	-	5	6	8		60**	97	
	60	-	-	-	-	-	6	6	9		70**	109	
	65	-	-	-	-	-	6	7	10		78**	119	
	70	-	-	-	-	-	7	7	14		84**	130	
	75	-	-	-	-	3	5	7	18		90**	141	
	80	-	-	-	-	3	6	7	21		100***	160	
	85	-	-	-	-	4	5	8	25		107***	172	
	90					4	6	8	28		113***	182	
45 (150)	7	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	3	B
	15	-	-	-	-	-	-	-	-		8	16	G
	20	-	-	-	-	-	-	-	6		17	31	G
	25	-	-	-	-	-	-	4	5		27	44	H
	30	-	-	-	-	-	-	6	6		30*	55	I
	35	-	-	-	-	-	3	5	7		40*	68	K
	40	-	-	-	-	-	4	6	7		48*	78	M
	45	-	-	-	-	-	5	6	8		55*	87	
	50	-	-	-	-	-	6	7	8		60**	99	
	55	-	-	-	-	3	5	6	9		72**	113	
	60	-	-	-	-	3	5	7	12		80**	125	
	65	-	-	-	-	4	5	8	16		87**	138	
	70	-	-	-	-	5	5	8	20		95***	156	
	75	-	-	-	-	5	6	8	24		105***	171	
	80	-	-	-	-	6	6	8	28		111***	182	
48 (130)	6	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	3	B
	15	-	-	-	-	-	-	-	4		7	19	G
	20	-	-	-	-	-	-	-	8		21	37	G
	25	-	-	-	-	-	-	6	6		30	50	I
	30	-	-	-	-	-	3	5	7		37*	65	J
	35	-	-	-	-	-	5	5	8		46*	77	L
	40	-	-	-	-	-	6	6	8		54*	87	
	45	-	-	-	-	-	5	6	9		60*	96	
	50	-	-	-	-	4	5	7	9		72**	115	
	55	-	-	-	-	5	5	7	13		81**	129	
	60	-	-	-	-	6	5	8	17		88**	142	
	65	-	-	-	-	7	5	8	22		99***	164	
	70	-	-	-	3	4	6	8	26		108***	178	

NOTE: Asterisk (*) indicates the number of 5 minutes air breaks

T3

DCIEM Surface Decompression Using Oxygen Table

Depth m (ft)	Bottom time	30 (100)	27 (90)	24 (80)	21 (70)	18 (60)	15 (50)	12 (40)	9 (30)	Surface Interval	Chamber on O_2 12m/(40ft)	Total decomp. time (min)	Repet. group
51 (170)	6	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	3	B
	10	-	-	-	-	-	-	-	-		6	14	D
	15	-	-	-	-	-	-	-	5		11	24	G
	20	-	-	-	-	-	-	5	5		25	43	H
	25	-	-	-	-	-	3	5	6		30*	57	J
	30	-	-	-	-	-	5	5	7		42*	72	K
	35	-	-	-	-	3	4	6	8		51*	85	M
	40	-	-	-	-	4	5	6	8		60*	96	
	45	-	-	-	-	5	5	7	9		70**	114	
	50	-	-	-	-	6	6	7	13		80**	130	
	55	-	-	-	3	4	6	7	18		89**	145	
	60	-	-	-	4	4	6	8	23		101***	169	
	65	-	-	-	5	4	6	9	27		110***	184	
	70	-	-	-	5	5	6	12	30		117***	198	
54 (180)	5	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	3	B
	10	-	-	-	-	-	-	-	-		7	15	E
	15	-	-	-	-	-	-	-	7		15	30	G
	20	-	-	-	-	-		6	6		28	48	H
	25	-	-	-	-	-	5	5	7		36*	66	J
	30	-	-	-	-	3	4	6	7		47*	80	M
	35	-	-	-	-	5	4	6	8		56*	92	
	40	-	-	-	-	6	5	7	9		66**	111	
	45	-	-	-	4	4	5	7	13		78**	129	
	50	-	-	-	4	5	5	8	18		88**	146	
	55	-	-	-	5	5	6	8	23		101***	171	
	60	-	-	-	6	5	6	9	28		110***	187	
57 (190)	5	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	3	
	10	-	-	-	-	-	-	-	-		8	16	
	15	-	-	-	-	-	-	4	5		19	36	
	20	-	-	-	-	-	4	4	6		30	54	
	25	-	-	-	-	-	7	5	7		41*	73	
	30	-	-	-	-	5	4	6	8		52*	88	
	35	-	-	-	3	4	5	6	9		60*	100	
	40	-	-	-	4	4	5	7	11		75**	124	
	45	-	-	-	5	5	5	8	17		85**	143	
	50	-	-	3	3	5	6	8	22		99***	169	
	55	-	-	4	3	5	7	9	27		110***	188	

