The
Inshore Diving
Supervisor's Manual

(Second Edition - Issue 2 – June 2011)

The following table summarises the changes made for Issue 2.

The affected pages for each section are included after the change record for printing and updating

From Page 3 to the end of this document, the replacement pages are set up for duplex printing (2 sided) printing using A5 size paper.

Issue 2 - Change Record

Section	*Page No:*	*Section*	*Change Summary*
Contents	3	R&UR	Issue 2 section updated
1	-	-	No changes made.
2	8	1.3, 11	Descriptions updated, example hazard rating matrix added.
3	9	2.3, 5	Reference to ACoP removed.
	19	9, 1	Reference to Manual page 55 removed.
	20	12, 3	Spelling error corrected on line 2
4	13	3.1, 1-3	Beaufort scale table added, Sea area forecast terminology added. Additional page makes use of page 11.
	16	3.3, 3	Spelling error corrected on line 4.
	17	3.4, 10	Spelling error corrected on line 3.
5	7	2.1, 2&4	Spelling errors corrected.
	8	2.2, 4	Affirmative reduced to 'Affirm'
	9	Fig 5/1	Affirmative reduced to 'Affirm'
	10	2.3, 1	Wording of whole section improved
	16	3.2, 6	Spelling error in DMAC 07 table corrected.
	17	3.2, 7	14 on line 2 removed as not applicable.
	20	3.6, 3	Reference to 2m removed, wording improved.
	21	3.8, 8	Wording improved.
	27-31	All	Section numbering corrected to match contents.
	28	4.2, 12	Reference to BS EN 14931:2006 PVHO added.
	30	4.5, 7	Wording of sub-section improved.
	31	3.7, 2	Spelling error corrected.
6	1	Front	Photo provided courtesy of SADS Ltd
7	21	2.2, 6	10 corrected to 33 on imperial formula (Lower).
	29	2.8, 4	Reference to US Gals corrected on bottom formula.
	37	3.3	Additional conversion added: CuFt – CuM both ways, msw – fsw both ways.
8	21	18, 2&4	Sternum depress corrected. 2010 ILCOR added.
	40	47,2	Spelling error corrected.
9	9	4, 16	Figure 9/1 added summarizing testing requirements.
	10	5, 6	Use of PTFE in O^2 environments clarified.
	15	9, 1&4	Terminology and spelling corrected.
10	*This Section will not be subject to Update*		

Additional Note:

The footer for each section has been updated to show the section and issue date:

The Inshore Diving Supervisors Manual – Section 9	*Second Edition - Issue 2 - 2011*

This is only applicable on Manuals printed after 20th June 2011.

Revision and Update Record

Section Reference and Title		Date of Issue 1	Date of Issue 2	Date of Issue 3	Date of Issue 4	Date of Issue 5	Date of Issue 6
1	**Introduction**	20/2/11	-				
2	**General Health & Safety**	20/2/11	20/6/11				
3	**Management**	20/2/11	20/6/11				
4	**Dive Planning and Emergencies**	20/2/11	20/6/11				
5	**Operation Elements**	20/2/11	20/6/11				
6	**Important Considerations**	20/2/11	-				
7	**Diving Physics and Calculations**	20/2/11	20/6/11				
8	**Diving Medicine and First Aid**	20/2/11	20/6/11				
9	**Gas Handling and Awareness**	20/2/11	20/6/11				
10	**Users Own Reference Material**	*This Section will not be subject to Update*					

ADC may, from time to time, make available updates of complete Sections of the Manual for owners to download, print and insert themselves.

An updated Revision Record will be issued with any updates made available, indicating the date on which the issue was officially released.

It is the responsibility of the manual owner to keep the Manual up to date by making occasional visits to the ADC website and downloading any section content.

ADC accepts no responsibility for persons who fail to access updates, and continue to refer to material that is considered to be out of date.

ADC Secretary. June 2011.

1.3 Risk Assessment

1. A risk assessment is an important step in protecting workers and business activities, as well as complying with the law. It helps those involved focus on the risks that may exist in the task or the site.
2. In many instances, straightforward mitigation efforts can readily control risks, as a simple example ensuring oil or spillages are cleaned up promptly so people do not slip, tools are stowed when not in use and cables or hoses are grouped and placed where the hazard to those working in the area are reduced or eliminated.
3. The law does not expect you to eliminate every risk, but you are required to protect people as far as 'reasonably practicable'.
4. There is not just one way to do a risk assessment, there are other methods that work just as well, particularly for more complex risks and circumstances. However, the method summarised here is considered to be the most straightforward for the majority of
5. **What is risk assessment?** A risk assessment is simply a careful examination of what, in your work, could cause harm to people, so that you can weigh up whether you have taken enough precautions or should do more to prevent harm. Workers and others have a right to be protected from harm caused by a failure to take reasonable control measures.
6. Accidents and ill health can ruin lives and adversely affect businesses when output is lost, equipment is damaged or people are injured. There is a legal requirement to assess the risks as part of diving so that an effective plan can be put in place a plan to control the risks.
7. Follow these five steps to conduct a Risk Assessment:
   Step 1 Identify the hazards
   Step 2 Decide who might be harmed and how
   Step 3 Evaluate the risks and decide on precautions
   Step 4 Record your findings and implement them
   Step 5 Review your assessment and update if necessary
8. Don't overcomplicate the process. In some work areas, the risks will be well known and the necessary control measures easy to apply.
9. You don't have to be a health and safety expert to conduct an assessment. The diving Supervisor, as a competent person, may be adequately knowledgeable to complete an assessment, or review and update an assessment started by someone else.
10. But remember, as the Supervisor, you are responsible for seeing that the assessment is carried out properly, and the control measures are implemented.

11. When thinking about your risk assessment, remember:

    * **What is a hazard?:** Anything that may cause harm, such as chemicals, electricity, using ladders or working over a quayside, to name a few.
    ** **What is a risk?:** The chance, be it high or low, that somebody could be harmed by the hazard.
    *****What is hazard rating?:** To simplify the assessment of risk it is common practice to apply a value to a risk according to the seriousness of a potential accident and the probability of that accident taking place.

Figure 2/1: *An example of a hazard rating matrix*

Severity **Probability**	**1**	**2**	**3**	**4**	**5**
1	Low	Low	Low	Low	Low
2	Low	Low	Medium	Medium	Medium
3	Low	Medium	Medium	Medium	Medium
4	Low	Medium	Medium	**High**	**High**
5	Low	Medium	Medium	**High**	**High**

1.4 Personal Protective Equipment

1. Employers have basic duties concerning the provision and use of personal protective equipment (PPE) at work and this sections, gives a brief introduction to what you need to do to meet the requirements of the Personal Protective Equipment at Work Regulations 1992 (as amended).

2. **What is PPE?** PPE is defined in the Regulations as ‘all equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work and which protects him against one or more risks to his health or safety’, e.g. safety helmets, gloves, eye protection, high visibility clothing, safety footwear, safety harnesses and even dry suits.

3. Hearing protection and respiratory protective equipment (including diving helmets) provided for most work situations are not covered by these Regulations because other regulations apply to them. However, these items need to be compatible with any other PPE provided.

4. **What do the Regulations require?** The main requirement of the PPE at Work Regulations 1992 is that personal protective equipment is to be supplied and used at work wherever there are risks to health and safety that cannot be adequately controlled in other ways.

5. The Regulations also require that PPE:
    * *is properly assessed before use to ensure it is suitable;*
    * *is maintained and stored properly;*
    * *is provided with instructions on how to use it safely; and*
    * *is used correctly by all employees.*

- *Work carried out and tools and equipment used.*
- *Any decompression illness, discomfort or injury suffered by the diver*
- *Any other factors relevant to the diver's safety or health or any emergency or incident of special note which occurred during the dive.*
- *The company stamp, affixed after the daily record has been signed by the diver and supervisor.*

2.4 Diving operations log books

1 There must be a daily record of all activities carried out during a diving operation. The minimum level of information required is:

- *Name and address of the diving contractor*
- *The date to which the entry relates*
- *The name of the supervisor making the entry*
- *Location of the diving project, including the name of any vessel from which diving is taking place.*
- *The names of all those taking part in the diving operation as divers or other members of the diving team*
- *The ACOP which applies to the diving operation.*
- *Purpose of the diving operation*
- *Breathing apparatus and mixture used by each diver*
- *Time at which each diver leaves atmospheric pressure and returns to atmospheric pressure plus his bottom time.*
- *Maximum depth reached by each diver*
- *Decompression schedule, containing details of pressures (or depths) and the time spent by divers at those pressures (or depths) during decompression.*
- *Emergency support arrangements*
- *Any emergency or incident of special note which occurred during the diving operation, including details of any DCI and treatment given.*
- *Details of the pre-dive inspection of all plant and equipment being used in the diving operation.*
- *Any defect recorded in the functioning of any plant used in the diving operation*
- *Particulars of any relevant environmental factors during the operation*
- *Any other factors likely to affect the safety or health of any person engaged in the operation.*
- *Company stamp, if appropriate.*

2.5 Chamber log books

1 When a chamber is used, the chamber log book is effectively part of the diving operations log book. It will normally contain:

- *The name of the supervisor*
- *The name of the person operating the chamber.*
- *Purpose of the pressurisation. This may be surface decompression or therapeutic.*
- *Decompression or treatment tables used.*
- *The names of divers under pressure*
- *The date and time of pressurisation, and the pressurisation procedure.*
- *Gases on line to the control panel and details of any changes*
- *Times of calibration of analysis equipment*
- *Details of chamber activities such as medical lock operations and filter changes.*
- *Decompression details*
- *Any cases of DCI or other illness or injury and treatment details.*
- *Any other factors likely to affect the safety or health of the divers.*

2.6 Reporting

1 In addition to keeping the diving operations log, the diving supervisor is normally responsible for a variety of reports, which may include:

- *Daily report*
- *Near miss, incident and accident reports*
- *Medical log*
- *Shipping records and shipping returns*
- *Equipment failures and damage report*

2.7 Checklists

1 Checklists are normally prepared as part of the planning for the diving operation. The person carrying out the checks may also be required to sign the completed checklist. Checks might include:

- *A visual and touch inspection before any power is turned on.*
- *An examination of the system for cracks and dents, loose parts, unsecured wires and hoses, oil spots, discolouration, dirty camera lens etc*
- *A function check of each component. Even if a valve is in the position required by the checklist, it should be operated and returned to the correct position (subject to any safety considerations).*

8. Trainee supervisor

1. A trainee supervisor can only supervise a dive in the presence of an appointed diving supervisor. He must not supervise a dive alone, and cannot be used as a relief for meal breaks etc.

