

“MILANO”

2008

CCR Extreme Expedition

**International Diving Team
Standard Operating Procedures**



**Lago Maggiore (VA)
Italy**

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Disclaimer

This document details diving and surface procedures based on the Team components personal beliefs coming from field experiences and personal knowledge. Informations published in this document are not ment as a diving manual.

Since we focus on an extreme exploration everybody involved is well aware of the potentially hazardous practice of the procedures and practices contained in this document which can expose a person to considerable risks including serious injury or death and everybody accept this risk.

Some of the techniques and procedures which are followed by deep divers go well beyond Recreational and Technical Training and Certifying Agencies recommend and teach and also beyond commercial diving procedures and practices. This procedures are intended for being used only inside this particular exploration. Nobody is encouraged to follow these extreme practices and philosophies. Author and team members are not responsible for any personal application of these directives outside this unique and particular operation.

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Fabio Manganeli

Visit my website at www.uwmadness.it

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Introduction

This document is a detailed description of Diving procedures, in water and surface assistance Standard Operating Procedures (SOP) to be followed by the "BIG DIVE 2008" Diving Team. These procedures are mainly based on previous experiences of some Team members previously involved in open water and cave extreme explorations like "Viminale 2005" expedition (-107mt), "Devoli 2007" expedition (-143mt), "Ardente 2007" (-123mt) and Saint Sauveur Spring International Expedition July 2005 (-182mt).

Wreck Position

"Milano" wreck is located at a distance of about 205 metres from the coast of Verbania ("puntaCastagnola") on Major Lake, north Italy.

Objectives

Team objectives are:

- To obtain a video footage of the wreck focusing on areas described further in this document and using human cameramen
- To work as an International closed circuit rebreather Team taking advantage of the experience of some of the most famous, expert extreme rebreather divers active these days in the world
- This will be a "record dive" on a wreck in open water. The maximum depth reached by divers in similar environment has been 205 meters of water.

Wreck description

We are going to explore a civilian WWII passenger vessel named "Milano" sunk after being attacked by three allied aircraft on September 26, 1944. The ship was travelling along the lake transporting several passengers and military personnel, there were many casualties as a consequence of the attack. The wreck has been discovered by an Italian Fireman diving unit during a training session using a remote operated vehicle aka ROV.

"Milano" vessel is approximately 50 meters long and 15meters wide. She is now divided in two sections lying 20 meters apart. One section lies in approximately 230/235 meters of water on an almost flat and muddy bed and the other in 215/220 meters on a slightly sloping bottom.

Rov images show a very good visibility although the extreme depth and muddy bottom and the quite good condition of the wreck here you can find some images from the rov

<http://news.centrodiascolto.it/video/id=215046/d=2008-01-23/w=guerra+mondiale>
and here

http://www.vcoazzurratv.info/index.php?option=com_content&task=view&id=12024&Itemid=86

go to the link "**vedi la puntata 82**"

Team composition

Project Leader

Deep Divers

Support Divers

DEEP SUPPORT DIVERS -135

DEEP SUPPORT DIVERS -90

MID SUPPORT DIVERS -60 mt

SHALLOW SUPPORT DIVERS – 21mt

SURFACE SUPPORT TEAM

Dive Marshall

NAME Fabio Manganelli

Phone: +393408992650

Emergency phone:

Email: uwmadness@fastwebnet.it

Dive supervisor

Diving Team Doctor

Surface Assistants (2/4)

Bell Team Supervisor

SURFACE EMERGENCY TEAM

RIB1 Captain

From Firemen Diving Team

RIB1 Assistant

From Firemen Diving Team

Standby EMERGENCY Divers

Deep Support

Mid Support

Shallow support

Logistics

Dive site and preparations

The wreck site is about 250meters from shore in a location called "Punta Chiappa. The operation will start on May 5, Monday(D-4) when the Firemen dive team will re-locate the wreck using the ROV system, exploring the wreck for conditions , for the best place to set a fixed shot-line and a surface buoy and for a safe setup of the surface pontoon.

Main Vessel – Pontoon

This vessel has an available surface of 112sq/meters and can carry up to 30 tons of weight, it will be the main vessel for diving operations. Its positioning will take place using four anchors of about 800kgs/cad and ropes of 2 cm of diameter. On the pontoon there is a crank for the open decompression bell and all the equipments and personnel.

Support vessel

There will be several support vessels ranging from Ribs to fiberglass boats.

Gas booster pump and Gas Filling

DDE Staff is responsible for gas filling.

Sofnolime

Each Diver will carry his own. Those who are unable will be helped by DDE Staff.

Recompression Chamber and first aid

There is no decompression chamber on-site since on shore will be available an emergency helicopter ready to evacuate to the closest medical installation available which is at 20 minutes of flight time. Medical assistance on-site is provided by Red Cross personnel for first aid and by Doctor Torcello which is Chief responsible for the hyperbaric treatment.

Flights and connections

Major Lake is next to Malpensa International Airport .

<http://www.lagomaggioreonline.it/>

How to get there:

Highway

A8Milan - Lakes

(to Castelletto Ticino connection with A26) A26 Genoa-Gravellona Toce

The highway escapes of the Lake Maggiore including:

Arona (low Lake Maggiore)
Meina (High Vergante)
Brovello Carpugnino (High Vergante) Baveno-Stresa (medium Lake Maggiore)
Gravellona Toce (High Lake Maggiore)
Joins to Gravellona Toce the highway becomes continuous superhighway and until to Switzerland, along drawn its finds all the escapes for the Ossola Valley

Big roads

SS32 Ticinese
SS 33 Sempione
SS 229 Orta Lake

Train

All the lake Maggiore is very served from the railway line.
The draft is Milan - Switzerland and in every towns of the coast, until the station of Verbania,
is present stopped railway Service

Airports

Airport of Linate (Milan) distance from the Lake Maggiore km.80
Airport of Malpensa (town of Somma Lombardo (VA) distance from the Lake Maggiore km.20

Malpensa International Airport (IATA: MXP, ICAO: LIMC) is located in the province of Varese, near Milan, Italy. It is one of 3 international airports in the Milan area.
The airport is connected to Milan by the Milano-Varese highway as well by a dedicated train called "Malpensa Express". It is also connected to Linate Airport by a scheduled bus service. The Milan airport system has a third international airport, Orio al Serio Airport, which serves low-cost and charter traffic.

http://en.wikipedia.org/wiki/Malpensa_International_Airport

Language

The official Team language is English. Each Team member must provide at least a basic language knowledge or being assisted by a member who speaks English.

Accomodation

An "on-site" accomodation is provided by DDE Staff.

Transportations

Most of the people is on his own anyway we will arrange transportation of those members in need.

Gear logistics

Appropriate logistic s provided in the base camp located in the "Verbania" touristic Marina.

Daily Schedule

May 5, MONDAY (D -4) : Fireman dive team and support team will position a descent shot to the wreck and the various shots for the pontoon.

May 6, THURSDAY (D – 3): Bell will arrive the site and setting up operation of the decompression system will start. All the decompression system is tested by the end of the day.

May 7, WEDNSDAY (D – 2): Divers and support Team will try an exercise. In particular Deep divers will enter the bell and try the equipments

May 8, (D – 1): Last preparations and general Briefing.

Dive Day FRIDAY 9 (D) : Will be on friday 9 may 2008. Very early wake up, gear checks and transfer to the dive site.

Dive Marshall and Surface Supervisor

A person responsible for surface Team operations and dive supervise is selected and is responsible of organisation, timing and coordination of various surface activities in collaboration with other Team supervisor (Firemen Team, Bell Team, Medical Team). He is called Dive Marshall and a detailed list of his tasks is detailed in chapter “ Daily jobs”.

Briefings

The General Briefing will take place on D-1 at 1700 Local time in the Verbania Marina and the short briefing will take place the Dive day, on the pontoon, at 0800 Hrs Local time.

Diving procedures

Briefing

There will be only one diving day so the General briefing will take place the day before the dive (D -1). All diving and support personnel are to attend. The general briefing will be given by the Dive Marshall. Daily jobs will be allocated and any specific equipment distributed (duties check lists). For clarity Dive Marshall will be giving a different briefing also in Italian language. On the Day of the dive a short briefing will take place to focus some of the main activities and duties of Teamers and focusing on emergency procedures. A de-briefing of the diving DAY will be presented by the Project Leader, the Dive Marshall, the Deep Divers and others. A brief verbal dive report will be required from each dive pair.

Support Equipment setup and preparation

Dive Marshall is responsible to have everything organised and arranged for everything needed by the support team at least by D -1 (one day before the dive), before the General Briefing.

The pontoon will establish a mooring with four heavy anchors to position itself right on top of the wreck to let the ROV to work easily and the bell to be positioned in the water next to the descent/ascent shot. These operations will take place on Monday 5 (D-4).

The ROV will establish a mooring line grappled into the wreck and which is the descent/ascent shot, so that the surface Team can tie up the decompression station.

From the decompression station will be placed a line to connect the station itself and the decompression Bell.

The lazy shotline (connecting the station to the bell), surface connecting rope and the first few deco station downline modules (connecting poles) will be prepared and installed in Fireman dive team Rigid inflatable boat number 1 for easy deployment.

All emergency bailout cylinders should be prepared, checked for contents, and primed on the main boat waiting for the deep support and other support divers to use them underwater. Moreover a set of this equipment (dedicated to the "separated diver scenario") should be prepared for easy deployment and primed on the Rib dedicated for the emergencies together with the first standby deep diver and the emergency decompression line.