NOTE: Asterisk (*) indicates the number of 5 minutes air breaks

T3

DCIEM Surface Decompression Using Oxygen Table

Depth m (ft)	Bottom time	Stop time (min) at different depths, m (ft) 30 (100)	27 (90)	24 (80)	21 (70)	18 (60)	15 (50)	12 (40)	9 (30)	Surface Interval	Chamber on O_2 12m/(40ft)	Total decomp. time (min)	Repet. group
60 (200)	5	-	-	-	-	-	-	-	-	MUST NOT EXCEED 7 min	-	4	
	10	-	-	-	-	-	-	-	-		9	17	
	15	-	-	-	-	-	-	5	6		22	41	
	20	-	-	-	-	-	5	5	6		31*	60	
	25	-	-	-	-	5	4	5	7		45*	79	
	30	-	-	-	3	4	4	6	9		56*	95	
	35	-	-	-	5	4	5	6	10		69**	117	
	40	-	-	-	6	4	6	7	15		82**	138	
	45	-	-	4	3	5	6	8	21		92***	162	
	50	-	-	5	4	4	7	9	27		108***	187	
63 (210)	10	-	-	-	-	-	-	-	5	MUST NOT EXCEED 7 min	7	20	
	15	-	-	-	-	-	-	7	6		25	46	
	20	-	-	-	-	-	7	5	7		36*	68	
	25	-	-	-	-	6	4	6	8		49*	86	
	30	-	-	-	5	4	4	7	8		60*	101	
	35	-	-	3	3	4	6	7	12		76**	129	
	40	-	-	4	4	4	6	8	19		88**	151	
	45	-	-	5	4	5	6	9	25		105***	182	
	50	-	3	3	4	6	6	13	29		116***	203	
66 (220)	10	-	-	-	-	-	-	-	7	MUST NOT EXCEED 7 min	7	22	
	15	-	-	-	-	-	4	5	5		28	50	
	20	-	-	-	-	5	4	5	7		40*	74	
	25	-	-	-	4	4	4	6	8		54*	93	
	30	-	-	3	3	4	5	7	9		68**	117	
	35	-	-	5	3	4	6	7	16		83**	142	
	40	-	3	3	4	4	7	8	23		99***	174	
	45	-	4	3	4	5	7	11	28		112***	197	
69 (230)	10	-	-	-	-	-	-	-	8	MUST NOT EXCEED 7 min	11	27	
	15	-	-	-	-	-	6	4	6		30	54	
	20	-	-	-	-	6	4	6	7		44*	80	
	25	-	-	-	6	3	5	6	9		58*	100	
	30	-	-	-5	3	4	5	7	12		75**	129	
	35	-	3	3	4	4	6	8	19		89**	154	
	40	-	5	3	4	5	6	9	27		107***	189	
72 (240)	10	-	-	-	-	-	-	4	5	MUST NOT EXCEED 7 min	14	31	
	15	-	-	-	-	-	7	5	6		30*	61	
	20	-	-	-	4	4	4	5	8		48*	86	
	25	-	-	4	3	4	5	6	9		60**	109	
	30	-	-	6	3	5	5	8	15		80**	140	
	35	-	5	3	4	4	6	9	23		98***	175	
	40	3	3	3	4	6	6	13	28		114***	203	

NOTE: Asterisk (*) indicates the number of 5 minutes air breaks

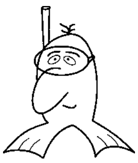
REPETITIVE DIVING PROCEDURES

INTRODUCTION

The Repetitive Diving tables are contained in Tables 4A (Repetitive Factors (RF) for Surface Intervals (SI) for Repetitive Diving) and 4B (No-Decompression limits for Repetitive Diving). These Tables have been validated using the Standard Air Decompression and Surface Decompression with Oxygen (SurD O_2) decompression methods to the limit of the "normal air range".

REPETITIVE FACTORS (RF) FOR SURFACE INTERVALS (SI) FOR REPETITIVE DIVING

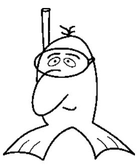
In Table 4A, repetitive factors (RF) are given for each repetitive group (RG) letter from A to O, at selected surface intervals (SI) from 15 minutes up to 18 hours. As the surface interval increases, the repetitive factor decreases until it becomes 1.0. A dive is considered a repetitive dive if it is conducted while the repetitive factor from the previous dive is greater than 1.0. For example, any dive within 18 hours after surfacing from a dive with a repetitive group of H or higher would be considered a repetitive dive.



The repetitive factor is used to calculate the effective bottom time (EBT) for the repetitive dive. This effective bottom time, determined by multiplying the actual bottom time of the repetitive dive by the repetitive factor, is the total of the actual bottom time and the time that has to be considered to have been already spent at that depth, due to the residual nitrogen remaining in the diver's body from the previous dive. The effective bottom time is then used to determine the decompression requirements for the repetitive dive.

TABLE 4B, NO-DECOMPRESSION LIMITS FOR REPETITIVE DIVING

In Table 4B, the no-decompression (No-D) limits for repetitive dives are shown for different depths as a function of the repetitive factor. These no-decompression limits are actual bottom times and not effective bottom times; the effective bottom times of these repetitive no-decompression limits are less than the no-decompression limits given in Tables 1 or 3, which are for first dives only. With Table 4B, calculations are unnecessary if only no-decompression repetitive dives are planned. For any repetitive dive, this table should be consulted to determine whether the planned dive could be conducted as a no-decompression dive or whether decompression will be required.



> **NOTE:** Multiple dives can be performed using the repetitive group of the effective bottom time and the depth of the repetitive dive; however, it may be necessary to adjust this repetitive group under certain conditions.

PROCEDURE

GENERAL

The procedure for using the Repetitive Diving Tables 4A and 4B is as follows:

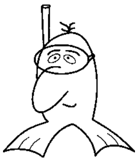
✔ Find the repetitive group from the first dive (using Table 1 or 3), and enter Table 4A.

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

✔ Proceed down the repetitive group column to locate the matching repetitive group letter from the first dive, and then proceed horizontally along the same line to the appropriate surface interval (SI) column. Where the repetitive group and the surface interval intersect, note the repetitive factor.

✔ Enter Table 4B at the repetitive factor column and proceed down to the applicable depth of the planned repetitive dive. Where the repetitive factor and the depth intersect, note the no-decompression limit for this repetitive dive.



NOTE: The No-Decompression Limit obtained is the Actual Bottom Time and not the Effective Bottom Time.

REPETITIVE DIVES NOT REQUIRING DECOMPRESSION

If the actual bottom time of the second dive is less than or equal to the no-decompression limit in Table 4B, the second dive is a no-decompression dive (if a third dive is not intended within the next 18 hours, no further calculations are necessary).

If a third dive is planned, and the actual bottom time of the second dive is less than the no-decompression limit, multiply the actual bottom time by the repetitive factor to obtain the effective bottom time for the second dive. Find the new repetitive group from the effective bottom time and depth of the second dive from the appropriate decompression table (this repetitive group may need to be adjusted before a third dive can be conducted — see Paragraph titled Adjustments for Multiple Repetitive Dives).