2. Whilst there is no specific role within the DWR or ACoP for the Trainee Supervisor, Industry recognises that without the ability to obtain some practice on site during an actual diving operation, the quality of available supervisors in the future may be affected.

9. Diver

1. He must be appropriately qualified. Duties and responsibilities may include:
   * *Undertaking dives and other duties as required by the supervisor*
   * *Informing the supervisor if there is any medical or other reason why he cannot dive.*
   * *Ensuring that his personal diving equipment is working correctly and is suitable for the planned dive*
   * *Ensuring that he fully understands the dive plan and is competent to carry out the planned task*
   * *Knowing the routine and emergency procedures*
   * *Reporting any medical problems or symptoms that he experiences during or after the dive*
   * *Reporting any equipment faults. other potential hazards, near misses or accidents*
   * *Checking and putting away personal diving equipment after use*
   * *Keeping his log book up to date and presenting it for signing by the supervisor after each dive.*
   * *Knowing and understanding his own responsibilities under the Health and Safety at Work Act. either as an employee or as a self-employed person.*

10. Tender

1 Provides general surface support for the diving operation. The diving supervisor must ensure that he is competent to carry out all the tasks that he is required to undertake. These may include:
   * *Umbilical handling*
   * *Operation of support equipment*
   * *Cleaning divers' equipment • Operation of winches or tuggers.*

11. Surface Crew

1. The surface crew will normally consist of qualified divers. together with non diving specialists like riggers or technicians. All members of the surface crew should:
    * *Be briefed on the work being carried out by the diver*
    * *Be made aware of the physical limitations of diving work*
    * *Understand ways in which equipment can be prepared on the surface to assist the diver*
    * *Be aware of the delays in communicating with the diver and the effect this has on lifting and other operations*
    * *Be familiar with good rigging practice and seamanship and know about safe working loads and safety factors*
    * *Wear suitable footwear, clothing, helmets, buoyancy aids, safety lines as appropriate*

12. Training and familiarisation

1. The supervisor must be satisfied that all Members of the diving crew, and any other personnel involved in the operation, are competent to carry out the tasks required of them.

2. A diver's competence can nornlal1y be assessed from his log book. If there is any doubt about his competence for a specific task, the supervisor should discuss the procedures in detail with the diver to assess his level of knowledge.

3. If the operation involves any unfamiliar or complex tasks, it may be necessary to arrange training before the operation commences. This would normally be carried out in shallow water. For simpler tasks, a pre-dive description of the task might suffice.

4. Newly qualified divers may only have a small amount of experience in basic diving tasks, and may be unwilling to admit it. Divers who are gaining experience and competence require support and assistance from the diving crew and from the supervisor.
5. Members of the surface crew, especially those who are non-divers, may require briefing or even a formal training session before the operation commences.

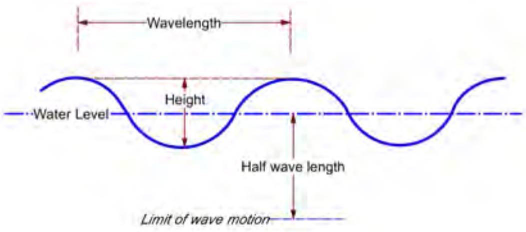
6. Specific safety training for all personnel may include:
    * *Site specific induction or safety training*
    * *Task-specific training outlining any special hazards associated with the tasks being carried out.*
    * *Refresher training at regular intervals*

3 Wind is said to back when it changes direction in an anti-clockwise direction (from south west to south-south west, for example) and to veer when it changes direction in a clockwise direction.

4 In wave forecasts, maximum wave height is defined as the greatest wave height observed in a 10 minute period.

Significant wave height is the average height of the largest one third of all waves observed in a 10 minute period.

Figure 4/5:



5 Precipitation is a general term covering drizzle, rain, sleet, hail and snow.

6 The classification of clouds is based on a system introduced by the British scientist Luke Howard in 1803. He recognised three basic types of clouds. Cirrus are high, streaky clouds (from the Latin for hair).

Cumulus are heaped clouds (Latin for a pile). Stratus are layers or sheets of clouds (Latin for a layer). They can be further described by adding the term nimbus to indicate a cloud producing precipitation, or alto meaning high.

7 These descriptions are combined as necessary. Cumulo-nimbus, the typical thunder cloud, is a heaped cloud producing precipitation. Nimbo-stratus is the continuous layer of grey cloud associated with steady rain.

Cirrocumulus are high streaky clouds starting to heap together. There are further classifications, based on height and more specific descriptions but the basic terms are adequate for everyday use.

3.2 Weather systems

1 Although advances in technology have made it possible for work to continue in relatively harsh conditions, all diving operations are ultimately weather dependent. The Diving Supervisor will rely on weather forecasts and his own observations of the weather.

2 All weather systems are driven by the heat received from the sun. The sun heats the earth's surface, which in turn heats the atmosphere. This produces an unstable system, with hot air close to the surface continually rising into the atmosphere.

3 In general terms, air pressure is low at the equator where the air is hotter and less dense, and high at the poles. This pressure difference sets up an overall air flow, from the poles to the equator. There, the air rises and returns to the poles at high altitude.

4 This overall flow is complicated by a large number of factors: the circulation of the earth, ocean currents, the periodic EI Nino event, the uneven heating of the continental land masses, the greenhouse effect, catastrophic events like large volcanic eruptions and long term effects like changes in solar activity and changes in the tilt of the earth.

5 At present, the general circulation is driven by alternating bands of high and low pressure which give the familiar pattern of prevailing winds

- *Easterlies in the polar regions*
- *Westerlies in the temperate regions*
- *Easterlies in the tropical regions*

6 Because of their importance in world trade, the tropical easterlies which carried European sailing ships across the Atlantic, are still referred to as the trade winds. There are also two calm zones, the Doldrums at the equator and the warm sunny high pressure areas in the tropics .

7 Superimposed on this pattern are the regional and seasonal weather systems: depressions, anticyclones, monsoons, hurricanes, tornadoes and all the winds and fogs that are governed by local conditions.

8 Winds blow into low pressure systems and out of high pressure systems, but are deflected by the rotation of the earth. In the northern hemisphere, if you stand with your back to the wind, the centre of low pressure is to your left, in the southern hemisphere it is to your right.

9 Most of the bad weather in temperate regions is caused by lows or depressions, which are compact and mobile low pressure systems. A typical temperate zone depression has a diameter of about 1600 km (1000 miles) Associated with most depressions are warm and cold fronts. A warm front is the leading edge of a mass of relatively warm air, a cold front is the leading edge of a mass of relatively cold air. The temperature difference between the warm and cold air masses may only be a few degrees.

10 An approaching depression, with warm and cold fronts, shows a well defined sequence of weather:

- *High cirrus clouds are driven ahead of the storm by high altitude winds. The sky remains clear and visibility is often exceptionally good. Pressure begins to fall slowly. There may also be the onset of a long swell, originating from the storm.*
- *The clouds thicken and become lower. Initially, the cloud layer is translucent and there is often a halo around the sun or moon.*
- *The wind freshens and backs. There is a slow temperature rise, which may only be noticeable with a thermometer. Wave height Increases.*
- *The clouds become low and dense and steady drizzle, rain or snow starts to fall.*
- *As the warm front passes, the wind slackens and veers. The rain or snow decreases or stops and the clouds become higher and thinner. Visibility is generally poor.*
- *As the cold front approaches, the wind backs and becomes squally. Clouds thicken and become heavy and towering cumulo-nimbus.*
- *The passage of the cold front is characterised by squally, unstable conditions, cumulo-nimbus clouds, heavy rain, sleet or snow showers and sometimes thunder.*

11 The rate at which these changes occur depends on the speed at which the depression is moving. If the centre of the depression passes directly over the worksite, pressure will fall and then rise again and there will a be period of calm as the centre passes over. The pressure is unlikely to fall lower than about 970mb in the centre. Wind speeds around a depression are typically 40 -50 knots

12 High pressure systems are stable and slow moving with clear skies and low wind speeds. In summer, they are typified by bright sunshine and calm seas. In winter, the temperature is low. because of the absence of insulating cloud cover, and there is often fog or poor visibility. Pressure stay be up to 1010mb.