It is the responsibility of the Support Team to ensure that all OC bottles that they will / might deploy contains the correct gas (labelled accordingly) and volume of it prior to the boat leaving the harbour.

Shot Setup

The Firemen dive Team is responsible of fixing the main shot on the wreck by Day -3. Descent shot will be fixed on the wreck using a ROV and other equipments and maintained into position by a surface buoy being sure to have a good exploration point since deep divers have very little possibility to move far from the shot since they are not using Dpv's. In the shallow the support team will tie a big buoy underwater to have the shot pointing upwards and another buoy out of the water to signal the shot (descending way). The Fireman Team has also the responsibility to light the tied area to show the exit way to the deep divers using their ROV.

Decompression station setup

On day D-3 the support team will place the decompression station together with the descent shot. Refer to Appendix 1 “Decompression Station System Layout” for a full description of the station before continuing.

The inflatable will be the main boat in deploying the station as much of the work can be done leaning over the side, without having to deploy the Stand-by Shallow Support Diver. The surface currents are almost non-existent that just hanging on near the surface is sufficient without having to let the standby diver go to perform a task. The 2 main weighted downlines of the deco station can now be deployed from the surface under the small buoys on the surface connecting rope. Instead, while RIB / Inflatable Assistant are able to clip the surface connecting rope to the top of the main shotline, so the two buoys are kept as close together as possible. The lazyline (connection between the decompression station to the bell) is a work that must be done by a support diver. The Standby Support Diver will then go in and check that the station is not tangled in any way and connect the poles between the downlines at 65 m. He will connect also the lazyline to the decompression bell.

Decompression Bell setup and operation

Deep divers will take advantage for the long and cold decompression by an open decompression bell which will be their “habitat” for some time, see appendix 2 for description. They will be using Open Circuit Oxygen delivered through special masks called BIBS (aka “Ultra BIB II High FLOW BIBS MASK”) which are designed to let the exhaust gas breathed from the divers go outside. The Bell is in communication with the surface via interphones (laryngophone) and a closed circuit video camera. Illumination is provided with handheld led lamps to minimise oxygen explosion risk and also hot water to warm decompressing divers is provided from the surface. A team of support divers will assist deep divers for the duration of the decompression. The bell will be placed down to 21 meters, next to the ascent shot and the decompression station. To avoid Oxygen saturation of the habitat an air system is provided to wash the bell. On the pontoon an air compressor and several 8 cu/mt bottles are provided as a reservoir to wash the bell. One Oxygen meter is placed inside the bell. Divers will wash the bell by themselves using an hand operated valve and monitoring the indications of the oxygen meter. Outside are placed eight oxygen bottles with a 8 cu/mt capacity (40 liters), equipped with redundant low pressure hoses connected to the bibs. Several EAN50 cylinders are placed outside the bell and equipped with long low pressure hoses and second stage regulators.

As soon as the divers will reach the bell at -21 meters they will be helped by support divers to de-kit. Rebreathers will be secured with an dedicated rope to the surface and a weighted belt will be provided to each diver. They will leave their rebreathers starting to breath from the EAN50 hoses and will enter the bell. Inside the bell will be available water, isotonic fluids and energy bars. At least one safety/support diver will be always present next to the bell, hopefully in contact with the surface with a full face mask communication system and ready to help/assist decompressing divers. Divers are constantly in contact with the surface via an audio/video connection as stated before. For Emergency procedures inside the bell refer to the appropriate section “Bell emergency procedures”.

Decompression Bell Emergency procedures

DCI inside the bell

Should a decompression illness happen during the “bell decompression phase”. This should happen also before entering the bell and this case is analyzed in the section “In water DCI scenario”

So we have to manage an illness between -21 meters to 12 meters. And during the decompression phase while at -12 meters, which is the longest part of the whole decompression (about 200 minutes).

Assuming that the bell can't be lowered again to apply some sort of “recompression” because this could have consequences on other divers decompression profile and that a diver can't leave the bell since the inert gas load doesn't let the diver to safely reach the surface, be evacuated and treated in the closest hospital, so in case a dci occurs between -21 and -12 meters the diver can't leave the dry habitat and what we can do is anticipate the pure oxygen a little (18 meters) taking into account appropriate break periods in accordance with the medical team. Once at -12meters we have pure oxygen at 2.2 bar, which is close to have an Hyperbaric treatment, and the diver can complete the decompression profile. If the situation doesn't improve we can think about lengthening the oxygen periods in accordance with the medical team and with respect to other divers. As soon as the decompression period is completed other 45 minutes are needed to ascent to the surface, at a speed of 1 meter every 3 minutes, while breathing oxygen. Surfacing the diver can be treated in an appropriate medical infrastructure.

Oxygen toxicity inside the bell

There are many publications available about oxygen toxicity. A very good source of information is the “Rubicon Foundation” website (<http://www.rubicon-foundation.org>). From literature the incidence of CNS toxicity, in a dry and warm environment like a chamber or a bell, is very low especially at a Po₂ not greater than 2.4 and provided adequate air/low po₂ gas breaks are regularly conducted. In any case, if a convulsion occur, the diver will stay at rest for some time (5-10 minutes) breathing air or a low Po₂ mixture (like Tx15/55) and then continue with oxygen and decompression. Medical attention is provided also in the bell, if needed.

Diving

We will aim to get all the divers on the bottom by 09:30am at latest. This is a compromise between starting the operation too early and having divers still decompressing in the late afternoon. The post dive activities will take a lot of time and divers must be at rest for a while after the dive. Dive pairs are deployed as close together as possible to minimise their spread in the decompression phase but also to give them the needed space on the ascent shot. Each diver is diving with his own "deep phase" bailout and each diver is ready to dive "solo".

Everyone will dive as a cameraman, carrying his own video-camera to maximize the chance to get good images of the wreck. Remember that it is important to get footage also with divers in them to provide scale and the eventual documentary is also about the expedition not only about the wreck.

Pontoon Assistants to aid divers in kitting up, provide regular bucketings of water to keep them cool if needed, and assist in getting off the boat. A deck hose would be useful. Divers are deployed a pair at a time. On reaching the wreck divers will start filming bearing in mind the very short time available and considering time to get back to the ascent shot. If you get a problem on the bottom resulting in having to go off CCR to OC then aim the ROV which is indicating the exit way, as soon as the shotline is identified then a diagonal ascent can be made. Any sort of free ascent should be avoided unless absolutely necessary as it will stretch the support team. In case the normal ascent is impossible plan a "separated diver" ascent. Each deep diver should have a reel with sufficient line and at least one SMB to be deployed as soon as possible (at least 200metres). Any SMB without communication slates and attached to a line will be considered, from the Surface Emergency Team, as an emergency signal, regardless of its colour. An emergency decompression station (drop-in line) will be deployed and a deep standby diver deployed also (the separated diver scenario is covered in the dedicated section).

On approaching 150/140m look upwards for the first Deep Support Diver. If you give the "OK" signal (hand on your head or circle with the light) and they return and "OK", then they will not come down to greet you. Any other actions (eg hand or torch fast and random waving) will be deemed as a problem and they will immediately descend to offer assistance.

The Deep Support Divers will not hand off any of his side mounted cylinders of Trimix 10/70 and/or Trimix 15/55. If you suspect that you will be needing some extra gas then go on to the Deep Support Diver's long hose and only take enough to get you to the point whereby the situation is calm enough to exchange cylinders, if needed/ feasible, and to continue unassisted.

Once all the divers are shallower than the 135 meters meeting point or all of the Deep Divers will have signalled "the OK" then Deep Support Divers releases the "ALL Back" SMB, ie the Orange/Red one with "All Back" communication slate written on it.

Once the "ALL Back" SMB has been seen on the surface (SMB without any line and with written communication slate attached) then the Emergency RIB, with his Emergency Deep Support Divers ready to go, will come back to the pontoon. Its deep divers may still be used as support divers in the shallow.

If some of the divers are beyond 5 minutes late (aka very late) at their expected arrival time at the meeting point, and there is no sign of them, then it must be assumed that they have had to do a free ascent. Then a Yellow "Missing Diver" SMB (without line but with communication slate) is sent to the surface with the name of the missing diver/s attached if possible. This tells the surface support crew how many and who they need to locate.

Transponders

We will be using an electronic tracking system to locate and monitor divers while they are on their own on the bottom of the lake. The Firemen Diving Team will provide an electronic equipment called "wideband sub-mini transponder/responder" which can be monitored from the surface. Each Deep diver will carry this equipment along with him. More informations here:

http://www.sonardyne.co.uk/Products/PositioningNavigation/8070_8071.html#top

Decompression phase

In the initial phase divers will ascend up the main shot.

As soon as its convenient/practicable, divers should transit from the main shot to their downlines onto the decompression station around (55/60meters). The first pairs to reach the station should go on to the nearest downline, as this keeps the group closer together and easier to support.

The Mid Support Divers (two people from 50/60 meters) will be on rebreather with diluent Tx 20/30 in case they must descent deeper in case of an emergency and they will carry a couple sidemount of Tx 21/35 and Tx 35/30. The Mid Support Diver should be on station at 50/60 m no later than the time the first divers reach their 63m stop.

In the shallow, on the station, will be present other staged cylinders and drink bags that will be moved by the mid support divers upwards as the deep divers ascend. Deep Divers could start undressing by unused and useless cylinders using the decompression station and support divers will move cylinders upwards along the station if it is practicable and the situation is calm otherwise they will be moved later by other support divers.