To find the minimum surface interval for a no-decompression dive, enter Table 4B at the depth of the repetitive dive and proceed horizontally to the intended bottom time of the repetitive dive. Proceed upward in the column to find the repetitive factor. Enter Table 4A at the repetitive group of the first dive and proceed horizontally to the appropriate repetitive factor. Proceed upward in the column to determine the minimum surface interval following the first dive.

EXAMPLE

Determine the no-decompression limit after a series of three dives. First dive 18m (60ft), bottom time 30 minutes, and surface interval 1 hour.

Second dive 15m (50ft), actual bottom time 30 minutes.

Intended third dive 12m (40ft) after surface interval 1 hour 15 minutes.

PROCEDURE

✔ Repetitive group of first dive = D (from Table 1)

✔ Enter Table 4A repetitive factor = 1.4

✔ Enter Table 4B no-decompression limit = 45 minutes

✔ The actual bottom time of the second dive (30 minutes) is less than the no-decompression limit, therefore no decompression required at this stage

✔ For the planned third dive, the effective bottom time for the second dive is 30 × 1.4 = 42 minutes

✔ Repetitive group for second dive = E (using 15m (50ft)/42 minutes in Table 1)

✔ Adjust the repetitive group for the second dive. Since the surface interval before third dive is less than 6 hours, and the repetitive group for the second dive (E) is greater than the repetitive group from the first dive (D), no adjustment is necessary therefore repetitive group remains at E

✔ Enter Table 4A for repetitive group = E and surface interval = 1 hour 15 minutes. Repetitive factor for third dive = 1.5

✔ Enter Table 4B. No-decompression limit for third dive is 100 minutes

EXAMPLE

Determine the minimum surface interval for the following series of dives. First dive 24m (80ft), bottom time 25 minutes.

Second dive 15m (50ft), bottom time 50 minutes.

Possible third dive.

PROCEDURE

✔ Repetitive group of first dive = E (from Table 1)

✔ Enter Table 4B for second dive. For 15m (50ft)/50 minutes, repetitive factor = 1.3

✔ Enter Table 4A for a first dive of repetitive group = E, a surface interval of 2 hours is required

✔ If another dive is planned, effective bottom time for second dive is (50 × 1.3) = 65 minutes, and the repetitive group = G (from Table 1)

REPETITIVE DIVES REQUIRING DECOMPRESSION

If the actual bottom time of the repetitive dive is greater than the no-decompression limit in Table 4B, then the repetitive dive requires decompression. Multiply the actual bottom time of the repetitive dive by the repetitive factor to obtain the effective bottom time and then use Table 1, or 3 to determine the decompression schedule for the depth and effective bottom time of the repetitive dive.

For repetitive bottom times exceeding the no-decompression limits in Table 4B, but with effective bottom times less than the no-decompression limit in Tables 1 or 3, a 5 minutes decompression stop at 3m (10ft) is mandatory.

> **NOTE**: The no-decompression limits in Tables 1 and 3 are for first dives only.

EXAMPLE

Determine the decompression schedule for the following series of divers. First dive 33m (110ft), bottom time 15 minutes, and surface interval 40 minutes.

Second dive 33m (110ft), bottom time 10 minutes.

PROCEDURE

✔ Repetitive group of first dive = D (from Table 1)

✔ Enter Table 4A. Repetitive factor = 1.5

- ✔ Enter Table 4B. For repetitive factor = 1.5, the no-decompression limit for the second dive is 7 minutes
- ✔ Effective bottom time for the second dive is (10 minutes × 1.5) = 15 minutes
- ✔ From Table 1, decompression schedule is 33m (110ft)/15 minutes

EXAMPLE

Determine the decompression schedule for the following series of dives. First dive 18m (60ft), bottom time 50 minutes, and surface interval 1 hour 45minutes.

Second dive 18m (60ft), bottom time 30 minutes.

PROCEDURE

- ✔ Repetitive group for the first dive = F (from Table 1)
- ✔ Enter Table 4A to find repetitive factor = 1.5
- ✔ Enter Table 4B. For repetitive factor = 1.5, the no-decompression limit for the second dive is 27 minutes
- ✔ Effective bottom time for second dive is (30 minutes × 1.5) = 45 minutes
- ✔ From Table 1, 18m (60ft)/45 minutes is in the no-decompression range, therefore mandatory decompression is 5 minutes at 3m (10ft)

■ SURFACE INTERVALS LESS THAN 15 MINUTES

Where the surface interval after the first dive is less than 15 minutes, if the first and second dives are at the same depth, add the bottom times of the first and second dives together to obtain the effective bottom time for the second dive. If a third dive is planned, use this total time to determine the repetitive group from Table 1.

If the first and second dives are at different depths, it is necessary firstly to determine the bottom time at the second dive depth, which would be equivalent to the first dive. Find the repetitive group from the first dive, proceed to the second dive depth and find the bottom time with the same repetitive group. Add this bottom time to the intended bottom time of the second dive to obtain the effective bottom time for the second dive.

EXAMPLE

Determine the decompression schedule for the following series of dives with a surface interval less than 15 minutes. First dive 18m (60ft), bottom time 30 minutes, and surface interval 10 minutes.

Second dive 18m (60ft), bottom time 25 minutes.

PROCEDURE

- ✔ Repetitive group of first dive = D (from Table 1)
- ✔ Effective bottom time of the second dive is (30 minutes + 25 minutes) = 55 minutes
- ✔ From Table 1, the decompression schedule for 18m (60ft)/55 minutes is 5 minutes at 3m (10ft), with a repetitive group = G

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

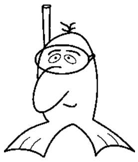
EXAMPLE

Determine the decompression schedule for the following series of dives with a surface interval less than 15 minutes. First dive 36m (120ft), bottom time 10 minutes, and surface interval 12 minutes.

