

Decompression Chambers at the Diving Worksite.

Have we got it right?

Deck decompression chambers (DDC's) at the surface supplied diving worksite has often been quite a contentious issue during my long career in the diving industry.

Their immediate availability or otherwise has been the result of costs, questionable regulation, failure to recognise the risks or simply just too much effort and a belief that any sort of decompression illness (DCI) could not possibly occur.

The original 1998 L104 Inland/Inshore Approved Code of Practice (ACOP) stated that for diving operations in less than 10.0 m of water, a decompression chamber should be no more than 6 hours travelling/distance from the dive site.

It also stated that for diving operations in water depths between -10.0 m and -50.0 m that a decompression chamber should be no more than 2 hours travelling/distance from the dive site.

This was repeated in the 2008 L104 re-print edition for both scenarios.

The ACOP2 that was released in 2014 (second edition) also repeated the same criteria for the shallow dives but the requirements for the deeper (-10.0m – 50.0 m) range had been changed.

Now, it was about Risk-Assessment (RA).

“For dives between -10.0 m and -50.0 m, the diving contractor should assess the risk of Decompression Illness (DCI) and the likelihood of a diver requiring emergency recompression.”

“This should be based on the depth and duration of the planned dives.”

“If the assessment demonstrates a significant risk of DCI, a suitable, operational, two-person, two-compartment chamber should be provided for immediate use at the site of the diving project.”

“If the assessment demonstrates relatively low risk of DCI, the diving contractor should identify the nearest suitable, operational, two person,two compartment chamber. Under no circumstances should this be more than 6 hours travelling distance from the dive site”.

“This change is to reflect medical advice and research into time to treatment for decompression illness.” ACOP2 2014.

In 2007, **Research Report 550 “Time to Treatment for Decompression Illness “** was sponsored by the UK HSE and the Report prepared by the then, North Sea Medical Centre in Norfolk, UK.

The primary aim of this research was to investigate the influence of ‘time to treatment’ with Hyperbaric Oxygen (HBO) in divers suffering from a neurological DCI, this would have been previously categorised as a Type 2 Serious DCI.

The research conclusion was that early HBO treatment in divers with a neurological DCI is robustly associated with a better outcome.

The study also recommended that a **“Time to Treatment Plan”** TTT Action Plan which specifies what is required if a diver develops suspicious DCI symptoms would help to ensure that divers will receive prompt HBO treatment.

“Of note is that (prompt) HBO gives complete resolution in serious DCI in the majority of cases and that diving contractors, diving supervisors, professional and amateur divers as well as medical staff need to be better informed and educated on the importance of early HBO treatment in divers with serious DCI.” (RR550.)

There is consensus amongst medical professionals that there is no substitute for hospital based settings, providing qualitative, supportive treatment in a diver suffering from a serious DCI.

In October 1992, The Diving Medical Advisory Committee (DMAC) had released DMAC 22.

“Proximity to a Recompression Chamber After Surfacing”

Although nearly thirty years old now, this advisory note does include interesting and valuable guidance from three decades ago.

*“It seems generally true that the more serious varieties of decompression illness which require an **immediate recompression arise fairly soon** after surfacing whereas the manifestations arising six or more hours after surfacing usually (but not always) require less urgent treatment.*

So, if we are to understand this advisory clearly, the more serious manifestations of DCI, those that require immediate recompression, **occur soon after surfacing.**

Therefore, if these serious DCI occur very soon after surfacing and have occurred in shallow water, having a Code of Practice whereby the nearest recompression facility may be up to six hours away, **should and ought to raise concerns.**

The current UK Inland/Inshore ACOP2, L104 states that *“under no circumstances shall recompression be more than 6 hours away in terms of time/distance.”*

However, this should not be used as a target and the individual Risk Assessment should always require a far closer time to recompression facilities with the most ideal case being those facilities located on site.

In support of this process, the Contractors Diving Project Plan should mandate a requirement for an effective, realistic, drilled and exercised, evacuation plan that details the requirements that transports the injured diver(s) safely from the point of incident to the recompression facility whilst breathing atmospheric oxygen and accompanied by the Diving Supervisor with the history of the dive and a fully qualified DMT to attend to the divers needs once in the recompression environment.

Basically, the Time to Treatment Plan.

Furthermore, this should also identify potential ‘impact activities’ such as traffic or other potential delays and provide advice and contingency options and be part of the Project Emergency Response.

Further references to the Research Report 550 revealed the following;

“There is a clear relationship between improved outcome and earlier HBO treatment.”

“Early treatment is beneficial for severely affected cases.”

“Dysbaric disorders are more responsive to HBO treatment in the first minutes rather than after hours had elapsed.”

“There is considerable evidence here that the sooner one receives treatment, the better the outcome will be.”

“General statistical modelling showed that a shorter time to HBO treatment was associated with a better outcome in divers with neurological DCI and that those who complied with the Guidelines (of the original 1998 ACOP) saw better responses to treatment than those who did not.”

The Research Report 550, Section 5 goes on to state.

Conclusions.