The Mid Support Divers (50/60 meters) are responsible for ensuring that the poles are shuffled up from the bottom of the deco station to 21m in 3mt increment as is appropriate for the average depth decompressing on the corresponding dowlines.

Once all the divers are back at 25m and everything looks OK, the Mid Support Divers (the pair for 50 meters) can complete their own deco and get out. Other cylinders on the station will act as back-up low PO2 break gas if needed. An open circuit support diver equipped with an AGA FFM and comms to the surface should be present to report in real time the situation to the surface (fireman diving team).

The Shallow Support Divers (4 people, one for each deep diver) must be in the water no later than the time the first pair reach their 25m stop. They could be on OC using Nitrox and preferably using AGA FFM and communication slates. Once the last pair have reached their 21m stop the Mid Support Divers (50/60 meters) can think about getting out.

Between them the shallow support divers are responsible for shuffling any kit no longer required still along the deep divers (eg videos, side mounts and rebreathers) to the inflatable / RIB (or surface pontoon)

It is necessary to de-kit underwater at 21 meters to enter the decompression bell. The shallow support divers will help each his own assigned deep diver and will take care of his rebreather , videocamera and sidemounts, if needed, which will be secured to a rope connected to the surface pontoon and raised after the transition inside the bell is completed for all 4 deep divers.

The decompression phase inside the bell is described in section “Decompression Strategy”

Divers will climb back onto the main boat remaining inside the bell.
The decompression station will be recovered by the Fireman dive team.

Lost Diver/separated scenario

Should happen a deep diver will miss the ascent line and the first support diver recognise the situation. Immediately the support diver will signal the surface of the situation using a YELLOW Smb with a slate attached to describe the situation “MISSING DIVER”, this Smb is NOT connected with a reel line. Meanwhile the separated diver will launch as soon as practicable a Yellow Smb (or a red one if shorten of times dictates), or any other, but connected with a Reel line being used to manage the initial part of the decompression. The surface support crew should treat all "separated diver" as having no spare deco gas and the situation is to be considered as an emergency.

From the surface there will be ready 3 (Three) stand-by divers to manage this scenario, one to dive till 130/150 meters, one to dive till 90/120 meters the third to dive till around 40/60 meters. From the surface assistant boat, as soon as the deep diver SMB will be spotted, will be launched an emergency decompression line (140 meters) along to the diver reel line and immediately the first deep support diver. At the end of the weighted line is placed one bottle of Tx 10/70. Later the other support divers in a timely schedule. Because of the importance for the deep diver to enter the bell at 21 meters and because of the practical absence of any tide in the lake, every effort MUST be made to tow the deep diver toward the bell, as soon as it is safe and practical.

Once an emergency drop decompression set has been deployed to at least to -130 meters, and the separated diver(s) checked by the Standby Support Deep Diver, the dive Marshall and the Emergency Team will assess the situation bearing in mind the main goal to rejoin the separated diver to the main shot. As soon as practicable the RIB should slowly start towing the separated diver back to the others on the main decompression station and to the bell. This should be done slowly so that the separated diver can almost maintain its decompression depth and when the separated divers and his assistant are in less then 100meters, ideally shallower than 60 meters in order to meet the decompression station.

If there are two groups of separated divers, then there will not be enough support Deep divers that can be dedicated to manage a possible “separated with bailout” scenario in fact there will be only one “standby team” waiting for the worst. Therefore the separated diver should signal the surface appropriately with a Red/Orange Smb, in case he is separated but he is ok OR with a Yellow emergency Smb, in case he is

having some troubles. The separated Deep Diver must make every effort to follow the color coded Smb plan but in case conditions dictate and he is forced to launch an Smb which is inappropriate to describe the actual situation (with the “wrong” color) the Surface Team should assess the situation bearing in mind that Closed Circuit Rebreathers usually produce very little bubble during normal ascent and an “open circuit” ascent leaves a much more consistent stream of bubbles probably easily detected from the surface. After this assessment they could launch the first Deep Support Diver on the diver who presumably is in trouble and needs further bailout cylinders.

Bailout scenario - Rebreather failure and Open circuit ascent

Because of the extreme depth and the very short bottom time in which divers must adapt to the situation and try to film something from the wreck it is a better and safer solution that every deep diver carry his own bailout for the first part of the ascent. Ideally from the bottom to around 130 meters. This means 2 decompression bottles like two ALU 80's. We suggest not to use a shared bailout philosophy since this option will limit a lot the operation of at least one diver in each couple and forcing to abort the buddy in case one of the couple abort the dive during his descent for any reason although the “shared bailout” should be feasible during the ascent with the deep support team. So the deep diver who needs to go on a bailout on the bottom will ascent changing only one bottle to 130 meters where a deep support will provide further gas together and in coordination with the other support divers.

In water DCI scenario

In case a symptom of decompression illness is experienced by one diver when still underwater he will manage the situation as his expertise suggest. Usually in deep dives the most common dci symptom is pain in bones and muscles. Some protocols suggest to re-descent for 3 or 6 meters (two decompression stops) , stay there for some minutes (30') and after that multiply the following stops by 1.5 (See Us-Navy Diving Manual Ch 17-11.5.1, Ch21-4.3, Ch21-5.1 and flowchart figure 21.3). If symptoms appear before entering the bell at -21meters stop the diver should also rise his Setpoint to 1.6, hydrate himself with fluids on the station and apply the procedure suggested above or any other he feels comfortable. There are few reasons to exit the water even if the diver experience the dci in the shallow (in our case we means 12 meters) since the decompression obligations are so high and the risk associated with a direct ascent to the surface is also very high even considering to be treated in less than one hour after being surfaced. Every effort must be made to recover the situation when still underwater or in the bell.

Smb's Color coding

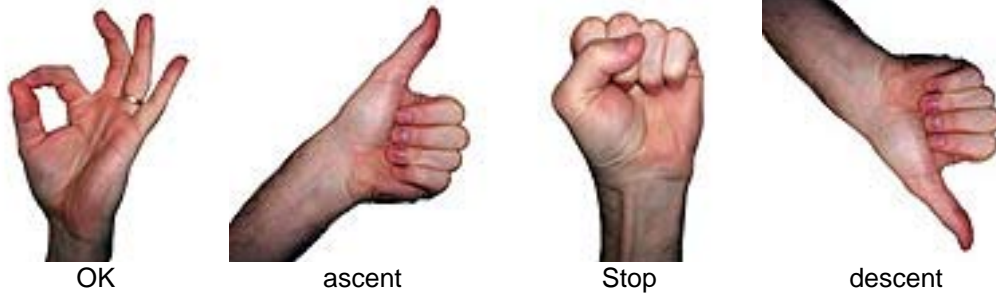
Orange/Red SMB - Off the decompression station, but currently OK.

Yellow SMB - Off the decompression station, and need gas NOW.

The Stand-by Support Diver will check on Yellow SMB's in priority over Orange ones. Divers should mark their Smb's with names for an easier identification.

Underwater communications

The need of a clear communication is paramount. Being a mixed language, international team misunderstood is likely to occur. For this reason teamers must read, understand and follow standard operating procedures as stated in this document, liaise with somebody who speaks English and report any communication issue to the Dive Marshall or Dive supervisor or any other person who might help. To minimize the risk of misunderstand any underwater communication and as a standard the following standard signals will be used.



OK ascent Stop descent



Where is your Buddy question How much deco?

Numbers



one two three four five



six seven eight nine zero

Moreover each diver will be equipped with a standard communication slate, see appendix 4, with the most common messages to deal with. Each diver is requested to use the standard communication code and report any problem to the surface (in his native language) as soon as a communication doubt occur.

Bailout/Decompression Bottles Marking and set-up

Bottles are to be marked with a standard set of characters. On the decompression/bailout bottle must be clearly visible the Maximum Operating Depth of the mixture. Bottles must be also clearly labelled with content analysis data such as oxygen and helium percentage plus the “analyzer” personal signature and date. All bottles must be properly rigged with standard top & bottom bolt snaps and carry handle plus a locking carabiner (the locking carabiner for the bottles staged on the decompression shot/station), regulator and bungies for second stage and pressure gauge. See Appendix 6 for further information.

Post Dive Activities

Once surfaced Divers will stay at rest for 10 to 15 minutes, breathing oxygen. They had already de-kitted themselves in the water before entering the bell. Now they will undress helped by the support divers avoiding any activity on the boat. As a standard protocol they will continue to breathe oxygen out of the water for 30 minutes, they will drink 1 to 1,5 liters of water minimum and will keep a comfortable body temperature.

De-Briefing

A dive de-briefing will be chaired by the Dive Marshall during the evening meeting

Daily Jobs

This section contains a duty list for each of the daily tasks that may be assigned according to the role. It is not a case of one person, one task. For example, the same person may do both the Dive Marshall and Diver Supervisor Roles, there may be two people who both do Hardboat Assistant and Driver, and the Team Doctor task only exist if we have one. Some roles use a color coded, back labelled T-shirt for better identification, see appendix 9.

TEAM ROLES and Duties

Pontoon

- Dive Marshall
- Dive Supervisor
- Surface Assistant
- Standby Support Diver (2)

Support Boats (Hard/Rib Firemen Department), one person each boat. Two boats

- RIB / Support Boat Driver
- RIB / Support Boat ASSISTANT
- RIB / Support Boat STANDBY DIVER

Support Divers

- Very Deep Water Support
- Deep Water Support
- Mid Water Support
- Shallow Water Support

Emergency Team

- Emergency Rib/Support Boat Driver
- Emergency Rib/Support Boat ASSISTANT
- Emergency Rib/Support Boat DIVER
- Emergency Team Very Deep Water Support
- Emergency Team Deep Water Support
- Emergency Team Mid Water Support

Others

- Surface Photographer / Videographer
- Medical Team
- Gas Mixing
- Dive Briefing

Each of the duty lists will be handed out in an A5 laminated form.