Second dive 21m (70ft), bottom time 20 minutes.

PROCEDURE

- ✔ Repetitive group of first dive = C (from Table 1)
- ✔ From Table 1, a dive with repetitive group = C at 21m (70ft) has a bottom time of 20 minutes
- ✔ The effective bottom time for the second dive is 20 + 20 = 40 minutes
- ✔ From Table 1, decompression schedule for 21m (70ft)/40 minutes is 5 minutes at 3m (10ft)



> **NOTE:** The repetitive factors (RF) in Table 4A have been cut off, arbitrarily, at 2.0. It is felt that after a strenuous first dive, the surface interval (SI) should be of sufficient length to reduce the residual nitrogen level of a diver to that degree. Should it be necessary to perform a repetitive dive before the repetitive factor reduces to 2.0, the above procedure for surface intervals less than 15 minutes can be used.

ADJUSTMENTS FOR MULTIPLE REPETITIVE DIVES

Repetitive dive tables, by their nature of having fixed limits, cannot take into account every possible diving situation. Repetitive group adjustments may be required in some cases if more than one repetitive dive is planned. These adjustments are necessary to avoid problems on repetitive dives after the first repetitive dive.

For example, if a series of similar no-decompression, repetitive dives are conducted (i.e. similar depth/bottom time/surface interval); it is possible to be locked into a loop resulting in the same repetitive group and repetitive factor after each dive. Because decompression will eventually be required, it is necessary to adjust the repetitive group to break out of this loop. Similarly, if a short duration dive follows a longer bottom time dive, the repetitive group calculated for the second dive will be too small and will not take into account the influence of the longer first dive. Thus, the second dive repetitive group has to be adjusted upward.

If another dive is planned after a repetitive dive, calculate the repetitive group that corresponds to the depth and effective bottom time of the previously completed repetitive dive from the appropriate decompression table (Table 1, or 3).

If the repetitive group of the completed repetitive dive is greater than the repetitive group from the previous dive, and the surface interval before the next repetitive dive is less than 6 hours, then no adjustment is necessary.

However, if the repetitive group is lower than or equal to the repetitive group of the earlier dive, adjust the repetitive group of the previously completed dive upward to equal the repetitive group of the previous dive plus one letter.

If the surface interval to the next repetitive dive is more than 6 hours, no adjustment is necessary.

EXAMPLE

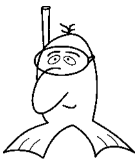
Determine the repetitive factor for the following multiple dives. First dive 21m (70ft), bottom time 25 minutes, and surface interval 15 minutes.

Second dive 21m (70ft), bottom time 8 minutes.

Third dive planned after surface interval 1.5 hours.

PROCEDURE

- ✔ Repetitive group of first dive = D (from Table 1)
- ✔ From Table 4A repetitive factor = 1.8
- ✔ The effective bottom time for the second (just completed) dive is (8 minutes × 1.8) = 14.4 minutes
- ✔ From Table 1, repetitive group of second dive is C (21m (70ft)/20 minutes) and is lower than repetitive group of first (previous) dive
- ✔ Adjust repetitive group of second dive from C to E (repetitive group =D +one letter)
- ✔ Enter Table 4A repetitive factor of second dive = 1.4 (from repetitive group = E and surface interval 1.30 to 1.59)



> **NOTE:** If the surface interval after the first dive was less than 15 minutes in the above example, then in accordance with Paragraph titled; Surface Intervals Less Than 15 minutes, the effective bottom time of the second dive would be (25 + 8) = 33 minutes. Consequently, the repetitive group would be E for the second dive.

FLYING AFTER DIVING

After a no-decompression dive, allow enough surface interval time to elapse for the repetitive factor to diminish to 1.0 before flying. After a decompression dive, a minimum of 24 hours surface interval is required before flying.

T4A

Table 4A – Repetitive Factors for Surface Intervals – Repetitive Diving

Repetitive group (RG)	Repetitive factors (RF) for surface intervals in hours and min										
	0.15 to 0.29	0.30 to 0.59	1.00 to 1.29	1.30 to 1.59	2.00 to 2.59	3.00 to 3.59	4.00 to 5.59	6.00 to 8.59	9.00 to 11.59	12.00 to 14.59	15.00 to 18.00
A	1.4	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0
B	1.5	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.0	1.0
C	1.6	1.4	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0
D	1.8	1.5	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0
E	1.9	1.6	1.5	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0
F	2.0	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1.1	1.0
G	–	1.9	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1.0
H	–	–	1.9	1.7	1.6	1.5	1.4	1.3	1.1	1.1	1.1
I	–	–	2.0	1.8	1.7	1.5	1.4	1.3	1.1	1.1	1.1
J	–	–	–	1.9	1.8	1.6	1.5	1.3	1.2	1.1	1.1
K	–	–	–	2.0	1.9	1.7	1.5	1.3	1.2	1.1	1.1
L	–	–	–	–	2.0	1.7	1.6	1.4	1.2	1.1	1.1
M	–	–	–	–	–	1.8	1.6	1.4	1.2	1.1	1.1
N	–	–	–	–	–	1.9	1.7	1.4	1.2	1.1	1.1
O	–	–	–	–	–	2.0	1.7	1.4	1.2	1.1	1.1

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

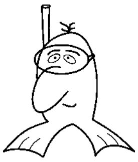
T4B Table 4B – No-Decompression Limits for Repetitive Diving

Depth	No-D limits (min) for repetitive factors (RF)									
m (ft)	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.0**
9 (30)	272	250	230	214	200	187	176	166	157	150
12 (40)	136	125	115	107	100	93	88	83	78	75
15 (50)	60	55	50	45	41	38	36	34	32	31
18 (60)	40	35	31	29	27	26	24	23	22	21
21 (70)	30	25	21	19	18	17	16	15	14	13
24 (80)	20	18	16	15	14	13	12	12	11	11
27 (90)	16	14	12	11	11	10	9	9	8	8
30 (100)	13	11	10	9	9	8	8	7	7	7
33 (110)	10	9	8	8	7	7	6	6	6	6
36 (120)	8	7	7	6	6	6	5	5	5	5
39 (130)	7	6	6	5	5	5	4	4	4	4
42 (140)	6	5	5	5	4	4	4	3	3	3
45 (150)	5	5	4	4	4	3	3	3	3	3

OMITTED DECOMPRESSION

INTRODUCTION

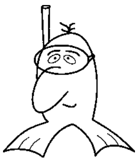
The Omitted Decompression table is contained in US Navy Table 5 (section 11). Where a diver has omitted decompression but remains asymptomatic, the procedure is dependent on the availability of a compression chamber.