3.3 Local weather

1 Thunderstorms may occur in the cold sector of a depression. or may develop locally during warm weather. The development occurs when a mass of air is heated from below. Powerful convection currents are established and the air mass becomes turbulent.

2 A pre-thunder sky is characterised by dense cirrus cloud, associated with banks of altocumulus and sometimes cumulus. Thunder clouds have a huge vertical development, with a rapid development and expansion at higher altitudes. The top of the cloud is often blown out into a characteristic anvil shape by high altitude winds.

3 Below the thunder clouds are squalls, violent gusts of wind and heavy falls of rain or hail. The thunder clouds typically collapse quickly, to be replaced by others. A thunder sky shows a confused mass of dense clouds, building, collapsing and re-forming.

4 Close to land, winds may be influenced by the difference in heating between land and sea. During the day, the land heats more rapidly than the sea, the air heats and rises and cool air is drawn in from the sea. At night, the land cools but the sea retains its heat. Air rises over the sea and is drawn in from the land. Onshore winds during the day, and offshore winds during the night are typical in an otherwise clear, stable conditions.

5 Powerful local winds occur in many parts of the world. They may be generated by the topography of the local land mass, but their effects can be felt far out to sea.

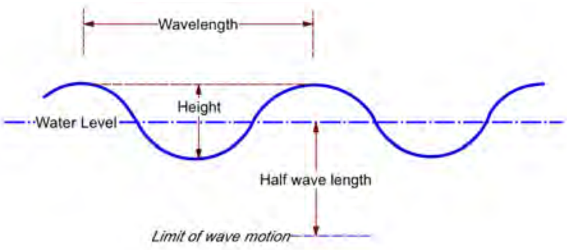
6 Fog forms when warm air blows over a cold surface. This may occur along a coast, or where warm and cold ocean currents meet. The mist, or sea fog along Scottish North Sea coasts, is caused by warm sea air in contact with the cold land.

3.4 Sea state

1 Most waves are wind generated. although they may also be caused by currents, seabed features or exceptional events like earthquakes, volcanic eruptions or surface or subsea landslips.

2 The dimensions of a wave are its height, from crest to trough, its wavelength, the distance between crests and the depth to which its movement can be felt.

Figure 4/5:



3 Wavelength is always much greater than height and if the ratio of height to wavelength becomes greater than about 1:13 the wave breaks. If the wave moves into shallow water it will slow down but the wave height increases rapidly. It will start to break when the water depth is equal to about half its wavelength.

4 Although waves can move at considerable speed, and transmit enormous amounts of energy, there is very little forward movement of water. The water in a wave moves vertically in a circle. An object apparently being moved horizontally by the waves is either wind blown or subject to a wind generated current or other current. Only when the wave breaks does the water start to move forward.

5 The height of a wind generated wave depends on the wind speed, the time that the wind has been blowing and the fetch. The fetch is the distance of open water that the wind has been blowing over. Wave height is also be affected by the height and direction of existing wave trains.

6 The distance that the waves will travel depends on their wavelength. Long wavelengths travel furthest, and it is common to experience a long wavelength swell generated by a wind many miles away.

7 Under normal conditions, the wave pattern is a combination of one or more wave trains. A local wind, for example, may generate waves on top of a remotely produced swell. The interference between the wave trains can produce considerable variation in wave height.

8 Where peaks of one train coincide with troughs of the other. wave heights will decrease. When peaks coincide with peaks, wave heights will increase. The wave trains are usually out of phase and peaks may only coincide every fifth wave, for example. This can establish a fairly regular pattern of changing wave heights and is the origin of the belief that the "seventh wave" is larger than the others.

9 In general, wave movement can be felt by the diver down to a depth equal to about half the wavelength. A typical wavelength is 20m (66 ft), with the turbulence felt down to 10msw (33fsw). A diver close to the surface will be badly affected by even a moderate swell. In all sea conditions, however, the consideration is not whether the diver can work, but whether he can be safely removed from the water.

10 In addition to the risk of being flung against the structure, the shallow air diver may be subject to considerable variations in pressure as the crests and troughs of waves pass overhead. This may affect his decompression if he is carrying out shallow stops in the water and in extreme cases may cause aural or pulmonary barotrauma.

11 Safe maximum conditions are hard to define. Many factors such as wave type and wave period and the behaviour of any vessel used must be considered. Waves are unlikely to pose a problem in small areas of water where the fetch is short, but can be significant on large lakes or lochs.

3.5 Tide and current

1 Tides are caused by the combined gravitational effects of the sun and the moon. When sun and moon are aligned, at full moon and new moon, the effect is at its maximum and the tidal range is at its greatest. These are known as spring tides. When the sun and moon are at ninety degrees to each other, at first and last quarters, the effect is at its minimum and the tidal range is at its lowest. These are known as neap tides.

2 The tidal range is the difference in height between low tide and high tide. It depends on the phase of the moon, the bottom and the shape of the coastline. Neighbouring harbours may have quite different tidal ranges.

3 The times and heights of high and low tides may be found by referring to tide tables. They can be affected considerably by strong winds. Before the Thames Barrier was built, for example, the coincidence of a spring tide and a storm in the English Channel would have caused a tide high enough to cause serious flooding in London.

4 The greatest tidal range, of about 18 metres (60 ft) occurs in the Bay of Fundy between New Brunswick and Nova Scotia. The time for the tide to travel up the inlet coincides roughly with the rise and fall of the tide in the open sea and the resonance effects produce the large range. A similar effect occurs in the Bristol Channel, where there is a tidal range of 15 metres (50 ft)

5 On average, the tide rises for 6 hours and 12 minutes. This is the rising, or flood tide. At the top of the flood, the level remains constant for a short period. This is the high water slack. The falling or ebb tide then runs for about 6 hours 12 minutes until low water slack Then the cycle begins again. In some areas, like the English Channel, flood and ebb tides may run for considerably less than six hours.

6 The change in water depth caused by the tide will clearly affect dive times and duration. In some cases, there may also be legal implications. UK legislation imposes a maximum depth for air diving of 50 msw (165 fsw). Working depth may be less than 50mSW at low tide, more than 50 msw at high tide.

2. Communications.

2.1 Introduction

1 Good communication is fundamental to the safety of any operation. Communication may be by voice, written document or a by variety of signals including hand signals and rope signals. Also see Chapter 1 - Documentation.

2 The Diving Supervisor must have reliable communications with everyone involved in the operation, and needs access to all of the communications of the worksite. Communications include all available systems, word of mouth, documentation. radio, telephone, mobile phone, fax etc

3 Video is also a type of communication system, letting people see what is happening. It has also been used to transmit hand signals or written messages, when audio communication has failed.

4 The Diving Supervisor is directly responsible for communications with the diver. He must have voice communication, and be able to monitor the diver's breathing pattern at all times. He must not hand over communication to any other person except another properly appointed and qualified Diving Supervisor.

5 When an ROV is in use, the diving supervisor has overall responsibility for the safety of the whole operation. Close communication with the ROV supervisor is vital. There should be a dedicated communications link and a repeat video monitor showing the same picture seen by the ROV pilot.

- *See Information Notes relating to Communications with divers*
- *See Information Notes relating to Remotely operated vehicle intervention during diving operations*

2.2 Voice communication

1 Voice communication is used to pass clear, complete and accurate information in plain language. The basic rules of good communication are as follows:

- *Only speak if it's necessary. (If you don't have anything to say. don't say it!)*
- *Think before you speak. and speak slowly and clearly.*
- *Say who you are speaking to and where you're speaking from.*
- *Ensure that the recipient of the message repeats all instructions back, to verify them.*
- *Use the standard words and phrases correctly. If in doubt. use plain English.*
- *Let the other person know when you have finished speaking, usually by saying "over" (Except in diver/supervisor communications).*

- *Have a procedure to deal with communications breakdown. In most cases, you will carry out the last instruction received and then stop the operation. Alternative methods of communication can then be used.*

2 After establishing contact, communications often open with a readability check. The standard phrase is "How do you read?". The reply is usually given as "loud and clear", "broken", "distorted" or "faint".

3 If all crew members are familiar with the system. The standard readability scale is more precise:

Strength	
1	Unreadable:
2	Readable but with difficulty:
3	Readable now and then:
4	Readable;
5	Perfectly readable.

The response to "How do you read?" would be, for example, "Reading you strength 4".