Dive Marshall Duties

- Overall responsibility for the day diving operations.
- Responsible for authorising / cancelling dive as appropriate.
- Principally Based on the pontoon but he can move.
- Give the Dive Briefing on the previous evening.
- Distribute laminated job sheets to all personnel.
- Liaise with the skippers (boat/rib drivers) and pontoon crew and brief them on the day's planned activities.
- Obtain weather forecast on the previous evening.
- Collect dive plan (timings) off each diver before the dive.
- Give dive plan details to the Dive Supervisor and all Support divers.
- Act as a coordinator of teams involved in the operations: Bell Team, Firemen diving Team, Divers support team, Divers emergency team
- Keep track of all divers (bottom & support) in, due and out times.
- Look out for either the "All Back" SMB (ie the Orange without any rope and the slate "All Back" written on it), or the "Lost Divers" SMB (ie the Yellow one with "Lost Divers" written on it).
- If a lost diver signal is received determine how many and who are missing (ie by the slate attached to the "Lost Diver" SMB or by the personal SMB deployed by the separated diver). Deploy lookouts for the missing divers SMBs.
- In case of lost/separated diver supervise the launch of the Emergency Team divers
- Supervise correct deployment of deco System.
- Supervise correct deployment of Bell decompression System.
- Supervise decompression operation.
- Supervise on site recompression if necessary.
- Maintain contact with the crew on the other boats.
- Chair the de-briefing during the evening meeting.

Dive Supervisor Duties

- Assist the Dive Marshall in the smooth running of the diving operations.
- Principally Based on the pontoon but he can move.
- Collect dive plan (timings) off each diver before the dive.
- Give dive plan details to the Dive Marshall and the Support divers.
- Keep track of all divers (bottom & support) in, due and out times.
- Look out for either the "All Back" SMB (ie the Orange one with "All Back" written on it), or the "Lost Divers" SMB (ie the Yellow one with "Lost Divers" written on it).
- Inform the Dive Marshall if any expected activity is overdue (eg "All-Back marker", divers surfacing etc).
- Maintain contact with any support divers using comms if available.
- Supervise the Firemen Team activity regarding tracking of deep divers and reports to the Dive Marshall

Surface ASSISTANT Duties

- Is based on the pontoon
- Ensure that the deco station is in good condition and perform any repairs as required (eg worn ropes).
- Collect any staged bottles and attach to the decompression station via the locking carabineer. Get the divers using them to check it before the station is deployed.
- Prepare Emergency Drop lines.
- Pass Decompression Station components in to the RIB including emergency drop lines
- Assist divers kitting up.
- Throw water over waiting divers (or use deck hose) to keep them cool, if needed.
- Administer drinks to waiting divers.
- Ensure un-obstructed path between kitting up location and boat exit point.
- Keep all equipment on the boat neatly stowed.
- Keep a look out for approaching ships.
- Keep a look out for surfacing divers.
- Keep a look out for surface marker buoys, especially if the "Lost Diver" signal has been deployed.
- Retrieve divers equipment before they enter the boat.
- Assist divers de-kitting.
- Retrieve ascent line and Deco System components from the RIB / inflatable.

Standby Support Diver(S) Duties

- Based on the pontoon
- Equipped with OC diving kit
- Ready to go in the water for any reason required
- Check the correct position of the lazy line from the main shot to the bell shot (decompression station)
- Report any problem to the Dive supervisor or Bell Supervisor
- May use an underwater comms system

Rib / Support Boat DRIVER Duties

- Drive the RIB / Support Boat.
- Maintain contact with the Dive Marshall on the main boat with an handheld radio
- Assist the Assistant present on board in deploying the deco station if needed
- Assist the Standby Support diver present on boarding deploying the deco station if needed
- Follow any free floating decompression divers who are off the main decompression station. Very slowly try to tow their drop line back towards the main station.

Rib / Support Boat ASSISTANT Duties

- Ensure that the deco station is in good condition and perform any repairs as required (eg worn ropes).
- Collect any staged bottles and attach to the decompression station via the locking carabineer. Get the divers using them to check it before the station is deployed.
- Pass Decompression Station components in to the RIB.
- Assist divers kitting up if needed
- Throw water over waiting divers to keep them cool.
- Administer drinks to waiting divers.
- Ensure un-obstructed path between kitting up location and boat exit point.
- Keep all equipment on the boat neatly stowed.
- Keep a look out for approaching ships.
- Keep a look out for surfacing divers.
- Keep a look out for surface marker buoys, especially if the "Lost Diver" signal has been deployed.
- Keep a careful eye for divers coming up off the decompression station, especially those sending up the **yellow** "I need gas" Smb's.
- Retrieve divers equipment before they enter the boat.
- Assist divers de-kitting.
- Deploy the Deco Station System components. Check the cylinder fixings and ensure that the regulator is pressurised but the cylinder is off. The downlines will be deployed as follows:

downline 1: **Trimix 21/35** @ 66m, water@ 30m, pvc pole @ 66 m, 63 m, 60 m, 57 m,54 m
downline 1: **Trimix 35/30** @ 40m, water@ 40m,

downline 2: **Trimix 21/35** @ 66m, water@ 30m, pvc pole @ 66 m, 63 m, 60 m, 57 m,54 m
downline 2: **Trimix 35/30** @ 40m, water@ 30m,

Rib / Support Boat DIVER/s Duties

- Enter the water to check the Deco Station deployment (eg for tangled lines) and descend to 55m to connect the poles between the downlines.
- Once the Deco Station has been deployed Position the lazy line (connection between the station and the bell) around 25 meters and the bell at 21meters.
- Have at least an air set (single cylinder in a BCD) and be suited up (preferably in a wet-suit) ready to enter the water for any contingency to be managed in the shallow

VERY DEEP WATER SUPPORT Duties

- Use a CCR with appropriate diluent. (ie Tx 8/80 to descent till 150 meters in case of need)
- Carry 2 side mounted 10L (or S80) cylinders of bailout/deco gas of Trimix 10/70 and Tx 15/55 for emergency supply to ascending bottom divers.
- Colder gas (less O₂) is always on the LEFT side and properly marked with MOD
- Obtain dive plans from wreck divers or Dive Supervisor in advance and write expected time to -135m onto check-in slate.
- Monitor and note times that divers descend (on a slate).
- Liaise with Dive Marshall to enter the water and descent on time to meet divers at the planned Run Time
- Stay within visual contact of a point 10-15m below -135, while backing up the line to minimise their own deco obligation.
- Go no deeper than 135m unless there is an emergency.
- Ensure that ascending divers are together (all back home) and there is no emergency.
- If divers are ok at the meeting point and all together deploy a RED Smb with a "ALL BACK" slate attached (the smb must be without any line attached).
- If the last divers are 5 minutes over due at the 135m meeting point (AKA very late) and are no where in sight, deploy YELLOW "Lost Diver" SMB (ie the one with "Lost Diver" slate slate attached or the one with "Lost Diver" written on it) to signal to the surface support that they need to look for delayed SMBs and how many are missing.
- Any diver requiring gas will be offered Trimix 10/70 on a 2m hose from the side-mounts. This gas should be offered as soon as a short fall is detected, allowing the diver to continue alone once the cylinder switch has been made and if required. Initially they will not be given the cylinder.
- Any diver requiring bailout trimix compatible with depth will be escorted until feasible (until the next support diver is met) and assisted with transferring the cylinder to themselves.
- Carry spare laminated decompression tables and OC bailout tables. Accompany final pair up the shotline until the next deep support pair

DEEP WATER SUPPORT Duties -90mt

- Use a CCR with appropriate diluent (ie Tx10/70 to descent till 120mtr in case of need)
- Carry 2 side mounted 10L (or S80) cylinders of bailout/deco gas of Trimix 15/55 and Tx 21/35 for emergency supply to ascending bottom divers.
- Obtain dive plans from wreck divers or Dive Supervisor in advance and write expected time to -90m onto check-in slate.
- Monitor and note times that divers descend (on a slate).
- Liaise with Dive Marshall to enter the water and descent on time to meet divers at the planned Run Time
- Stay within visual contact of a point 10-15m below -90, while backing up the line to minimise their own deco obligation.
- Go no deeper than 95m unless there is an emergency.
- Ensure that ascending divers are not in an emergency.
- Any diver requiring gas will be offered bailout gas on a 2m hose from the side-mounts. This gas should be offered as soon as a short fall is detected, allowing the diver to continue alone once the cylinder switch has been made and if required. In initially they will not be given the cylinder.
- Colder gas (less O2) is always on the LEFT side and properly marked with MOD
- Any diver requiring Bailout Trimix compatible with depth will be escorted until feasible (until the next support diver is met) and assisted with transferring the cylinder to themselves.
- Carry spare laminated decompression tables and OC bailout tables. Accompany final pair up the shotline until the next support divers pair.