> **NOTE:** Figure 8 shows an omitted decompression flow chart to assist in determining the appropriate course of action when using the decompression tables.

COMPRESSION CHAMBER IMMEDIATELY AVAILABLE (LESS THAN 7 MINUTES)

Where a compression chamber is available to a diver within 7 minutes of the diver leaving the water, the procedure is as follows:



✔ If the 9m (30ft) or deeper stops were not completed, either;

- ☞ Treat in accordance with Table USN Table 5 (section 11) if the total omitted decompression time is less than 30 minutes; or
- ☞ Treat in accordance with Table USN Table 6 (section 11) if the total omitted decompression time is equal to or greater than 30 minutes.

✔ If the 9m (30ft) stop was completed with no previous decompression omitted, recompress the diver in the chamber on oxygen to 12m (40ft) and decompress in accordance with Table 3.

✔ When using Table 3 for any dive profile not including a 9m (30ft) in-water stop, if the surface interval of a surface decompression with oxygen exceeds 7 minutes, treat in accordance with Table USN Table 5 (section 11).

> **NOTE**: If the surface interval of a surface decompression with oxygen is completed within the 7 minutes, the diver cannot incur omitted decompression.

EXAMPLE

Calculate the compression chamber schedule for the following omitted decompression. Dive 39m (130ft), bottom time 40 minutes.

Table 1 calls for:

✔ 12m — 4 minutes stop

✔ 9m — 7 minutes stop

✔ 6m — 9 minutes stop

✔ 3m — 39 minutes stop

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

SITUATION

The diver surfaces after completing the 12m (40ft) stop, the 9m (30ft) stop and 3 minutes of the 6m (20ft) stop. The diver is asymptomatic and a compression chamber is available.

PROCEDURE

- ✔ Since the diver has completed the 9m (30ft) stop, dive on oxygen in compression chamber to 12m (40ft).
- ✔ Using Table 3, for 39m (130ft)/40 minutes dive, 36 minutes on oxygen is called for.
- ✔ Add 5 minutes air break after 30 minutes on oxygen for a total decompression time of 41 minutes in the compression chamber.

■ COMPRESSION CHAMBER NOT IMMEDIATELY AVAILABLE

Where a compression chamber is not immediately available to a diver having omitted decompression, the preferred action is to get the diver to a compression chamber for treatment. The diver should receive 100% oxygen by double-seal oral nasal mask en-route to the compression chamber. However, the supervisor has the following options if the situation warrants it:

- ✔ Return the diver to the next deeper stop where the omission occurred. Continue decompression with the original schedule (see *Example* 1).
- ✔ If no deeper stop was called for, spend the time of the first stop at the next deeper stop and complete the total schedule (see *Example* 2).

EXAMPLE 1

Dive 39m (130ft), bottom time 40 minutes.

Table 1 calls for:

- ✔ 12m — 4 minutes stop
- ✔ 9m — 7 minutes stop
- ✔ 6m — 9 minutes stop
- ✔ 3m — 39 minutes stop

SITUATION

Diver surfaces after completing the 12m (40ft) stop, the 9m (30ft) stop and 3 minutes of the 6m (20ft) stop. Diver is asymptomatic and a compression chamber is not available.

PROCEDURE

- ✔ Recompress immediately to either 9m for 7 minutes (Table 1).
- ✔ Resume schedule beginning with the 6m (20ft) stop.

EXAMPLE 2

Dive 39m (130ft), bottom time 40 minutes.

Table 1 calls for:

✔ 12m — 4 minutes stop

✔ 9m — 7 minutes stop

✔ 6m — 9 minutes stop

✔ 3m — 39 minutes stop

SITUATION

On ascent to 12m (40ft) stop, diver loses control and surfaces (blow-up). Diver is asymptomatic and a compression chamber is not available.

PROCEDURE

✔ Return diver to 15m for 4 minutes (Table 1) or 50ft.

✔ Complete total decompression schedule.

■ VIOLATION OF 7 MINUTE SURFACE INTERVAL — SURD O2

Where the 7-minute surface interval of a surface decompression with oxygen has been exceeded but the diver remains asymptomatic, either:

✔ treat in accordance with Table USN Table 5 (section 11) if the surface interval of a surface decompression with oxygen exceeds 7 minutes but is less than 30 minutes; or

✔ treat in accordance with Table USN Table 6 (section 11), if the surface interval of a surface decompression with oxygen equals or exceeds 30 minutes.

■ DECOMPRESSION STRESS DURING SURFACE INTERVAL—SURD O_2

During the surface interval (SI) of a surface decompression with oxygen dive, the required decompression has been intentionally violated in order to take the diver out of the water and complete the decompression in a recompression chamber. At the completion of the surface interval, the diver is re-pressurized in the chamber to a depth of 12m (40ft), deeper than called for by the decompression schedule. The diver is given additional decompression during the chamber phase of the surface decompression with oxygen profile for the increased stress of the surface interval.

During the surface interval, the diver is exposed to a higher level of decompression stress than would be encountered if in-water decompression only had been executed. Therefore, the diver may experience signs or symptoms of decompression stress. Manned validation has indicated that when symptoms do occur during the surface interval, they are almost always very mild and late into the surface interval.