4 The following words and phrases are widely used in voice communication:

- **Key Words:** Roger, Affirm, All stop, Come up or down, Correction , Easy, I understand your message, Yes, or you are clear to proceed, Wilco
- **Action Instruction:** Stop the action and wait for further instructions, Lift or lower. on a winch or crane, Go ahead
- **Enquiry:** How do you read? I say again, Negative, Over Out, Read back, Repeat, Say again, Say again Slowly, Speak slower, Standby That is correct, Verify
- **Acknowledgement:** Proceed with your message. How are you receiving me. Repetition of a message. No, or you are not clear to proceed. Message ended and waiting for a reply.
- **Repetition:** Message ended and no reply expected. Repeat the message as received. Similar to "say again" but usually used to emphasise a word or phrase, Do not, repeat do not, come up on the winch"
- **Confirmation:** 'Wilco', I have received all of your last transmission. This is probably the most misused phrase in voice communication. I have understood your message and will carry out the instructions. *(Only use this after you have verified the instructions by repeating them.)*

Figure 5/1:

Words and Phrases widely used in communications:	
Phrase	***Meaning***
Acknowledge	I understand your message
Affirm	Yes, or you are clear to proceed.
All STOP	Stop the action. Await further instructions
Come up or down	Lift or lower action on a winch or crane
Correction	An alteration to the previous message
Easy (Up or down)	Lift or lower slowly, very controlled.
Go ahead	Proceed with the message
How do you read?	How are you receiving me?
I say again	Repetition of last message
Negative	No, or you are not clear to proceed.
Over	Message ended, awaiting reply.
Out	Message ended, no reply expected.
Read back	Repeat message as received
Repeat	Similar to say again, but emphasised
Roger	Confirmation I have received your last.
Say again	Repeat the message
Say again from	Repeat from a given point.
Slowly	Lift or lower controlled.
Speak Slower	Slow down
Standby	Waiting for a message.
That is correct	Confirmation
Verify	Confirm the accuracy of the last message.
Wilco	I have understood and will comply.

5. When spelling out words, it is preferable to use the phonetic alphabet. It is intended for unambiguous international use, as is the pronunciation of the numbers. If there is any difficulty in remembering the phonetic alphabet, other suitable words can be used.

6. Numbers must always be given with care. It is very easy to confuse "thirty" and "thirteen", for example.

   * Always specify the units of measurement -metres, feet tonnes, kilograms..
   * Always say a number twice, once by name once as individual digits -"Thirteen, that is One, three" or "Thirty, that is three. zero".
   * Always request a confirmation of the number
   * Try to avoid using fractions. It is better to say "Four point fiver" than "Four and a half'.

* If fractions must be used, describe the fraction as well, to avoid confusion "One third, that is, One over three"

Figure 5/2:

The Phonetic Alphabet			
A	Alpha	*O*	Oscar
B	Bravo	*P*	Papa
C	Charlie	*Q*	Quebec
D	Delta	*R*	Romeo
E	Echo	*S*	Sierra
F	Foxtrot	*T*	Tango
G	Golf	*U*	Uniform
H	Hotel	*V*	Victor
I	India	*W*	Whisky
J	Juliet	*X*	X Ray
K	Kilo	*Y*	Yankee
L	Lima	*Z*	Zulu
M	Mike		

Numbers			
0	Zero	*5*	Fiver
1	Wun	*6*	Sixer
2	Too	*7*	Sev-en
3	Thuh-ree	*8*	Ait
4	Fow-er	*9*	Niner

2.3 Voice communication with the diver :

1 There must be two way voice communication with the diver at all times. Voice communications can be made more difficult by the noise of the diver's breath being exhausted, as well as other external noises including, but may not limited too, water jetting, burning, hydraulic tools etc. Communications from the surface should, as far as possible, be fitted around or be sited to avoid the main source of this noise. It is time wasting and tiring to try and talk over a loud noise.

2 If there is an urgent need to talk to the diver, most underwater tools and equipment can be switched off at the surface to reduce noise, provided there is no hazard to the diver.

3 The following basic rules make communication easier and safer:

* *Don't talk to the diver during lifts, lowers or other operations where he may need to warn surface urgently of any problems.*

3 Procedures During Diving

3.1 Introduction

1 All diving operations require a dive plan which should include a risk assessment of the diving techniques to be employed and the site-specific hazards. See Section 4.

2 There must always be enough personnel to allow the diving operation to be conducted safely and effectively.

3 Team members may carry out more than one duty, provided that they are competent to do so and that their different duties do not interfere with each other. Duties and responsibilities must be clearly defined in the dive plan to avoid confusion.

4 Suitably qualified trainees may form part of the team, but under normal conditions will not be allowed to take over the functions of the person training them. A trainee supervisor, for example, can only work under the direct control of the supervisor.

5 The divers and standby diver must all be medically fit to dive and clear of any decompression penalties. They may be unfit to dive for a variety of reasons, including colds or flu, ear infections, and stomach upsets.

6 The appointed Diving Supervisor must be in control of the operation at all times, and must be in direct two way voice contact with the diver. He must be able to monitor the diver's breathing pattern at all times. He must not hand over communication to any other person except another properly appointed and qualified Diving Supervisor.

7 Voice communications with the diver may be recorded, and the recording should be kept until it is clear that there have been no problems during or following the dive. On many sites, however, this is not practicable.

8 If possible, the standby diver should listen in to the communications with the diver. The more he knows, the more effectively he can respond in an emergency.

9 The diver's breathing equipment must supply him with a suitable gas, at a suitable rate of flow, at a suitable temperature in all foreseeable conditions, including emergencies.

10 There must be provision to maintain the diver in safe thermal balance. On some worksites he may require a hot water suit, or other type of healed suit.

11 If dry suits are used. suit inflation must be from the main gas supply, or from a separate bottle, and never from the bailout bottle.

12 If the diver is not using a helmet and working in the splash zone, or in any other area where he may be subject to significant water movement close to a structure, consideration should be given to head protection.

13 Before any dive, in addition to items on checklists, the Diving Supervisor should check the following points:

* *Are arrangements in place to recover an injured or possibly unconscious diver from the water?*
* *Is any permit to work (or other documentation) in order?*
* *Have all relevant people been informed that the dive is to take place?*
* *Have all those taking part in the operation been fully briefed on the task, potential hazards and emergency procedures?*
* *Have any valves or other items of equipment whose operation could endanger the diver been made safe?*
* *Are the minimum amounts of gas and air available at suitable pressures and minimum amounts of other consumables?*
* *Are the weather conditions suitable and likely to remain so for the duration of the dive?*
* *Are the correct signals and flags being displayed to ensure that others know that diving is taking place?*

14 Emergency procedures will be included in the dive plan and the emergency procedures given in this chapter are intended for guidance only.

3.2 Exposure limits and decompression

1 To minimise the risk of DCI the dive plan should incorporate the depth lime limits shown in the following table.

2 If the divers are breathing nitrox, the equivalent air depth (EAD) should be used to establish the maximum time limits.

3 Decompression should be carried out according to the procedures in the dive plan. There must be provision for transporting the diver to a decompression chamber in the event of DCI.

4 Dive computers must not be used. The dive, including decompression, must be under the direct control of the diving supervisor.

5 There may be rare occasions when diving in dams in mountain areas, that decompression tables may have to adjusted for altitude.

6 Restrictions on flying after diving will be stated in the dive plan.

DMAC 07 gives the following guidance:	Time before flying at a cabin altitude of....	
	2000 ft	8000 ft
No-stop air dives, with less than 60 minutes under pressure in the last 12 hours	2 Hours	4 Hours
All other diving (less than 4 hours under pressure)	12 Hours	12 Hours

7 The maximum depth for air or nitrox breathing is 50msw. The recommended maximum P02 for surface supplied diving is 1.5 bar. This limit should only be applied after taking into account possible errors in analysis equipment and depth measurement. For example, the maximum P02 might be calculated for a depth 5 msw (16 fsw) below the planned dive depth to allow for any errors or unexpected depth changes.

3.3 Availability of decompression chambers

1 The diving contractor has a responsibility to provide emergency recompression facilities, should this be necessary.

2 If the chamber is not on site, there must be provision for safe and rapid transport of the diver to the chamber.

Travel times should be based on achievable boat and/or road transit times from the actual dive site, not on travel time from the nearest roadside point.

There must always be a vehicle ready for transport. A vehicle that is designated for other work and may be off site during the day, is not acceptable as an emergency vehicle.

3 The minimum chamber requirements are normally documented in Guidance Notes and are periodically updated by industry groups.

The most recent version issued by ADC is included in the Model Format document, ***The Assurance of Diving Plant and Equipment, for Diving Contractors Working Inland / Inshore in the UK and Ireland.***

4 A helicopter may be available in emergency, but this cannot be relied upon.

5 The chamber must be fully operational, with all necessary gas supplies and there must be competent personnel available to operate the chamber.

Where the chamber is beyond the direct control of the diving supervisor, he must ensure that it is available for use during the times that the diving operation is taking place.

Tides or other operational conditions may require the diving team to work at irregular hours and staff may not be available to provide access to the chamber or operate the chamber.

6 The dive plan must record the chamber(s) that have been identified as suitable, and the arrangements that have been made for emergency recompression.

7 Oxygen must be available at the dive site, and there must be sufficient oxygen to supply the diver with 100% oxygen for the duration of the transfer to the chamber, or until the emergency services reach the casualty.

3.4 Diver's equipment

1 The diver should wear a full face mask, fitted with either an oral nasal or a mouthpiece. He must have a bailout bottle, a lifeline to surface and two way voice communication with the supervisor.

2 If there are two divers in the water, a separate stand-by diver may still be required, refer to the dive plan arrangements.

3 Wet suits are not normally suitable for commercial diving. Dry suits with suit inflation are the most popular. Air from the suit inflation should come from a separate supply, and not from the divers bailout bottle.

4 For deep or long dives some form of heated suit may be used. This is almost invariably a hot water suits. Electrical heating systems have been used but have not routinely adopted by contractors.

5 The amount of heat reaching the diver depends on the hot water flow rate and temperature at which the hot water reaches the diver.

A lower temperature and a higher flow rate can transport as much heat as a higher temperature and a lower flow rate.

A higher temperature will transfer this heat more effectively to the diver, but increases the risk of scalding.