Mid Water Support – 50mt

- Use a CCR with Diluent Tx **18/40**.
- Dive no deeper than 50meters unless it is required due to an emergency.
- Be in the water by the time the first divers reach 65m, or as soon as the conditions dictates considering the Run time
- Check the correct deployment of the Deco Station.. Fix any rope tangles, check correct cylinder attachment and that the are off but pressurised.
- Add any diver personal stuff to the station.
- Carry one personal sidemount of 21/35 and Trimix bailout (Tx 21/35 and 35/30) for the deep divers
- Colder gas (less O2) is always on the LEFT side and properly marked with MOD
- Assist wreck divers swapping out side-mounted cylinders for emergency ones if needed. Request replacements from the surface for any cylinder used.
- Carry spare laminated decompression tables and OC bailout tables.
- Rotate round the divers on the station ensuring that everything is OK.
- Shuffle all staged deco cylinders, drinks etc up the deco station so they are ready for divers who run short on their shallower stops.
- Shuffle the decompression station horizontal bars upwards along with the average decompression depth together with the Firemen Diving Team
- Monitor divers back to 21m, where the Shallow Support Diver will take over.

Shallow Water Support -25mt

- Keep the Diver Supervisor informed of the in-water status.
- Should use a twinset of air with FFM and Comms or a rebreather with diluent air.
- Be in the water by the time the first divers reach 25m.
- Carry one sidemount of air for himself.
- Rotate round the divers on the station ensuring that everything is OK.
- Assist in the removal of no longer needed equipment, such as bottom bailout cylinders, videos, cameras, etc. A spare downline from the surface must be used to aid this.
- Assist the deep divers undressing their rebreathers, getting in contact with Ean50 and entering the Bell.
- Ensure the rebreather is first connected to a downline from the surface once ready to be carried on the support boat
- Dive no deeper than 35meters unless it is required due to an emergency.
- Stay in the water until the last bottom diver has left.
- Assist with the recovery of the Deco Station.

Surface Photographer / Videographer

- Avoid getting involved with helping the diving operations, unless safety is compromised.
- Photograph / Video what is going on, especially the diver preparations, entry and exits.
- If you are helping somebody kit up and get in then you are not photographing / videoing it.
- Ensure footage gives good coverage to any sponsors. Ensure logos are prominent everywhere and set-up specific shots if required.
- Liaise with the media personnel help them get the surface footage they require, without letting them compromise the safety of the diving operations by getting in the way.

Gas Mixing Supervisor

- Supervise gas mixing and boosting.
- Fill all cylinders with required gases
- Track down and fill any emergency, support diver side-mounts used.
- Ensure that all cylinders are analysed and correctly tagged with the target mix (providing it is dose enough) using the supplied garden tags and bungee. It is up to the individual divers to determine their actual mix prior to diving and to mark cylinders with MOD.
- Stow filled cylinders according to their gas contents and usage (eg divers, deco station stage, emergency drop set, etc),

Team Doctor /Medical Rescue Team

- Responsible for diagnosis and first aid of an diving related illness outside the water.
- Responsible for arranging any off-site medical and re-compression treatments.
- If a chamber is available on-site, ensuring that it is maintained in a state readiness, and supervise any treatments provided.
- Collect and analyse Doppler scores from the surfacing divers.
- Provide feedback on any changes that should be applied to our decompression strategy.
- Provide feedback and advise in case any Dci occurs in the water and/or in the bell
- Provide feedback and advise in case any oxygen toxicity occurs in the water and/or in the bell
- Provide feedback on whether any team member is in a medically fit condition to dive.

Dive Briefing

Running through briefings in the following order should keep the meeting controlled.

Dive de-brief conducted by day's Dive Marshall,

- Dive Marshall's overview of day's events
- Did all systems work well? Analysis of any problems that occurred
- Were objectives fulfilled?
- Are skipper and crew satisfied?
- Each team member comments on day's events and possibilities for improvement etc.
- Collect laminated job sheets
- Are duplicate videos underway?

Project update by the-Project Leader

- Overview of the current project status.
- Any special political considerations (press, team image)?
- Any special press considerations?
- Any new visitors expected?

Dive briefing conducted by the Dive Marshall, Project Diving Officer and Dive Supervisor

- Overview of following day's objectives
- Weather forecast
- Agreement of diving duties for following day
- Allocation of laminated job sheets for following day
- Set boat depart and dive times.
- Run right through dive procedure in detail using check list in appendix 7 and 8
- Collect deco schedules for following day
- Set time for following day's briefing
- Questions. Does everyone understand their duties?

EMERGENCY TEAM

Preferably the emergency Team Is located on the same "Emergency" Rib/Boat. It is composed by

- A boat driver
- One or more assistants
- Three emergency support divers

To follow the specific duties of the emergency team members

Emergency Team Hard Boat/Rib DRIVER Duties

- Drive the EMERGENCY RIB/Support Boat.
- Maintain contact with the Dive Marshall on the main boat with an handheld radio
- Follow any free floating decompression divers who are off the main decompression station. Very slowly try to tow their drop line back towards the main station.
- Once an emergency drop line has been deployed to a separated diver and the Very deep and deep support has been launched the goal is to slowly tow them back to the main decompressing group using the RIB / Inflatable. Assess the situation with Dive Marshall

Emergency Team Hard Boat/Rib Assistant Duties OK

- Prepare Emergency Drop lines.
- Assist divers kitting up.
- Throw water over waiting divers (or use deck hose) to keep them cool if needed.
- Administer drinks to waiting divers.
- Ensure un-obstructed path between kitting up location and boat exit point.
- Keep all equipment on the boat neatly stowed.
- Keep a look out for approaching ships.
- Keep a look out for surfacing divers.
- Keep a look out for surface marker buoys, especially if the "Lost Diver" signal has been deployed.
- Keep a careful eye for divers coming up off the decompression station, especially those sending up the yellow "I need gas" SMBs.
- Retrieve either the "All Back" SMB (ie the Orange one with "All Back" written on its slate), or the "Lost Divers" SMB (ie the Yellow one with "Lost Divers" written on it) and report back to the Dive Marshall on the main boat. If the "Lost Divers" signal is deployed report, if possible, the name of the diver/s.
- Deploy emergency drop gas station if required.
- If an emergency drop line is used, fetch another one from the main boat and be ready to use it.
- Help the Emergency Deep Support Diver kitting up and entering the water if needed
- Help the following Emergency support divers if needed
- Retrieve divers equipment before they enter the boat.
- Assist divers de-kitting.
- Retrieve ascent line and Deco System components from the RIB / inflatable.
- Assist in retrieving the RIB / hardboat.

Emergency Team Support Divers

Duties are the same as the :

- Very Deep Support Divers
- Deep support Diver
- Mid support diver

Use the same job sheets. In particular the “Emergency Diver Team” member divers must be ready to descent together with deep divers of the main support diver team.

Gas And Decompression Strategy

“Milano” seems to be lying on an even keel on the muddy lake bed. As you can see from the videos taken from the Firemen Team ROV she is divided in two parts, almost 20 meters apart. The first section lies in ~215mt and the second is deeper starting from ~230 to ~238 meters. In this expedition we will go for the deeper section because seems to be more interesting

We are going for 14 to 20 minutes (at worst and in an emergency) bottom time which means a run time ranging from ~380 to ~500 minutes. First decompression stops will start around -180 meters

It has already been decided for logistical and support reasons that the whole team will be using a common set of gases and decompression tables.

Individuals may choose to follow a more conservative set of table, however, nobody is to run anything more aggressive. The gas selection and decompression strategy been based on a 5' min bottom time at an average depth of 230 mt. A standard set of mixtures has been studied and chosen as the best compromise between divers needs and believes and operating needs.

Bottom Diluent Gas: trimix 6/80

END (N2&O2) : 38m@ 230 mt

PO2: 1,4 bar@230m

Where : CCR Inboard

Quantity : minimum 10ltrs, preferably one S80

This is to give an acceptable END because we've to put some nitrogen to counteract the possible effects of HPNS. A relatively high quantity of He3540 gives reduced gas density for a low WOB and maximises scrubber efficiency (which is important as we're doing dives far deeper than maximum test depth of all rebreather used)

Carried First Bottom Bailout Gas: Trimix 6 /80

END (N2&O2) : 38m@ 230 mt

PO2: 1,4 bar@230m

Where : Carried side mounted

Quantity : minimum 10ltrs, preferably one S80

Gives acceptable narcosis on the bottom, and quite high PO2 to give maximum SCR re-cycling capability. Although the PO2 is quite high on the bottom time spent on the wreck is very short (around 5 min maximum) and hopefully you would ascend quickly shallower toward the ROV, then you can make your way back to the shot from there.

Carried Intermediate Bailout Gas : Trimix 10/70

END : 40mt@160mt depth

PO2 : 1.64-1,03, per 160-96 mt depth range

Where : Carried side-mounted

Quantity : Minimum 10L

This is an Hypoxic mix. We are beginning reducing helium content. The quite high PO2 at gas switch is manageable considering the very short time we stay at switch

depth. We are in a 20" stop phase. Doing this switches at a quite high PO2 give us the chance to stay on a profile similar to the Closed Circuit one (or even better) and the oxygen exposure is still limited.

We manage to stay on a bailout mixture maintaining a PO2 between 1,6 and 1,0. This will give us an average PO2 similar to the CCR profile.