In addition, the symptoms usually completely resolve during the compression to 12m (40ft) in the chamber. Experimental dives have demonstrated that the divers who experienced surface interval symptoms had the same incidence of decompression illness after the completion of the dive as those divers who did not experience signs or symptoms during the surface interval.

Therefore, during surface decompression with oxygen diving, when all signs and symptoms of surface interval stress have completely resolved by the time the diver is confirmed on oxygen at 12m (40ft), the decompression profile is to be completed as planned.

When the signs and symptoms of surface interval stress have not completely resolved by the time the diver is confirmed on oxygen at 12m (40ft), it should be treated as decompression illness. The diver should be immediately compressed to 18m (60ft), treatment in accordance with table, USN Table 6 (section 11) initiated, and a medical practitioner appropriately trained in underwater medicine contacted.

DCIEM - OMITTED DECOMPRESSION FLOW CHART (ODFC)

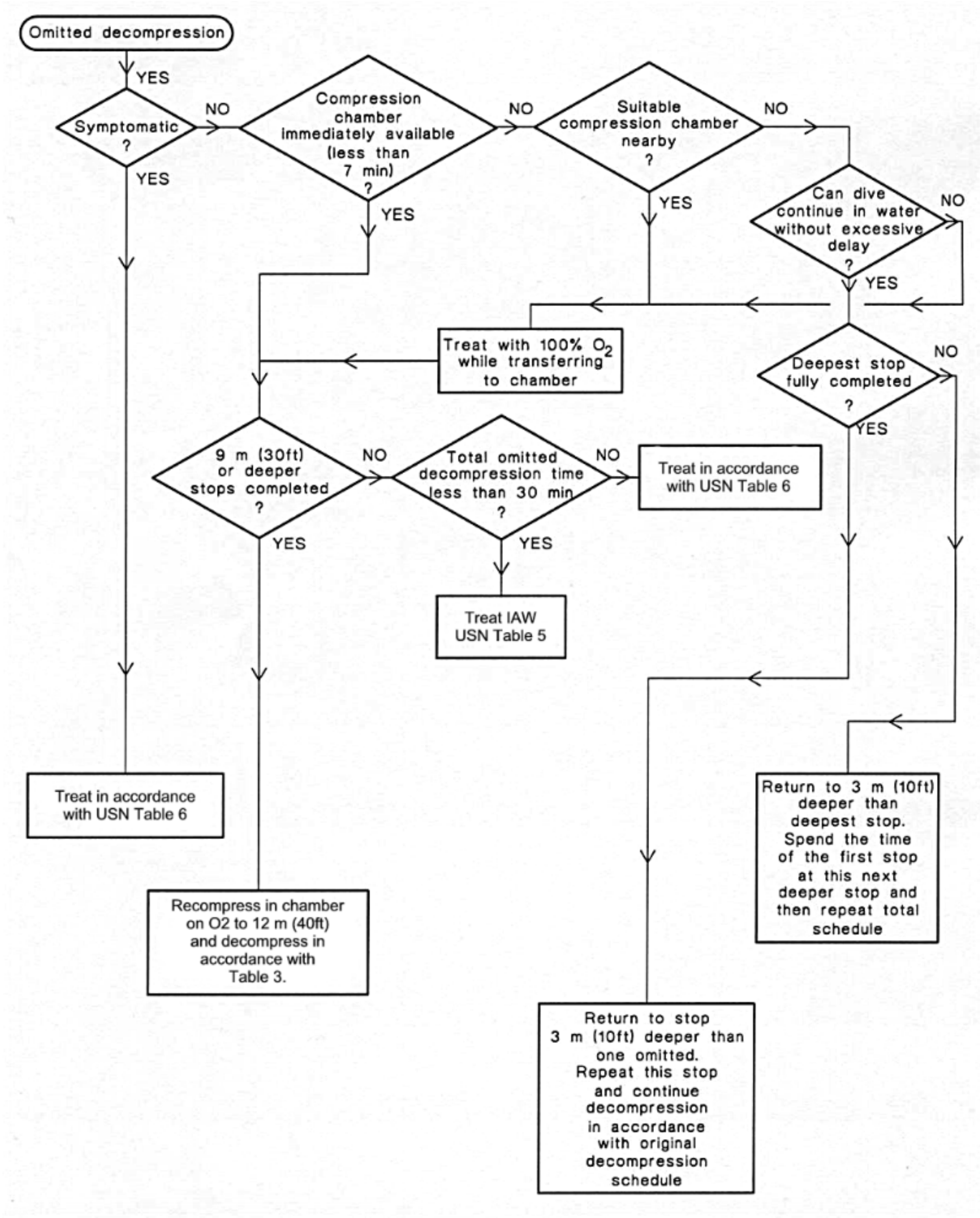


Figure 8: DCIEM - Omitted Decompression Flow Chart (ODFC).

DEPTH CORRECTIONS FOR DIVING AT ALTITUDE

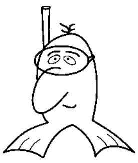
INTRODUCTION

Depth corrections for diving at altitude are given in Table 5. The depth corrections in these tables have not been experimentally validated and have been derived by recalculating the Standard Air Decompression tables (Table 1) at different altitudes. They should not be used with any other published tables.

The corrections for altitude shown in Table 5 only apply for divers who have been acclimatized at that altitude, i.e. for those who have spent at least 12 to 24 hours at the altitude of the dive site. Corrections to the depth would be greater for those who have not acclimatized.

If diving at altitude is conducted within 24 hours of arriving at the altitude of the dive site, apply an additional 3m (10ft) to the actual maximum depth of the dive used in Table 5. After 24 hours, this additional correction is not required (see Example 2).

PROCEDURE



The procedure for using Table 5 is as follows:

✔ Establish the altitude of the dive site and determine the actual maximum water depth of the dive.