2. *“This study provides medical evidence which supports the fact that the sooner an injured diver receives HBO, the better the outcome for the diver, prompt treatment could therefore limit disability in divers associated with DCI and result in prompt resolution of symptoms. There is a suggestion that, in order to receive the optimal effect of HBO, a diver with DCI should receive HBO treatment within 6 hours after surfacing from the incident dive.”*

3. *“Concerning Hyperbaric chamber availability, this study provides evidence that supports the current ACOP1 for Inland/Inshore diving regarding times in which divers with DCI should receive HBO.”*

This point (3) refers to the original 1998 ACoP requirements of TWO hours for dives deeper than -10.0 m

2007 Research Report 550, Section 6.

Recommendations.

1. *“Time to hyperbaric treatment needs to be taken into consideration when planning a diving operation for work purposes. This study provides evidence that supports the time limits regarding chamber availability as laid down in the current ACOP1 (1998/2 hours) for inland/inshore diving under the 1997 DaWR.” (-10.0m -50.0 m)*

So, DDCs at the diving worksite, have we got this right ?

Why was ACOP1 changed from not exceeding 2 hours to not exceeding 6 hours in ACOP2 for dives between -10.0 m and -50.0 m depth?

Was it because;

“in order to receive the optimal effect of HBO, a diver with DCI should receive HBO treatment within 6 hours after surfacing from the incident dive.” (Also RR550)

Or could it have been influenced by the difficulties in providing DDC's at Inland/Inshore locations supporting aquaculture and renewables?

Let us consider the content of other external references.

In January 2021, the International Oil and Gas Producers (IOGP) re-issued the first update to the 2008 Recommended Practice Report 411 Diving Operations.

Table 1/Page 42 states that;

“The diving contractor has responsibility to ensure the provision of facilities so that a diver can be recompressed in an emergency should this become necessary. Treatment of a DCI in a compression chamber should commence as soon as possible and the safest option is to have a recompression chamber located as near as practicable to the diving site.”

No Planned In-Water Decompression, Depth zero to -10 m.

Chamber Requirement.

*“Diving contractor should identify the nearest suitable operational two person, two compartment chamber. Under no circumstances should this be more than **2 hours.**” **(NOT 6 Hours.)***

All Diving, Depth -10 m to -50m

Chamber Requirement.

“A suitable, operational, two person, two-compartment chamber should be provided for immediate use at the site of the diving project.”

IMCA D 014 International Code of Practice for Offshore Diving states that;

Page 26/Section 4.1.4

“Therapeutic Recompression/Compression Chamber.

No surface supplied diving operation within the scope of this code is to be carried out unless a two - compartment chamber is at the worksite to provide [immediate] suitable, therapeutic recompression treatment.”

** The Author acknowledges that not all Inland/Inshore diving contractors will own or have access to a DDC and that they may have operated safely without any DCI history for many years.

During the writing of this article, much valuable information regarding the optimal location for recompression facilities and the requirement for immediate recompression has been provided through various current reference material.

Now let us look at the Second Edition (2014) of L104 ACOP2 for Inland/Inshore diving operations.

Introduction 4. *“The ACOP has been revised to simplify some of the information....”*

(a) The availability of compression chambers. This change is to reflect medical advice and research into time to treatment for DCI.”

So, seven years after the Research Report 550 was issued, the content suggested that no changes were required to the original 1998 L104 ACOP, however the ACOP2 edition stated that;

Availability of Compression Chambers

“ 114. The diving contractor has a responsibility to ensure the provision of facilities so that a diver can be recompressed in an emergency, should this be necessary. Treatment of DCI in a chamber should commence as soon as possible.”

115. In addition, the following minimum standards should be applied;

“115a... For dives that are shallower than 10 metres with planned in-water decompression not exceeding 20 minutes, the diving contractor should identify the nearest suitable operational two-

person, two compartment chamber. Under no circumstances should this be more than **6 hours** travelling distance from the dive site.”

6 Hours!

*“115b.... for dives between -10 and -50 metres with planned in-water decompression not exceeding 20 minutes, the diving contractor **should assess the risk of DCI and the likelihood of a diver requiring emergency recompression.**”*

“This should be based on the depth and duration of the planned dives etc.....If the [risk]assessment demonstrates a significant risk of DCI, a suitable, operational, two person, two compartment chamber should be provided for immediate use at the site of the diving project.”

*If the assessment demonstrates relatively low risk of DCI, the diving contractor should identify the nearest suitable, operational two person, two compartment chamber. Under no circumstances should this be more than **6 hours** travelling distance from the dive site.”*

Of course, this is entirely dependent upon the effectiveness and efficiency of the Diving Project Risk Assessment, the Risk Assessment supporting team, the safety commitment and competence of both client and diving contractor. Is it that difficult to influence the outcome of a Risk Assessment ?

So from this, are we to assume that a serious DCI will never occur in depths down to -10.0m ?

Well, they have.....!

Does Boyles Law not indicate that the greatest volumetric change is in that first -10.0 m of water pressure?

The greatest volumetric change is therefore in these shallower depths.

Is Inland/Inshore diving so different to that conducted offshore, where there will be a Deck Decompression Chamber at every site?