Staged very deep Bailout Gas : Trimix 10/70

END : 40mt@160mt depth

PO2 : 1.64-1,03, per 160-96 mt depth range

Where : Staged on the "bailout rope" at -140mt

Quantity : Minimum 10L each diver (4 bottles)

At this depth there will be only cylinders on the decompression rope. Any support diver will be present. Even if deep divers will be on their own on the bottom, around this depth (-150mt) they should consider a Team philosophy to manage a possible bailout. Anyway on the "bailout rope" will be present a sufficient quantity of bailout OC gas available for almost each diver. At -140mtrs 4x10lt Tx 10/70 cylinders will be present

Staged deep Bailout Gas : Trimix 15/55

END : 36mt@93mt depth

PO2 : 1.60-1,18bar per 93-63 depth range

Where : Staged on the "bailout rope" at -100mt

Quantity : Minimum 10L each diver (4 bottles)

Even if the bottles are going to be staged on the decompression line a support diver will be present at -90mtrs in case anybody is in need. He is going to have is own minimum bailout, the rest shared with shallower support divers and other staged on the decompression station. The PO2 is ranging from 1,6 to 1,18 Bar@63mtrs.

Staged intermediate Bailout Gas : Trimix 21/35

END : 37mtrs@ -63mt

PO2 : 1.49 -1.16 bar, per 63 - 30m depth range

Where : Intermediate support diver, decompression station

Quantity : Minimum 10L each diver (4 bottles)

At -60mt a support diver is provided in case of need. Anyway deep divers will find all the bailout they need staged on a rope which comes parallel to the main shot. The same principles apply to this bailout regarding PO2 management

Staged intermediate Bailout Gas : Trimix 35/30

END : 17mtrs@ -30mt

PO2 : 1.3 -1.16 bar, per 30 - 21m depth range

Where : Intermediate support diver, decompression station

Quantity : Minimum 10L each diver (4 bottles)

At -30mt a support diver is provided in case of need. Anyway deep divers will find all the bailout they need staged on a decompression station which comes parallel to the main shot. The same principles apply to this bailout regarding PO2 management.

Staged decompression mixtures and O2

On the decompression bell there are staged all the decompression gases. EAN50 with long hose and O2 with redundant long hose.

Redundant O2

If possible each diver should also carry a small redundant cylinder of O2 (eg 1.5L). This will enable the dive to continue closed circuit in the event of losing primary O2 for any .

CCR Set-Points :

Descent setpoint of 0.70, bottom set point of 1.40 and a deco setpoint of 1.5, with the switch at 150m. Even if this is a relatively high setpoint the shortness of the time spent on the bottom is limiting the CNS under 100% until the divers will reach a depth of around 30mtrs .

At the 21mtrs decompression stop, where the divers will enter the bell and rest in a semi-dry environment, the CNS load will be less than ~150% (~135%). In the latter parts of the dive where the CNS is high, we will be decompressing inside the bell. Although the CNS% is high we will be faced with this anyway, so we just need to manage it. Its interesting to note that reducing the deco set-point doesn't necessarily reduce the CNS% loading much because of the extra deco required as a consequence means you have more time to load up on O2. The aim is to enter the dry bell as soon as possible minimizing the time in cold water. It is better to manage the CNS% with Low PO2 breaks inside the bell.

Low PO2 Breaks :

We will need to start low PO2 breaks at the 12 stop inside the bell. If we start them at a CNS of about 200%, which will be after a run time of about 180 minutes. To be effective you need to spend at least 5 minutes breathing a PO2 less than 0.50 bar, and preferably less than 0.40 bar. We will be using Tx 15/55 for breaks at 12mtrs. Experimental research data from DCIEM (Toronto, Canada) indicates that a 5 minute low PO2 period after every 20 minutes of 100% O2 (ie high PO2), allows you to breath O2 for twice as many total minutes before you have the same damage as breathing O2 continuously. This is actually a bit more than 200% on the O2 CNS clock if we talk about "in water" decompression but since we are decompressing in a dry environment experience from previous expeditions (Saint Saveur) show that this can be extended a lot without consequences. Low PO2 breaks are being counted as part of the deco

because the periods of low PO₂ actually make the body able to off gas quicker because the blood cells are not too clogged with O₂.

Flush to a lower He mix :

We choose not to do any diluent change because of the isobaric counterdiffusion potential danger. One diluent all the way up even if a diluent switch could have shortened the decompression obligation a little. Having a bell the benefit of a shorter decompression obligation is little compared to the danger of an isobaric DCI hit due to a counterdiffusion problem.

Last Deco Stop Depth :

From previous experience in very deep overhead environment in cold waters has been seen that divers could manage long periods on oxygen at high PO₂ provided a dry habitat and warm conditions. Using a dry bell from the depth of 21mtrs we meet this conditions. Divers are asked to stay for their last stop at 12mtrs on O₂ and once completed their decompression obligation they will continue on O₂ at an ascent speed of 3 minutes per meter.

Because of the huge amount of inert gas load the last decompression step is similar to an Hyperbaric treatment. In such semi-ideal conditions divers can extend their tolerance to oxygen toxicity.

Deco Algorithm.

Experience gained from previous expeditions and several publications has shown that long exposure dives below about 110m using conventional Buhlmann based deco algorithms can led to a fairly high DCS niggle rate. Experience has shown that utilising high Helium mixes and really slow ascent rates from very close to the bottom helps, eg a minimum of 1 min stops every 10 m of the ascent, until the first scheduled deep stops. Thereafter a deep stop orientated profile seems to be of benefit.

Software based on a Variability Permeability Model (VPM) had shown good reliability and several extreme divers had used for dives far deeper than this one.

Has been noted how the pure VPM model was inadequate and too aggressive. During last years several adjustment has been made to the original algorithm since has been noted from experimental analysis that a "Buhlmann style" correction was needed to lower the DCS rate. And also a further conservatism has been added for those dives considered "extreme" , those with more than three hours in the water.

We are using the V-Planner with VPM B/E algorithm and a conservatism of +4.

Some decompression tables have been cut and it is important to realise that these tables will give a slower ascent in the middle section than the VR3 will give (for those equipped with a VR3 using a "classic" version and not with the VPM software version. However, the total out-time should be very similar.

To sum up, having a total Run Time of around 6 hours for a 15 min bottom time and only 5' near the bottom filming the wreck is an acceptable target. We enter the bell after around 150' which is well inside the limit of the scrubber considering also that most of the time is spent decompressing on the shot with very limited workload.

CCR Decompression Tables

Look at appendix 5 for decompression tables. They can be copied, cut and laminated. Deco tables is provided by the Dive Marshall.

Decompression tables validation

We do not have any validation of this decompression profile so far. Deep divers produced this tables after a long discussion and confronting their previous experiences. Finally they agreed on flying this profiles.

Scrubber Duration

The Oroborous scrubber has been shown to be good for at least 5+ hours on the deep warm water dives. This is probably because :

- a) better scrubber efficiency in warm water.
- b) The divers work rate is very low apart from the first 15/20 minutes when on the bottom, so the divers CO₂ production rate will be very low for the majority of the dive, and most importantly, later stages of the scrubbers life.
- e) After about 150 minutes run-time the decompressing diver will be shallower than about 21m and into the bell. He will leave the CCR for an OC decompression gas. Previously he was using his loop with a Helium rich gas, so the gas density is very low, leading to improved scrubber efficiency.
- e) However if a workload increase is needed on the bottom divers are suggested to go open circuit for the time needed and after regain the loop as soon as the situation is feasible.

Bailout Tables

The choice of OC bailout and staged gases is such that an OC PO₂ between 1.60 and 1.10 is maintained throughout the ascent. The average of these approximates to the chosen CCR set-point and over, hence the deco profile and total run-time is not too dissimilar in the first part of the ascent profile and is going to be shorter than the CCR profile.

The bailout deco tables can work out quicker (not necessarily safer) because helium is eliminated gradually from the breathing mixes and deeper.

The bottom bailout gas consumption does not take into account the gas needed to swim back to the shotline. Diver are suggested to use, if it is possible, a semiclosed procedure.

Personal Equipment List

Documents

- Passport, ID card
- Driving licence
- Medical Insurance Documents
- Cash (Euros)

Electrical

- In Italy we use 220V socket 50 Hz supply with a standard European round pin plugs.
- European mains adaptors
- Roaming enabled GSM mobile phone.
- Cameras, film & batteries
- Calculator
- Laptop
- Alarm clock
- Chargers for:
 - Lights
 - Video/cameras
 - Laptop
 - Mobile phone

Personal Medical

- Sudafed or similar nasal decongestant
- Ibuprofen (eg Nurofen) or similar anti-inflammatory medications
- Aspirin
- As personally needed

Personal Spares & Repairs

- Toolkits
- CCR sensors
- CCR batteries
- Other CCR spares
- Buddy clean or other loop disinfectant
- O2 grease
- Spare batteries for the VR3 or other diving computer
- Spare C cells for strobes and bail out lights
- Assorted regulator service kits (Apex, Poseidon, Scubapro) as needed
- Assorted O-rings
- Assorted blanking plugs.
- Cylinder valve spares
- Spare CCR cylinder
- Spare CCR valve
- Spare bulbs for lights

Dive Kit

Drysuit, hood & dry gloves.

Spare drysuit

Tininsulate and other undergarments (socks etc)

CCR, harness and wing.

CCR O2 and diluent cylinders

3 x bailout regulators

3 x fully rigged bailout cylinders

Suit inflation cylinder and regulator.