6 Water temperature is measured at the machine but there is a considerable temperature drop in the umbilical. This temperature drop depends on the temperature at the machine, umbilical length, flow rate and sea temperature. It can usually be found from charts or tables in the hot water machine operating manuals.

7 If the water reaches the diver at temperatures in excess of about 45°C (113°F) there is a risk of scalding, blistering and hyperthermia.

Scalding typically occurs at wrists and ankles. If the temperature or flow rate is too low there is a risk of hypothermia.

8 The diver himself is not a reliable judge of temperature. After some time in the water he may start to suffer from what has been described as "thermal confusion". In other words he may not be able to assess his heating requirements adequately. He may ask for more heat to deal with a cold spot in his suit and scald himself elsewhere or he may not realise that his body temperature is dropping and become hypothermic.

9 Both hyperthermia and hypothermia are gradual in onset and will not be noticed by the diver. Symptoms that might be noticed by the supervisor are signs of fatigue or confusion, or changes in breathing pattern.

10 The hot water machine should have an audible alarm which sounds if the outlet temperature varies by 1-2°C (2-4°F).

11 If the diver asks for more heat it is generally better to increase the flow rather then raise the temperature, to avoid scalding.

3.5 Baskets and handling systems

1 Baskets and wet bells are man-riding systems and all elements of the handling system must meet the testing and certification requirements for man-riding equipment.

2 All lift wires whether intended for routine or back-up lifting must be non rotating, have an effective safety factor of 8: 1 and be as compact as possible to minimise the space requirements for their operating winches.

3 Winches, whether hydraulically or pneumatically operated, should have independent primary and secondary braking systems. They should be so constructed that a brake is automatically applied when the control lever or switch is not held in the operating position. They are not to be fitted with a pawl and ratchet gear in which the pawl has to be disengaged before lowering.

4 Lift wires suffer from frequent immersion in salt water, shock loading from waves and may pass over multiple sheaves.

They can suffer from rapid deterioration if they are not properly maintained and special maintenance procedures must be followed. All maintenance should be logged.

5 Hydraulic motors should be kept running, to maintain the system at operating pressure, even when the winch is stopped during lifting and lowering operations. A mechanical brake should be applied automatically during any such stop.

6 A wet bell or basket may have two guide wires, fixed at the ends of a clump weight to avoid spinning, a single guide wire and weight or fixed guide wires. Fixed guide wires might incorporate a "weak link" to allow at least one to be broken free for secondary recovery of the bell in an emergency.

7 The wet bell umbilical may have its own winch or simply run over sheaves for storage in a basket. Sheaves must be designed with a diameter and groove profile that will support the umbilical adequately and not allow any part of the Umbilical to become trapped or damaged. The umbilical may be clipped onto the main cable at intervals to prevent bights forming.

8 If members of the diving crew are involved in basket. wet bell or umbilical handling close to the edge of the water, they should wear helmets and lifejackets or safety lines.

9 If there is a failure of the main winch or cable additional means of recovery are required. Every system should have a back up power supply for the main winch and a secondary winch system.

10 Guide wires should be capable of lifting the wet bell at least to the surface. A lazy tugger wire may be permanently attached to the wet bell.

11 The umbilical should be strong enough, or incorporate a strength member, to allow it to be used to recover the wet bell. If the umbilical is used for secondary recovery there is always a risk of damage to the Umbilical and this method should only be used if other methods cannot.

12 There must be a clear communications system between the winch operator and the diving supervisor.

3.6 Diver's Umbilical

1 The maximum length of the diver's umbilical should be included in the dive plan. In general, it should be as short as possible to limit drag, reduce the risk of snagging and make it easier to recover the diver in an emergency.

2 If the dive is likely to bring the diver within range of any hazard, like thrusters or water intakes, the umbilical should be tied off, or otherwise physically restrained, to stop the diver coming within 5 metres (16 ft) of the hazard. *(Although separate controls may be required to fully mitigate the risk)*

3 The standby diver's umbilical should be longer than the diver's Umbilical, to ensure he is able to reach the diver in an emergency.

4 It is advisable to have some indication of the length of umbilical deployed. A common system for example, uses a turn of red tape for every 5 metres and a turn of black tape for every 10 metres. If the different coloured tapes are also of different widths, it is possible to check Umbilical length by touch.

5 Different umbilical types may be positively, neutrally or negatively buoyant, and any implications of the umbilical buoyancy should be included in the risk assessment.

6. The umbilical also acts as a 1ifeline and must be strong enough to lift a fully equipped diver from the water.

3.7 Control panels

1 The guidance relating to the design and use of control panels for air diving operations is periodically reviewed and updated by industry groups.

2 Prospective supervisors should be familiar with the most current industry guidelines that would normally be available from the diving contractor.

3.8 Dive locations

1 Dive teams may work from a variety of locations, ranging from shallow work in canals or harbours to maintenance on large vessels or deep dives on dams or pipelines.

2 The dive plan must assess the effect that the location will have on the safety and efficiency of the diving operation.

This will normally include an on-site risk assessment, which should also assess risks to members of the public arising from the diving operations

3 Some shore based operations may have the following disadvantages:

- Easy access to members of the public. The site may need to be securely fenced off.
- Difficult access from the diving system to the water. There may be a significant height difference or obstructions such as fencing, moored vessels etc.
- Hazards to the diving team from other work being carried out nearby, moving vehicles or other plant and equipment
- Hazards from vessels operating in the area.
- Hazards from outflows, lock gates etc. (See DP Guidance)
- Hazards from polluted water, underwater debris etc

4 Work boats used for diving may range in size from an inflatable to a tug boat.

The vessel must be large enough to carry a suitable air supply, control panel, umbilical(s), as well as other equipment and the minimum required diving crew. An overcrowded boat is a significant hazard in its own right.

5 Some vessels used as work boats are not generally designed for diving operations and may have a number of limitations:

- Lack of manoeuvrability
- Low grade navigation systems.
- Single point anchoring, which allows the vessel to swing over the diver if conditions change.
- Minimal or very limited deck space
- No ne available, or limited, crane or lift facilities
- Low electrical power reserves
- Unsuitable propeller guards
- Limited bad weather capability for over the side operations.
- Limited personnel accommodation.
- Limited crew experience with diving operations.

Consideration of some or all of the above may need to taken into account when planning a diving operation.

6 These vessels will be generally be working from a shore base and should remain within the required travelling time to the chamber, as specified in the dive plan. They are restricted to operating in good weather and good visibility.

7. Sea conditions must be such that the diver can safely enter and leave the water and such that the vessel can be safely brought alongside the harbour or jetty.

8 The dive plan must include provisions to protect the diver from injury caused by propellers and ensure that the appropriate signs and signals are shown while diving is in progress. The vessel should always have communication with the shore, either by radio or mobile phone.

8 Live boating, or operating from a moving boat has significant additional hazards.

The diver may be struck by the moving boat or the boat may run over and snag his umbilical. There may be difficulties if the boat engine fails and the boat begins to drift.

If live boating is necessary – and no alternative method of conducting the operation is available - these potentially life threatening factors must be considered in the risk assessment.

9 Remote locations, such as, islands or dams in mountain areas, may need special consideration.

Communications may be poor and access may be difficult and weather dependent. Icy roads or foggy conditions for example, may increase travel time to a designated chamber.

10 If there is any risk, in any location, of the diver being carried away by wind or current, there should be a safety boat on standby.

3.9 Water intakes and discharges (See Section on Differential Pressures)

1 When there is any risk of suction injury to the diver, the dive plan should consider:

* *The maximum safe length of the diver's umbilical.*
* *Any other means of physically protecting the diver, such guards over intake points, or physical barriers.*
* *The identification and isolation of all equipment that could endanger the diver if it were operated. It may be possible to remove valve handles and keep them until the dive is completed.*
* *Procedures to inform everyone who may operate the equipment that there is a diver in the water and to make them aware of the risk.*
* *The inclusion of these measures in the permit to work system .*

4. Chamber Operations

4.1 Introduction

1 Air chambers are normally defined as those which are not intended for continuous operation, but the main chamber should be large enough to allow two divers to lie fully extended on bunks.

2 Chambers and fittings require periodic examination, testing and certification. This may be the responsibility of the diving contractor, or of the operator of the chamber if it is in a place not under the control of the diving contractor.

3 Extensive guidance provided by both IMCA and ADC is available and should be researched by the Supervisor.

4.2 Fire hazard in chambers

1 If a fire occurs inside a chamber the occupants will be at risk both from the fire itself and from the toxic fumes which will be given off by the burning materials. Even if ignition does not occur an overheating electrical cable, for example, could give off toxic fumes.

2 Fire requires ***fuel, heat and oxygen.*** It will not start, or continue unless all three are present.

Figure 5/5:
Fire Triangle and Tetrahedron

The fire triangle is a useful reference tool, but fails to identify the fourth essential element of fire: the sustaining chemical reaction.

3. This has led to development of the fire tetrahedron: a triangular pyramid having four sides (including the bottom). Some fire suppression agents do not remove or reduce any of the three necessary components, but rather interfere with their chemical combination, such as Halon. In most fires, it does not matter which element gets removed; the fire fails to ignite, or it goes out. However, there are certain chemical fires where knowing only the "fire triangle" is not good enough.