✔ Find the correction for the actual depth according to the altitude from Table 5 and add this correction to the actual depth to obtain the effective depth (ED).

✔ Determine the decompression schedule from the appropriate decompression table by applying the effective depth and the actual planned bottom time.

✔ Replace the stop depths from the normal decompression table with the actual stop depths shown at the bottom of Table 5 (the stop times are not changed).

✔ Decompress on this altitude schedule in accordance with normal procedures using the regular travel rates, unless the altitude is above 1524m (5000ft), in which case reduce the ascent rate to 15m (50ft)/minutes.

EXAMPLE

Altitude of dive site 2195m (7200ft).

Dive 30m (100ft), Bottom time 23 minutes.

Decompression by Standard Air Decompression (Table 1).

PROCEDURE

✔ Enter Table 5. Depth correction for 2195m (7200ft) is +9m (+30ft).

✔ Effective depth (ED) of the dive is 30m +9m =39m (100ft + 30ft = 130ft).

✔ For 39m/25 minutes Table 1 calls for;

- ☞ 6m—7 minutes stop
- ☞ 3m—11 minutes stop
- ☞ Repetitive group H

✔ From Table 5, actual decompression schedule, corrected for stop depths, as follows:

- ☞ 7.5m—5 minutes stop
- ☞ 5.0m—7 minutes stop
- ☞ 2.5m—11 minutes stop

EXAMPLE

Altitude of dive site 2195m (7200ft).

Dive 30m (100ft), bottom time 23m.

Unacclimatised diver.

Decompression by Standard Air Decompression (Table 1).

PROCEDURE

Apply depth correction. Actual maximum depth of dive is 30m +3m =33m (100ft + 10ft = 110ft).

Enter Table 5. Depth correction for 2195m (7200ft) is +12m (+40ft).

Effective depth (ED) of dive is 33m + 12m = 45m (110ft + 40ft = 150ft).

For 45m/25 minutes, Table 1 calls for:

- ✔ 12m—4 minutes stop
- ✔ 9m—5 minutes stop
- ✔ 6m—8 minutes stop
- ✔ 3m—23 minutes stop
- ✔ Repetitive group J

From Table 5, actual decompression schedule, corrected for stop depths, as follows:

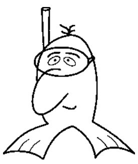
Table 5 calls for:

- ✔ 9.5m—4 minutes stop
- ✔ 7.0m—5 minutes stop
- ✔ 5.0m—8 minutes stop
- ✔ 2.5m—23 minutes stop

T5 Table 5 - Depth Corrections – Diving At Altitude

T5

Actual depth m	Depth correction at altitude, m								
	100 to 299	300 to 599	600 to 899	900 to 1199	1200 to 1499	1500 to 1799	1800 to 2099	2100 to 2399	2400 to 3000
9	+0	+3	+3	+3	+3	+3	+3	+6	+6
12	+0	+3	+3	+3	+3	+3	+6	+6	+6
15	+0	+3	+3	+3	+3	+6	+6	+6	+6
18	+0	+3	+3	+3	+6	+6	+6	+6	+9
21	+0	+3	+3	+3	+6	+6	+6	+9	+9
24	+0	+3	+3	+6	+6	+6	+9	+9	+12
27	+0	+3	+3	+6	+6	+6	+9	+9	+12
30	+0	+3	+3	+6	+6	+9	+9	+9	+12
33	+0	+3	+6	+6	+6	+9	+9	+12	+15
36	+0	+3	+6	+6	+6	+9	+9	+12	+15
39	+0	+3	+6	+6	+9	+9	+12	+12	+15
42	+0	+3	+6	+6	+9	+9	+12	+12	+18
45	+3	+3	+6	+6	+9	+9	+12	+15	+18
48	+3	+6	+6	+9	+9	+12	+12	+15	+18
51	+3	+6	+6	+9	+9	+12	+15	+15	+21
54	+3	+6	+6	+9	+9	+12	+15	+15	-
57	+3	+6	+6	+9	+12	+12	+15	-	-
60	+3	+6	+6	+9	+12	+12	-	-	-
63	+3	+6	+6	+9	-	-	-	-	-
66	+3	+6	-	-	-	-	-	-	-
69	+3	-	-	-	-	-	-	-	-



NOTE: See over the page for adjustments to actual stop depths.

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

T5

Sea Level Stop depth, m	Actual decompression stop depth at altitude, m								
	100 to 299	300 to 599	600 to 899	900 to 1199	1200 to 1499	1500 to 1799	1800 to 2099	2100 to 2399	2400 to 3000
3	3.0	3.0	3.0	3.0	3.0	2.5	2.5	2.5	2.5
6	6.0	6.0	6.0	5.5	5.5	5.0	5.0	5.0	4.5
9	9.0	9.0	8.5	8.5	8.0	7.5	7.5	7.0	7.0
12	12.0	12.0	11.5	11.0	10.5	10.0	10.0	9.5	9.0
15	15.0	14.5	14.0	13.5	13.0	12.5	12.0	12.0	11.5
18	18.0	17.5	17.0	16.5	16.0	15.0	14.5	14.0	13.5
21	21.0	20.5	20.0	19.0	18.5	17.5	17.0	16.5	16.0
24	24.0	23.5	22.5	21.5	21.0	20.0	19.5	19.0	18.0
27	27.0	26.0	25.5	24.5	23.5	22.5	22.0	21.0	20.0

THERAPEUTIC RECOMPRESSION/OMITTED DECOMPRESSION

AS/NZS 2299.1:1999 Appendix F6 gives procedures for omitted decompression (p 122). *Table F4, p 124* gives treatment for omitted decompression.