Assorted carabiners, screw-gate , double-ended bolt snaps etc

Cylinder contents tags

Primary lamp

Backup lamp

Primary reels (minimum 200m line)

Spare reel

Orange/Red Delayed SMB & spare

Yellow "I need gas" Delayed SMB

Lifting bags

Goody Bags

Mask & spare

Fins

Jon line & spare

Ankle weights

Weight belt including lead

VR3 deco computer & CCR Link (for those who use this)

D- timers / guage mode computer (reading over 10Om)

Wrist slate & permanent marker pens

Flat slate & pencil

Knives / net cutters

Lifting bags

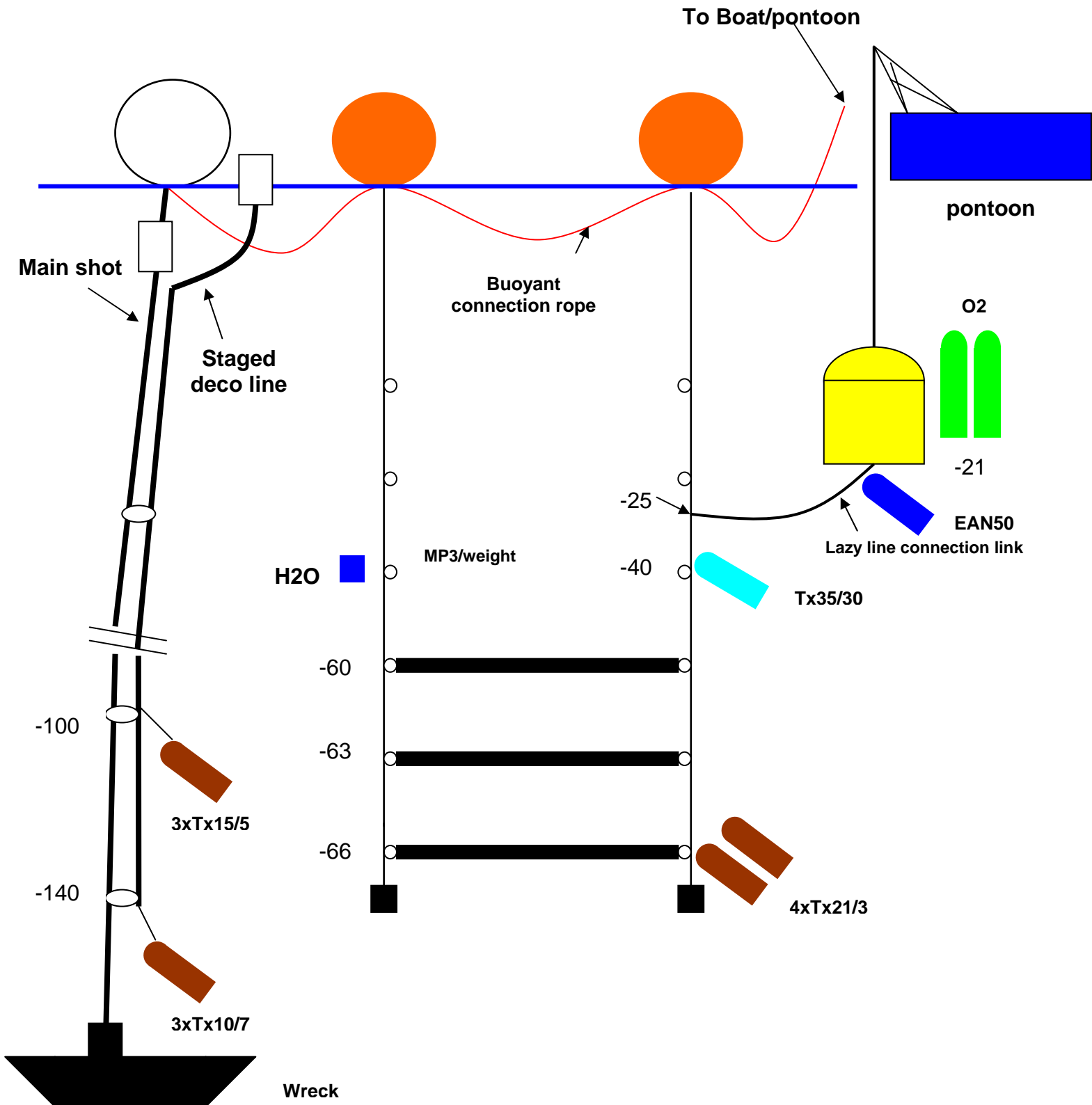
Goodie bags

P-Valve chonkies and/or Nappies

Deco entertainment (eg suitable magazines, laminated books mp3s)

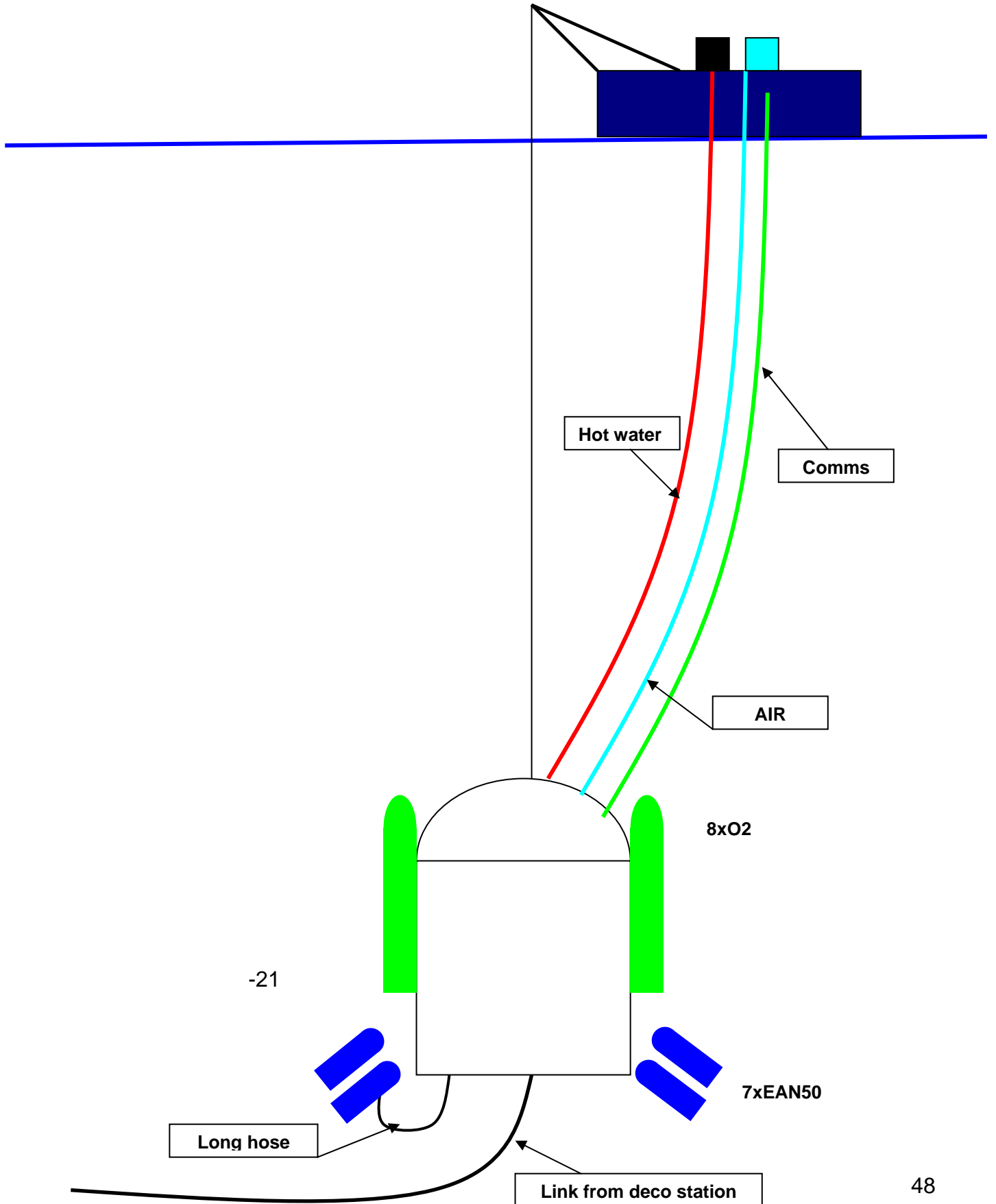
APPENDIX 1

DECOMPRESSION SYSTEM LAYOUT



APPENDIX 2

Bell description



APPENDIX 3

In water DCI treatment

UsNavyProcedure

Treatment of Decompression Sickness Occurring While at a Decompression Stop in the Water