4 Combustion is the chemical reaction that feeds a fire more heat and allows it to continue. With most types of fires, the old fire triangle model works well enough, but when the fire involves burning metals (known as a class-D fire in the American system of fire classifications, involving metals like lithium, magnesium, etc.), it becomes useful to consider the chemistry of combustion. Putting water on such a fire could result in the fire getting hotter (or even exploding) because such metals can react with water in an exothermic reaction to produce flammable hydrogen gas. Therefore, other specialized chemicals must typically be used to break the chain reaction of metallic combustion and stop the fire

5 The normal fuels which might be found in a chamber environment are paint on the chamber walls, clothing, books and newspapers, food packaging materials, sugar and other foodstuffs.

6 Because of the higher oxygen percentage the fire hazard is far greater in an air chambers than in saturation chambers and as a result no inflammable material should be taken in.

7 Heat, or the source of ignition, could be provided by a faulty electrical supply, a battery, or at high oxygen levels by a static discharge or simply by friction .

8 ***Unbelievably, fatal fires in air chambers have been caused by divers smoking.***

9 The ease with which fire will start depends both on the percentage of oxygen and on the P02. In an air atmosphere at 24msw (80fsw), where the percentage is 21 % but the P02 is over 700mb, a grinding spark is sufficient to ignite cotton overalls.

10 The rate at which a fire will bum depends only on the P02. A fire occurring at a raised P02 could be a flash fire which almost constitutes an explosion. Fatal fires which have occurred in air chambers have all been flash fires, associated with high oxygen levels, poor maintenance and failure to take common-sense precautions.

11 An assessment of fire risk must take into account oxygen concentration, the flammability of materials in the chamber and likely sources of ignition.

12 In general, whenever the oxygen percentage is 21% or above there is fire risk and extra precautions should be taken. The percentage should never be allowed to rise above 23.5% (Refer: BS EN 14931:2006 - PVHO). The precise level will be stated in the company manual.

4.3 Air chambers

1 All air chambers must be two-compartment. The smaller outer lock is principally used for rapid pressurisation during surface decompression. It also provides access to the main chamber without loss of pressure.

2 The chamber is normally controlled by operating the chamber hull valves directly, or through a control panel mounted on the chamber. There are two sets of identical valves and controls, one set for the main chamber and one set for the outer lock.

3 There are two separate sources of air for pressurisation, both on line to the chamber to provide main and back up supplies. There are usually two exhaust valves (a main exhaust and a fine bleed), an analysis line and a separate line to the depth gauge

4 There must be voice communication with the main chamber and outer lock, and viewports close to the control panel to allow the operator to see the divers.

5 The main chamber and outer lock have pressure relief valves, set to operate at slightly below the safe working pressure of the chamber, and sump drain valves. There are internal equalisation valves linking the main chamber and the outer lock. The quarter turn valve in the main chamber is normally open and the quarter turn valve in the outer lock is normally closed. This allows equalisation from the outer lock if the divers in the main chamber are incapacitated.

6 Internal fittings may include lights, communications, $C0^2$ scrubbers, heating or cooling systems and the appropriate number of BIBS masks. External lights, shining through the ports, are fitted in some chambers.

7 Chamber doors can be dogged or locked in the closed position, normally using a handle that can be operated from either side of the door. It must always be possible to open a chamber door front the outside, to allow access to the chamber. It is normal to remove the dogs as soon as the door is sealed .

8 Refer to the section Gas handling for information on analysis equipment.

4.4 Gas supplies for air chambers

1 The main air supply is usually from an LP compressor with a back up supply provided from an HP air quad. As a minimum, oxygen must be available for supply to the BIBS. Some chambers also have 50/50 and other mixes.

2 Back up gas requirements should be stated in the dive plan. The minimum quantities for air chamber use offshore are laid down in

Industry Guidance Notes and are appropriate for onshore use. These quantities are in addition to those required for planned use.

3 reference to "Two totally independent sources" could be two separate compressors operating from different power supplies (one electric supply and one diesel for example) or one compressor and an HP air quad.

4 Ring main air is not suitable. It is not a dedicated supply, may not be of the required purity standard and may not be available in the quantity or to the quality required.

4.5 General procedures for air chambers

1 No-one should enter a chamber without removing footwear and dirty overalls. Pockets should be checked for boxes of matches, lighters or other forbidden materials before entering a chamber. Even experienced divers may forget what they are carrying. This applies even if personnel are only entering a chamber to clean it or carry out maintenance. A lighter, for example, could be dropped and remain undetected during pressurisation.

2 The chamber should be cleaned after every use and kept clean. When it is not in use, the door should be dogged.

3 HP air and gas pressures should be checked on a regular basis, even if the chamber is not in use, and volumes kept at least at the minimum levels specified in

4 Full internal and external checklists should be carried out before every dive, even if use of the chamber is not planned. It is always on standby for therapeutic or emergency use.

5 During surface decompression procedures, the main chamber should be pressurised to the required depth before the dive, so that the diver can be pressurised quickly in the outer lock.

6 No one should undergo therapeutic treatment without an attendant in the chamber. Ideally the attendant should know the symptoms and treatment of acute oxygen poisoning and be competent to carry out neurological checks following a checklist.

7 During the breathing of oxygen rich mixes on the BIBS. the chamber oxygen percentage should be monitored and the atmosphere should be flushed if levels approach the maximum specified in the company procedures. If there is no oxygen analyser, provided the BIBS have overboard dump capability, the chamber should be flushed on a regular basis, usually every 15 or 20 minutes.

4.6 Chamber fires

1 Fires in air chambers are rare. They are usually flash fires and are almost invariably be fatal. In the event of a smoulder fire, or controllable fire, the divers should move to the other compartment and close the door. All oxygen supplies to the chamber should be turned off.

4.7 Chamber pressure loss

1 If there is a rapid pressure loss in the chamber the divers will be liable to suffer from decompression sickness and barotrauma. There will also be considerable noise, making communication with the affected chamber impossible. Misting will occur as the temperature drops and it will be impossible to see the divers and assess their condition or location.

2 Attempts should be made to find the source of the leak, while air is added to the chamber to try and maintain pressure.

3 The divers in the chamber should also look for the leak, and be aware of the risk of suction injury.

4.8 Un-breathable atmosphere

1 The chamber atmosphere may become un-breathable because of toxic fumes. These may be produced by toxic materials, like epoxy resin, on the divers' equipment.

2 The divers should go onto BIBS until the chamber atmosphere has been thoroughly flushed.

Photo provide courtesy of SADS Ltd

Section 6
IMPORTANT CONSIDERATIONS

2.2 Output of Surface Supply Compressors

1. Compressors are rated according to the volume of air that they take in each minute. This is the 'free gas volume' of the air that is supplied to the diver.
2. The volume of air used by the diver will vary according to the work rate (refer to section 2.1), so these variations are dealt with by having a reservoir on the compressor.
3. The supply pressure must, of course, be adequate to deliver air to the diver.

   At 50 msw (165 fsw), which is the maximum depth for air diving (Refer to the ACoP, para 46), the pressure is 6 Bar.

   Allow 10 Bar for the regulator, and the supply pressure must be at least 16 Bar.

   A pressure of around 20 Bar (290 psi) would more normally be used for safety.
4. Most commercial compressors used in diving operations supply air pressures well above this level.

   The same cannot be said of the smaller, lightweight compressors, generally designed for other activities not relating to diving.

   Always check the supply pressure and ensure that a compressor of suitable output, fitted with an adequate reservoir is to be used.
5. The following examples of a Metric and Imperial calculation check are intended to demonstrate how simple it is to establish the size of compressor that is required for any particular diving operation.
6. Remember the formulae for calculating the absolute pressure at a particular depth are:

$$\text{Absolute pressure} = \frac{\text{Depth (msw)}}{10} + 1\ \text{Bar}$$

$$\text{Absolute pressure} = \frac{\text{Depth (fsw)}}{33} + 1\ \text{At}$$

7. For the avoidance of doubt you should be aware that there are 14.7 psi in 1 AT.

Example 11: *(Metric)*

An LP compressor supplies 250 Ltr/min at 17 Bar.
Two divers are planning to work at 30 msw.

Is the air supply sufficient?

$$\begin{aligned}\text{Absolute pressure} &= \frac{\text{Depth (msw)} + 1\text{ Bar}}{10}\\ &= \frac{30 + 1\text{ Bar}}{10}\\ &= \mathbf{4\ Bar}\end{aligned}$$

Allow 10 Bar for the demand valve.

$$\begin{aligned}\text{Pressure required} &= (4 + 10)\text{ Bar}\\ &= 14\text{ Bar}\end{aligned}$$

The compressor delivers 17 Bar, so the pressure is suitable.

$$\begin{aligned}\text{Gas consumption} &= \text{Absolute pressure(Bar) x 40 ltr/min}\\ \text{Absolute pressure} &= 4\text{ Bar}\\ \text{Gas Consumption} &= 4\ \text{x}\ 40\ \text{x}\ 2\text{ Ltr/min} \qquad \textit{(See 2.1, 3)}\\ &= 320\text{ Ltrs / Min (Required)}\end{aligned}$$

(Remember, there are two divers)

Answer: **The compressor delivers 250 Ltr/min, so the volume is insufficient.**

2.8 Hot Water Suits

1. Although not extensively used on Inland /Inshore sites, their occasional presence suggests that Supervisors would benefit from having an understanding of their operational use and limitations.
2. The amount of heat reaching the diver depends on the temperature of the water and the flow rate of the fluid. A low temperature and a high flow rate transport as much heat as a higher temperature and a low flow rate. If the water reaches the diver temperatures in excess of 45^0C, there is a significant risk of scalding.
3. In practical terms, it is easiest to measure the hot water temperature at the machine, but there is considerable heat in the umbilical. Most hot water machine operating instruction manuals contains reference charts or tables to assist in estimating the temperature drop and expected temperature when the fluid reaches the diver.
4. As a 'rule of thumb' guide only, the following formulae may be used to estimate temperature drop.