SAFETY USING TABLES

When making calculations using tables, it is common practice to use safety factors. Some examples of ways this is done include:

RISK CONTROLS FOR CALCULATIONS USING TABLES

BROAD CATEGORY	RISK CONTROL MEASURE	ACTION BY DIVE SUPERVISOR
Planning	Use conservative tables and add safety factors to plan dives	Use the tables in AS/NZS 2299.1 (which are generally more conservative than other commonly used tables). Apply following safety factors: ✔ Choose exact or next deepest depth ✔ Choose exact or next longest time ✔ Add safety stops ✔ Slow down ascent to approx 10 metres/minute ✔ Use nitrox on an air table ✔ Time the stops at the depth of the stop, not from leaving the bottom

BROAD CATEGORY	RISK CONTROL MEASURE	ACTION BY DIVE SUPERVISOR
Planning	Shorten your allowable bottom time to cater for predisposing factors for decompression illness	Assess predisposing factors for each diver and apply 10% safety factor to bottom time for each predisposing factor, for example: ✔ Every 10 kg over normal weight ✔ Every decade over age of 40 ✔ Cold conditions ✔ Exertion Do not allow divers to dive if unwell. Ensure divers are well hydrated.

First Edition — December 2003; Revision (0)

REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

8 CHAPTER 8 – CONTINGENCY PLANNING

CONTINGENCY PLANNING

INTRODUCTION

An important part of managing overall risk is planning for contingencies. Contingency planning includes planning for possible changes to the task itself, the conditions of the task, environmental conditions, as well as planning for emergencies.

CHANGES TO THE WORK METHOD OR ENVIRONMENTAL CONDITIONS

It is important when you are planning an alternative approach to a task, that you consider any possible changes to the hazards or to the level of risk. By planning for possible changes in the work method, you will have the opportunity to manage the risk properly.

Another part of contingency planning is estimating how much bottom time the diver is likely to need, and what possible problems could occur that might increase the bottom time. Plan for any contingencies by knowing whether the diver is likely to come close to the maximum bottom time limits.

Having to make unplanned changes to the way you do a task at the dive site puts you under much more time pressure. It is much more difficult to fully assess the changed risk when you are on-site. If, despite your best planning efforts, this does occur – and it may – make sure that you take the time to consider any changes in risk, and consult with the team if appropriate. Document what you do to assess the risk and decide whether it is appropriate to go ahead with the changed approach.

Another useful habit to get into is continually checking on the progress of the task at the dive site and the environmental conditions. From this, you can judge whether it is likely to require putting a contingency plan into action. This allows you plenty of time to think about the best course of action.

EMERGENCY PROCEDURES

The next part of contingency planning is to ensure the availability of emergency assistance, both from within the diving unit and from outside sources as necessary.

This section of the dive planning process is designed to ensure that procedures are in place to cope with any foreseeable emergencies resulting from the diving operation. The procedures put in place will vary depending on the degree of remoteness and isolation of the dive site and access to formal emergency response services and resources such as specialist hyperbaric medical advice, rescue helicopter services, ambulance, air ambulance, SES, police rescue, and so on. A diving organisation may have pre-prepared emergency procedures for dive sites at which they regularly conduct dive operations. In this case, it is important to check that the details are current.

The procedures must include:

- ✔ the identification and contact details for all relevant agencies – particularly police and ambulance, and
- ✔ detail of actions to be taken in specific circumstances – eg; traumatic injury, hyperbaric emergency (eg CAGE, DCI, pulmonary barotrauma).

It could include best access routes to relevant services including names of streets or roads, map references including topographic grid references if appropriate, distances to or from towns or facilities, communications channels/frequencies for relevant agencies such coast guard and water police, diving support vessels and so on.

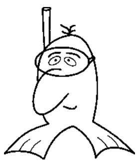
REVISED BY: Active Learning Partners (Bronwen Campbell), Ian A. Milliner, and Paul Bulter **DATE & TIME:** 24-Feb-05 10:26
FILE REF: c:\documents and settings\ian milliner\my documents\data-1\milly\adas\text books\supervisor\a-dive supervisor - section 5.doc
ADAS REF: This Section corresponds to Module 6.5, Manage risk associated with dive operations.

9 CHAPTER 9 – SUMMARY

RISK MANAGEMENT

- ✔ General diving risk management involves having a thorough knowledge of physics and physiology and the effects on the diver of breathing and working underwater in changing pressures and temperatures.
- ✔ Specific risk management includes assessing site and task-specific risks, selecting risk control measures, planning for contingencies.
- ✔ Risk control measures can be broadly categorised under planning, training, supervision and equipment.
- ✔ Risk control relating to buoyancy includes ensuring appropriate equipment, training, and controlling the rate of ascent when lifting.
- ✔ Risk control measures for risks involving light and sound transmission include training and underwater lighting. Eliminate unnecessary noise and remove divers from water when detonating explosives.
- ✔ Risk control measures associated with increased thermal conductivity include appropriate suit underwater and clothing or shelter on the surface.

AIR DECOMPRESSION TABLES



- ✔ Tables are used to assist in planning dive depths and times within safe limits. The details vary according to the decompression model used.
- ✔ There are different tables for standard air decompression, repetitive diving and therapeutic recompression.
- ✔ The DCIEM (Defence and Civil Institute of Environmental Medicine) tables are reputable and are the basis of most of the tables in *AS/NZS 2299.1:1999*.
- ✔ You should not swap between versions of tables during diving operations.
- ✔ Safety factors should be included when using the tables.
- ✔ The ADAS risk assessment template provides a basis on which to allocate a numerical value to the risk and calculate a risk factor.
- ✔ If a Risk Assessment produces a risk rating of more than 9, **no diving will take place** until control measures are introduced to reduce the risk.

✔ A job safety analysis involves breaking a job into sequential steps and identifying hazards associated with each step of a job. Control measures are put in place to minimise the risk to personnel, environment and property.

✔ Contingency planning includes possible changes to the work method, work conditions, environmental conditions and preparation for potential emergencies.

✔ Standard emergency procedures need to be checked for currency for every dive operation.