Does the human body physiology alter to any extent when working onshore or offshore?

Of course it does not, but more inland/inshore shallow work is performed in these ‘greatest volumetric changes,’ shallow depths than offshore, so therefore the serious DCI risk potential increases due to the potential for Pulmonary Barotrauma, particularly if there are multiple descents and ascents, or whilst working hard in open water, or moving up and down in the water column, for the surface supplied diver.

L104 ACOP2 Second Edition (Para’ 46) states that;

“Diving carries an inherent risk of decompression illness. The incidence of DCI drops if the length of time that a diver spends at any particular depth is limited.”

This suggests that regardless of the RA outcome, any DCI is not necessarily predictable.

This article sets out to challenge existing guidance regarding chamber availability.

The Author’s own opinion, and that of many of his peers, is that the 6 hours maximum travelling time introduces significant risk to the successful treatment of a diver suffering a serious DCI.

Where is the medical evidence that supports 6 hours?

An Incident.

In December 2018, a surface supplied air diving operation was underway in Spanish Jurisdiction by a trade association member, diving contractor.

The tasks involved heavy rigging work and welding/grinding in open water down to a depth of -18.0 m, planned as free time diving.

During the course of the project, a diver, suffered a massive, aggressive serious vestibular DCI.

The diving contractor's emergency response plan was not followed, the diving contractor's own hyperbaric medical specialist was not notified nor consulted and the divers next of kin was not contacted.

This was a life-threatening injury.

The diver collapsed at the worksite and was placed on a stretcher breathing oxygen at atmospheric pressure.

The diver was then taken to Las Palmas Hospital where there were no emergency recompression facilities. He was then forwarded by helicopter, to the next nearest available recompression facilities at Tenerife, resulting in an elapsed time of just short of six hours before the diver received the recompression treatment that had been available on site.

In effect, the diver was removed from a place of safety to a place without the necessary recompression facilities and from there it was a helicopter flight at less than atmospheric pressure to Tenerife University Hospital.

The total elapsed time between the diver leaving bottom on the incident/hit dive and finally leaving chamber surface for recompression was 6 hours.

The diver suffered life changing, permanent neurological injuries and will never dive again.

This incident has been used as an example to demonstrate a worst-case scenario whereby a diver sustains a serious neurological DCI and immediate recompression is not provided.

Many readers will know that the injured diver was my Son, Lewis.

Finally, one incident is never likely to drive the significant changes required to revise certain elements of an ACOP which may or may not be correct.

**** Note that the 1997 DaWR and supporting ACOP's are not applicable to this incident location.**

Conclusion.

Between 1998 and 2014 the maximum permitted travel time/distance from the site of a diving project to the nearest available and accessible recompression facility was 6 hours in the zero to -10.0m depth range.

In 2014, ACOP2 was issued which extended the maximum allowable elapsed time to recompression from 2 hours to six hours for the -10.0m - -50.0m depth range.

Now, let us look at the example incident.

There were two DDC's available but neither were used, so in effect, there was no recompression facility available to the seriously injured diver for 6 hours.

The incident dive was at a depth of -18.0 m but serious DCI events have occurred in that shallower depth range, so this scenario could have had a DDC up to 6 hours away depending upon Risk Assessment efficiency had it been in the UK.

So, the question is, decompression chambers at the diving worksite.....Have we got it right ?

What happens if there is an incident involving two working divers coming close to the end of their free time, let's say in -30.0m of water, there's a problem, the standby diver has to assist, omitted decompression results, resuscitation or Diver Medic Technician input in a chamber setting is required?

The Risk Assessment has not identified the potential for an incident and the DDC is 6 hours away.

Finally, there is another question surrounding the actual use of decompression chambers at the worksite.

Around the diving world, the use of Surface Decompression using Oxygen has been greatly reduced, many surface-supplied diving operations apply a free-time only approach or achieve longer free times through the use of Nitrox as the breathing medium, in the North Sea it is common to only surface dive to -15 or -18.0 m then have a saturation capability working shallow to deep perform the rest of the work.

Back in the 1970's, 80's and 90's every member of a dive team practised, drilled and exercised the use of a Deck Decompression Chamber and knew how to operate it for both a routine surface decompression or a treatment table, it was an integral part of the diving operation.

Flushing a DDC main lock through, whilst maintaining a constant depth was frequently practised.

That skill seems to have been lost (faded) over the years, maybe it's time to do something about chamber operator competence and enforce it with a Letter of Appointment requirement at all diving project worksites.

I fully accept that this article will not be supported by some in the diving community but I believe that as a community of practice we should work together to achieve a safer and more consistent approach to getting it right, where DDC's at the diving worksite are concerned.

About the Author.

The author entered the diving Industry as a nineteen year old in the 1970's when the North Sea and global demand for trained commercial divers far outstripped a reliable supply.

He worked continuously on global diving operations before retiring as BP's first Global Diving Technical Authority in 2020.

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Acknowledgements.

The author acknowledges and thanks the following for their support in the production of this article.

Dr Phil Bryson. Medical Director of Diving Services International SOS.

Mr Brendan Kearns LLB, LLM. Director of KB Associates

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