   This formula would generally only apply where a water temperature of approximately 5^0c (41^0F), the temperature generally expected to experienced in UK waters.

$$\textbf{Temperature drop } (^0\textbf{C}) = \frac{\textbf{Umbilical length(m)}}{\textbf{Flow (Litres/min)}}$$

$$\textbf{Temperature drop } (^0\textbf{F}) = \frac{\textbf{Umbilical length(ft)}}{\textbf{4 x Flow (UK gals/min)}}$$

$$\textbf{Temperature drop } (^0\textbf{F}) = \frac{\textbf{Umbilical length(ft)}}{\textbf{5 x Flow (US gals/min)}}$$

Important:

Note the difference between US and UK gallons.

2.9 Buoyancy

1. It is important to acknowledge that the selection and use of buoyancy bags, for lifting and moving tasks underwater, should not be considered as an exact science.
2. It is relatively simple to calculate the weight of an object to be lifted and the amount of buoyancy that should be needed. In practice the object is often stuck in mud or silt, held by an almost incalculable suction force.

   Reference should be made to the Operational Elements Section for developing safe work procedures when using lifting bags.
3. There are two forces acting on an object in the water;
   (1) Its self weight, which acts to try and make it sink.
   (2) The upthrust from the water, which acts to make it float.

   When these forces are equal, the objects stays where it is, in effect it is considered to be neutrally buoyant.

   When the weight is greater than the upthrust, it sinks, more generally considered to have negative buoyancy.

   When upthrust is greater than weight, it will float up, this being described as having positive buoyancy.

Upthrust	**=**	**Volume of water displaced x density of water**

4. Sea water in more dense than fresh water. As a result objects float more readily in sea water.

   A boat sailing from the sea into fresh water of a canal or river, will sink lower in the water as it moves from one to the other.
5. The density of sea and fresh water are listed below for reference;

Sea water		1.03 Kg	Per litre
	=	10.3 lbs	Per imperial gallon
	=	12.4 lbs	Per US gallon
	=	64.38	Lbs/ft^3
Fresh Water		1.00 Kg	Per litre
	=	10.0 lbs	Per imperial gallon
	=	12.04 lbs	Per US gallon
	=	62.50	Lbs/ft^3

3.3 Reference Conversion Table

To Convert	*Into*	*Multiply by*
Atmospheres	Pounds/Sq in (PSI)	14.70
^{0} Centigrade	^{0} Fahrenheit	(^{0}Cx9)/5+32
Centimetres	Inches	0.3937
Chain	Metre	20.12
Cubic Feet	Cubic Metres	0.02832
Cubic metres	Gallons	220.17
Cubic metres	Cubic Feet	35.31
^{0} Fahrenheit	^{0} Centigrade	^{0} F – 32/9 x 5
Feet	Metres	0.3048
Feet of water	Atmospheres	0.02950
Feet of water	Pounds/Sq in (PSI)	0.4335
Fsw	msw	0.3048
Gallons	Cubic metres	4.543 x 10^{-3}
Gallons (US)	Gallons (Imp)	0.83267
Inches	Metres	2.540 x 10^{-2}
Kilograms	Pounds	2.205
Knots	Nautical miles/hr	1.0
Knots	Statute miles/hr	1.151
Kpa	PSI	0.147
Litres	Gallons (Imp)	0.22017
Litres	Gallons (US)	0.264
Metres	Yards	1.094
Miles (Nautical)	Metres	1853.0
Miles (Statute)	Metres	1609.0
Miles / hour	Knots	0.8684
msw	fsw	3.281
Pounds	Kilograms	0.4536
Square feet	Square metres	0.09290
Square inches	Square feet	6.944 x 10^{3}
Square metres	Square feet	10.76
Square yards	Square metres	0.8361
Tons	Kilograms	1016.0
Tons (Imperial)	Tonnes (metric)	1.0160
Tonnes (metric)	Pounds	2205.00
Yards	Metres	0.9144
Users own specific Conversion Information:		

airway is clear, start with five rescue breaths before going into the standard CPR sequence (30 chest compressions to two rescue breaths). After one minute, if the casualty has not started breathing again, ensure that emergency medical services are en-route.

6 Rescue breaths should be of about one second duration and just sufficient to make the chest rise. Forceful ventilations should be avoided as they are likely to inflate the stomach and increase the likelihood of stomach contents being regurgitated.

18 Circulation

1 A person who is unresponsive and not breathing normally is considered to be in cardiac arrest. Checking for a carotid pulse is no longer considered to be practically effective. Profuse, arterial bleeding will often indicate the presence of a pulse.

2 Chest compressions should be applied to the centre of the sternum with the heel of the palms of the hands delivering a downward force sufficient to depress the sternum > 5cm.

3 30 chest compressions should be delivered at a rate of 100-120 compressions per minute. (2010, ILCOR update)

4 On the up-stroke of each compression the chest should be allowed to rise to its full extent, while keeping the hands in position on the centre of the sternum.

5 After delivering 30 compressions, give two rescue breaths. Each breath should be of about one second duration and just sufficient to make the chest rise.

6 If the casualty resumes breathing this will confirm circulation has returned. It may still be necessary to support the casualties breathing and oxygen should always be administered.

7 If available, an automated external defibrillator (AED) should be used by appropriately trained personnel. This very effective piece of equipment literally talks the user through the procedure and can be used with the minimum of training.

8 Only proceed to the next step when the casualty is breathing, or others are able to assist you.

19 Cervical Spine Injury

1 After any accident involving a fall, impact or whiplash, suspect injury to the c-spine. These are the vertebrae in the neck and injury can lead to serious and incapacitating damage to the spinal cord.

2 Detecting symptoms in an unconscious casualty is impossible, and a conscious casualty may not experience any initial symptoms. Always handle such casualties with care, avoid moving the neck and immobilise by fitting a neck collar as soon as possible.

3 A neck (c-spine) collar provides only one point of immobilsation and may still allow sufficient movement to cause damage and even after it is fitted. It will be necessary to continue to support the casualty's head until full, three point immobilization has been put in place.

4 Damage to the spinal cord causes a variety of symptoms including numbness and tingling in the extremities and paralysis. These symptoms are, of course, identical to those of Decompression Illness (DCI). If there is reason to suspect DCI (ie. casualty has been under pressure or diving within past 48 hours) they should be pressurised on the appropriate therapeutic table while continuing any other first aid procedures.

20 Disability

1 This is a quick check of the casualty's level of consciousness (LOC) to establish a baseline for monitoring their progress. LOC is also referred to as ‘neurological disability’.

2 The AVPU scale of consciousness is widely recognized:

- A - Alert
- V - Responds to Verbal stimulus
- P - Responds to Painful stimulus
- U - Unresponsive

21 Expose and Examine

1 Exposing the casualty's body surface will reveal any further injuries, which can be dealt with in order of importance.

2 It may be necessary to cut off a diver's suit to carry out the examination. Note that a tight fitting wetsuit or undersuit may act both to reduce bleeding and to restrict blood flow into the limbs, thus maintaining blood pressure in the vital organs and brain. Cutting or removal of the suit may cause a serious blood pressure drop.

44 Anoxia

1 Anoxia is a complete lack of oxygen. It has occurred in diving operations when the diver has been supplied with pure helium or nitrogen instead of the correct gas mix.

2 If a diver breathes pure inert gas, the normal pressure gradient in the lungs is reversed. The P02 in the breathing gas is lower than that in the diver's body. Instead of oxygen passing from the lungs into the bloodstream, it passes from the bloodstream into the lungs, removing oxygen rapidly from the body. Collapse is almost instantaneous and death follows quickly.

3 The diver must be removed to a safe environment and CPR should be started immediately, preferably using a high P02. 100% O2 if at surface.

4 Pure inert gas is unlikely to be held on the worksite, but if it is this fact should be considered in the risk assessment and strict procedures put in place to control its use.

5 Whenever any mix other than air is on the worksite it must be standard practice to analyse the gas before it goes to the diver. Analysers must be fitted with visual and audible high and low alarms, which are turned on during diving.

45 Hypoxia

1 Hypoxia is a shortage of oxygen. This is generally considered to occur when the P02 is less the 160mb (0.16atm). A completely inactive person can survive for a time on less than 100mb (0.1atm).

2 In the water the P02 should never be lower than the 210mb.

3 If the P02 is very low, the effect is identical to anoxia. If the P02 is only slightly below the limit there will be a gradual onset of symptoms and signs. The victim is confused and has a pale skin with a bluish tinge. He will gradually lapse into unconsciousness and ultimately die. If working hard in the water the onset will be faster.

4 Treat by removing to a safe atmosphere and resuscitating on oxygen if necessary.

46 Nitrogen Narcosis

1 The narcotic effects of deep air breathing have been familiar to divers since the last century, but it was only in the 1940s that nitrogen was identified as the toxic element.

2 The effects are similar to drunkenness, and can occur whenever the partial pressure of nitrogen (PN2) exceeds 3 bar. In air diving, narcosis starts to affect most divers at depths in excess of about 30 msw (115 fsw), depending on the susceptibility of the individual.

3 Divers can learn to cope with the effects of narcosis by a series of "work up" dives, increasing the depth a little each time. A deep mixed gas diver is not necessarily competent to cope with narcosis on a deep air dive and should go through a series of work up dives.

47 Hypercapnia

1 The symptoms of hypercapnia or carbon dioxide poisoning are headache, sweating and increased respiration usually accompanied by feelings of apprehension.

2 Almost all cases of C02 poisoning in the water occur when the diver loses control of his breathing rhythm. This may be caused by stress, or by hard physical work. There may also be a build up of C02 in the dead space in a helmet if there is a poorly fitting / serviced oro-nasal mask.

3 The breathing becomes rapid and shallow and his lungs are not flushed adequately. C02 levels rise in his lungs, increasing the carbonic acid level in his bloodstream. This, in turn, stimulates his breathing, His breathing becomes faster and shallower and he is caught in a dangerous cycle with the C02 in his body rapidly reaching toxic levels. Collapse can follow very quickly, without any other symptoms. The diver can avoid the situation by taking regular slow breaths.

4 The diving supervisor should always be alert to the possibility, especially when the diver is carrying out strenuous work or moving against a current. The diver's breathing rate should be closely monitored and he will be instructed to slow down, take a break and flush the mask, if it starts to increase.

5 Carbon dioxide can accumulate in chambers, but the build up is usually slow and can be dealt with easily by flushing. The maximum PC02 limit in a chamber is usually 5 mb. Carbon dioxide levels can be monitored electronically or with chemical sampling tubes.

12 Refer to Industry Guidance and HSE Safety Notices referring to some cylinder pillar valves that are designed exclusively for surface use, which should not be used underwater. These include valves supplied for fire fighting breathing apparatus which may be sold second hand into the diving market.

13 Bailout bottles may be placed in a tank of water whilst charging, to minimise the risk and prevent heating during compression. ~

14 There are three main areas of concern about water in bailout bottles:

- *The reduced capacity of the bottle (because of the presence of water) to contain sufficient gas to adequately supply the diver in case of emergency*
- *The possibility that water, rather than gas, may be fed to the diver*
- *The potential for serious or fatal injury to personnel if the bottle should explode during charging, because of accelerated corrosion.*

15 Bailout bottles and other cylinders used underwater should be examined on a regular basis (see appropriate legislation). Bailout bottles should be checked every six months by removing the pillar valve and checking for moisture or rust or other corrosion particles. If there is any such evidence of corrosion the bottle should be returned for testing. A similar test should be carried out on cylinders fitted to baskets or wet bells, but only if there is any suggestion that water may have entered them.

16 All cylinders require hydraulic testing and certification according to the current regulations. The following table summarises the requirement applicable in 2011.

Figure 9/1: *(All cylinders must be date stamped on the neck)*

Type	***Applicable Standard***	***Hyd Test***	***Internal Insp***
Steel	BS EN 1968:2002	5 Years	2.5 Years
Aluminium	BS EN 1802:2002	5 Years	2.5 Years
Note 1:	All cylinders used in commercial diving will be subject to external visual inspection every six months, over and above the requirements outlined above, in accordance with the requirements of a planned maintenance system.		
Note 2:	The rate of corrosion that can occur in cylinders used underwater can be significantly greater than that applicable to other cylinders. As a result precautions should be adopted to mitigate this occurrence. (See HSE DVIS No 10 issued in December 2007)		

17 Reservoirs on air compressors are pressure vessels and also require testing and certification. They must be fitted with a suitable relief valve.

18 All pipe work and hoses must be safely routed and secured and colour coded as appropriate. Special considerations for oxygen are outlined in the following sections.

5 Oxygen Handling.

1 Pure oxygen under pressure, or any gas mix containing over 25% oxygen has the potentia1 to generate a serious fire or explosion. Almost all materials will ignite easily and burn rapidly in high pressure oxygen. If oxygen flows rapidly into a pipe, for example. the heat of compression can raise the temperature sufficiently to ignite traces of dirt or grease, which in turn will ignite the metal. Combustion occurs with the speed of an explosion and there have been numerous accidents involving serious bums and fatalities.

2 Any gas mixture containing more than 25% oxygen by volume should be handled like pure oxygen.

3 Flexible hose should be kept to a minimum in oxygen systems and rigid pipe work used as far as possible. Special consideration should be given to the use of stainless steel in oxygen systems, since some grades are not suitable.

4 Quarter turn valves must not be used. They can be opened quickly, allowing a rapid gas flow which can generate enough heat of compression to cause ignition. Needle valves must be used, which can only be opened slowly.

5 Quarter turn valves may be in-line as emergency shut off valves. They should be labelled as such and lightly taped open to prevent routine use.

6 Sealants should be used sparingly. A loose end of teflon (PTFE) tape inside a pipe can ignite easily and will burn to produce the toxic gas phosgene. PTFE and liquid thread sealants, such as Loctite, are not safe for use in conjunction with pressurised oxygen. Liquid sealants may be suitable if fully cured. This may take several days in cold conditions and should only follow review of the manufacturers instructions.

7 All pipe work, hoses, valves and other fittings used in the oxygen system must be oxygen clean, according to procedures laid down in the company manual. All cleaning must be logged and precautions must be taken to ensure that cleaning fluids are not left in the system.

8 Equipment received directly from suppliers cannot be considered oxygen clean, and must be cleaned according to the procedures.

9 To minimise the fire risk, oxygen pressure is normally reduced to 40 bar or less at the quad. Higher pressures may, however, be used for

9. Oxygen analysis.

1 Oxygen analysis may be carried out using a fuel cell analyser or a ‘paramagnetic’ cell. Analysers are produced by a number of manufacturers, paramagnetic analysers are produced by Servomex and are commonly known by this trade name. Analysers are more widely used, because they are robust, lightweight and suitable for providing remote readings.

2 A fuel cell is a battery which generates electricity in proportion to the P02. The cell may be fitted inside the analyser with the gas sample flowing over it. or placed in a chamber and connected to the analyser in the control room.

3 It is not generally necessary to zero a fuel cell analyser and the scale reading can be set using dry air or a calibration gas. If the fuel cell is placed in a chamber. it can only be calibrated when the chamber is on the surface, or by reference to another analyser sampling the gas on the surface.

4 A fuel cell in the chamber can only be used as a guide to the P02. Errors may be caused by condensation on the fuel cell, changes in chamber temperature, changes in the temperature of the wires carrying the signal to the analyser and radio transmissions and other electromagnetic fields.

5 Since the fuel cell is a battery. it will run out. normally in about six months. This is indicated by erratic readings. The cell is expensive and should not be discarded but returned to base where it can be reconditioned.

6 Magneto-dynamic cells rely on the fact that oxygen is one of the few paramagnetic gases and the molecules are attracted by a magnetic field. The cell consists of a small quartz dumb-bell suspended in a strong non-uniform field. When the sample gas enters the cell, oxygen molecules are attracted to the strongest part of the field, changing the forces acting on the dumb-bell and causing it to rotate. The rotation is measured by the movement of a beam of light across a split photocell and converted to an electric current.

7 Although delicate, the cell is surprisingly robust. It will be distorted by high flow rates of the sample gas, which can move the dumb-bell excessively. The angle at which the analyser is placed affects the suspension of the dumb-bell and it must be calibrated in situ.

10 Chemical sampling tubes

1 The most widely used chemical sampling tubes are probably those manufactured by Draeger, and all tubes are commonly described as Draeger tubes. They are widely used for carbon dioxide analysis in a chamber, and to test LP air supplies for contaminants.

2 The glass tube contains a chemical which changes colour in proportion to the amount of the sample gas drawn through the tube. The tubes are usually calibrated in percentage or parts per million, for use on the surface, but actually measure the partial pressure of the gas. If a chamber or bell atmosphere is sampled using a tube on the surface, there is no need to make any correction to the reading.

3 If the tube is used under pressure, a correction must applied. For a true percentage or parts per million, divide the scale reading by the absolute pressure in bars. For a true partial pressure, regardless of depth, divide a percentage scale reading by 100 or a parts per million scale reading by 1,000,000. (Refer to the Section on Diving Physics and Calculations to gain a better understanding on PPM and how to convert from other units of measure).

4 Some companies use Percentage Surface Equivalent (PSE) or Surface Equivalent Percentage (SEP). This is simply the scale reading and companies provide a table of safe PSE’s for each depth. To convert a surface reading from a bell or chamber to a PSE, simply multiply the surface reading by the absolute pressure.

5 To use a tube. follow the manufacturer's instructions. In general the procedure is as follows:

- *Check that you have the correct tube for the gas to be analysed, and that it is in date.*
- *Note the number of pumps needed. This is normally indicated on the tube as N= I, or N= 10. There may be more than one scale on the tube, for different numbers of pumps .*
- *Check that you have the correct pump. the volume of gas drawn through the tube is critical.*
- *Check the pump by fitting the unbroken tube into the pump and exhausting the bellows. The pump should not re-inflate. If it does, it is leaking and the reading will be inaccurate .*
- *Break the ends off the glass tube and fit it into the pump with the arrow pointing towards the pump. Gas is drawn through the tube.*