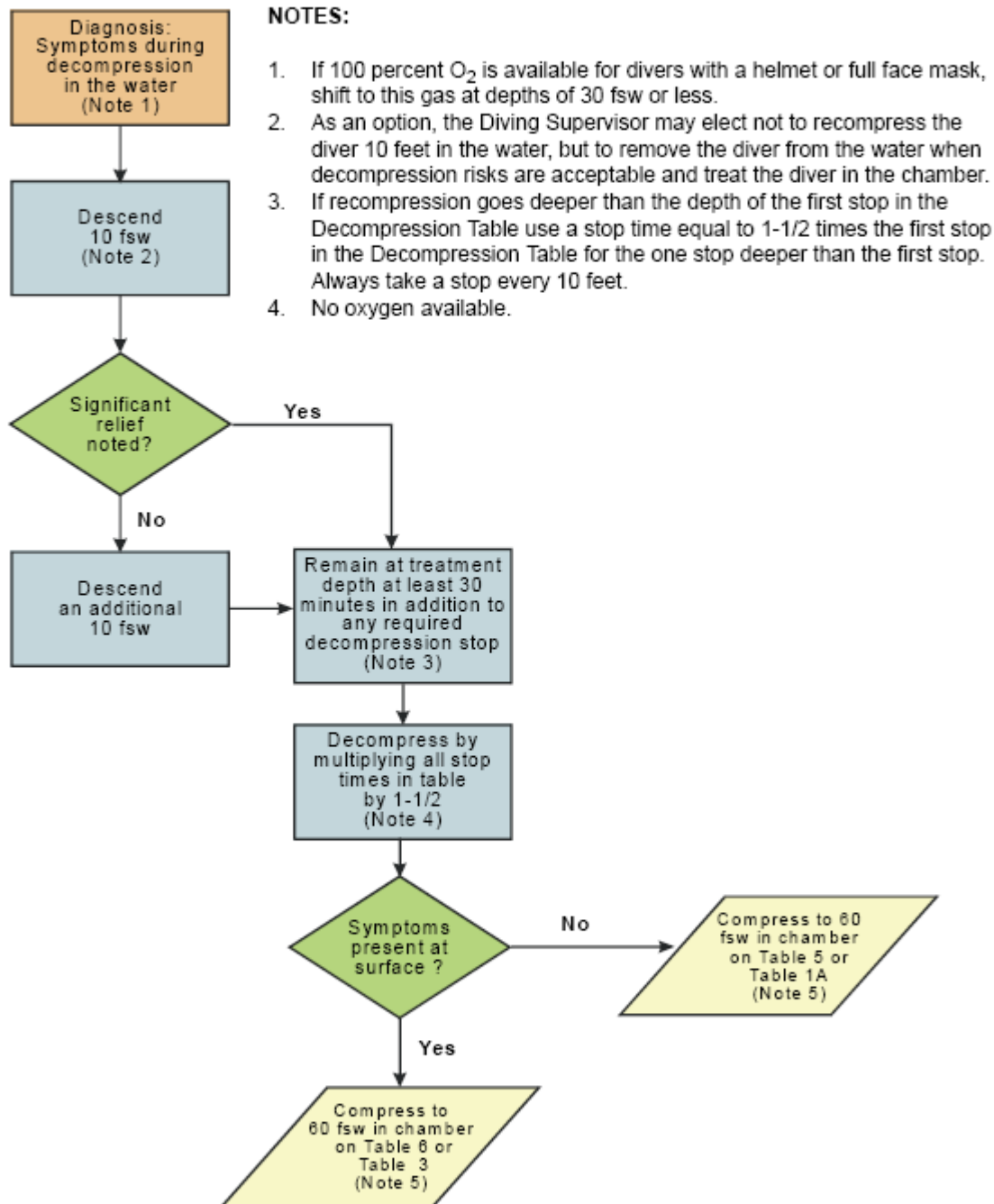


Figure 21-3. Treatment of Decompression Sickness Occurring while at Decompression Stop in the Water.

APPENDIX 4

Communication Slate

Everything OK ?	
Going UP ?	
TOTAL DECO ?	
GAS PRESSURE ?	
FEELING COLD?	
REMAINING DECO ?	
NEED WEIGHT	
I'M POSITIVE	
I'M NEGATIVE	
CHANGE SETPOINT TO:	
DO a DIL FLUSH	
WHERE IS..?	
WHERE IS THE SHOT?	

EMERGENCIES

I'M IN EMERGENCY	
LOST GAS	
CONTROLLERS	
SCRUBBER	
GET HI O2 ALARM	
GET LOW PO2 ALARM	
FLOODED LOOP	
PAIN HERE	
GET NAUSEA	
GET HEADACHE	
GET COLD	
DRYSUIT WET	
TIRED	

APPENDIX 5

Decompression Table Main Plan

230 meters for 14 minutes

D: Depth, T: Time, RT: Run Time, SP: Setpoint, DIL: Diluent, Mix: bailout mixture

D	T	RT	SP	DIL
230	0	14:00	1,4	6 80
189	0	16:10	1,4	6 80
186	0	16:20	1,4	6 80
183	0	16:30	1,4	6 80
180	0	17:00	1,4	6 80
177	0	17:20	1,4	6 80
174	0	17:40	1,4	6 80
171	0	18:10	1,4	6 80
168	0	18:30	1,4	6 80
165	0	19:00	1,4	6 80
162	0	19:20	1,4	6 80
159	0	19:50	1,4	6 80
156	0	20:10	1,4	6 80
153	0	20:40	1,4	6 80
150	0	21:00	1,5	6 80
147	0	21:40	1,5	6 80
144	0	22:10	1,5	6 80
141	0	22:50	1,5	6 80
138	0	23:20	1,5	6 80
135	0	24:00	1,5	6 80
132	0	24:30	1,5	6 80
129	0	25:10	1,5	6 80
126	0	25:50	1,5	6 80
123	0	26:40	1,5	6 80
120	1	27:40	1,5	6 80
117	0	28:30	1,5	6 80
114	0	29:20	1,5	6 80
111	1	30:20	1,5	6 80
108	0	31:10	1,5	6 80
105	1	32:20	1,5	6 80
102	1	33:30	1,5	6 80
99	1	34:50	1,5	6 80
96	1	36:10	1,5	6 80
93	1	37:30	1,5	6 80
90	1	38:50	1,5	6 80
87	1	40:20	1,5	6 80
84	1	42:10	1,5	6 80
81	1	44:00	1,5	6 80
78	1	46:00	1,5	6 80

75	2	48:00	1,5	6	80
72	2	50:00	1,5	6	80
69	2	52:40	1,5	6	80
66	2	55:20	1,5	6	80
63	2	58:10	1,5	6	80
60	3	61:10	1,5	6	80
57	3	64:10	1,5	6	80
54	4	68:20	1,5	6	80
51	4	72:30	1,5	6	80
48	4	76:40	1,5	6	80
45	4	81:00	1,5	6	80
42	6	87:00	1,5	6	80
39	6	93:10	1,5	6	80
36	6	99:30	1,5	6	80
33	7	107:10	1,5	6	80
30	9	116:20	1,5	6	80
27	9	125:40	1,5	6	80
24	11	137:40	1,5	6	80
21	11	149:40	OC	50	20
18	16	166:40	OC	50	20
15	22	189:00	OC	50	20
12	206	395:40	OC	100	

Decompression Table Contingency 1

230 meters for 16 minutes

D	T	RT	SP	DIL
230	0	16:00	1,4	6 80
195	0	17:50	1,4	6 80
192	0	18:00	1,4	6 80
189	0	18:20	1,4	6 80
186	0	18:40	1,4	6 80
183	0	19:10	1,4	6 80
180	0	19:30	1,4	6 80
177	0	20:00	1,4	6 80
174	0	20:20	1,4	6 80
171	0	20:50	1,4	6 80
168	0	21:10	1,4	6 80
165	0	21:40	1,4	6 80
162	0	22:00	1,4	6 80
159	0	22:30	1,4	6 80
156	0	23:10	1,4	6 80
153	0	23:40	1,4	6 80
150	0	24:20	1,5	6 80
147	0	24:50	1,5	6 80
144	0	25:30	1,5	6 80
141	0	26:00	1,5	6 80
138	0	26:40	1,5	6 80
135	0	27:30	1,5	6 80
132	0	28:20	1,5	6 80
129	0	29:10	1,5	6 80
126	0	30:00	1,5	6 80
123	1	31:00	1,5	6 80
120	0	31:50	1,5	6 80
117	0	32:40	1,5	6 80
114	1	33:50	1,5	6 80
111	1	35:10	1,5	6 80
108	1	36:20	1,5	6 80
105	1	37:40	1,5	6 80
102	1	39:00	1,5	6 80
99	1	40:20	1,5	6 80
96	1	41:40	1,5	6 80
93	1	43:40	1,5	6 80
90	1	45:30	1,5	6 80
87	1	47:20	1,5	6 80
84	2	49:20	1,5	6 80
81	2	51:20	1,5	6 80
78	2	53:40	1,5	6 80
75	2	56:20	1,5	6 80

72	2	59:10	1,5	6	80
69	2	62:00	1,5	6	80
66	2	64:50	1,5	6	80
63	3	68:10	1,5	6	80
60	4	72:10	1,5	6	80
57	4	76:20	1,5	6	80
54	4	80:30	1,5	6	80
51	4	84:50	1,5	6	80
48	6	90:50	1,5	6	80
45	6	96:50	1,5	6	80
42	6	103:00	1,5	6	80
39	6	109:50	1,5	6	80
36	9	118:50	1,5	6	80
33	9	127:50	1,5	6	80
30	10	138:00	1,5	6	80
27	12	150:30	1,5	6	80
24	13	163:40	1,5	6	80
21	15	179:10	OC	50	20
18	19	199:00	OC	50	20
15	26	225:10	OC	50	20
12	238	463:10	OC		100

Decompression Table Contingency 2

238 meters for 15 minutes

D	T	RT	SP	DIL
238	0	15:00	1,4	6 80
195	0	17:10	1,4	6 80
192	0	17:30	1,4	6 80
189	0	18:00	1,4	6 80
186	0	18:20	1,4	6 80
183	0	18:40	1,4	6 80
180	0	19:10	1,4	6 80
177	0	19:30	1,4	6 80
174	0	20:00	1,4	6 80
171	0	20:20	1,4	6 80
168	0	20:50	1,4	6 80
165	0	21:10	1,4	6 80
162	0	21:40	1,4	6 80
159	0	22:10	1,4	6 80
156	0	22:40	1,4	6 80
153	0	23:20	1,4	6 80
150	0	23:50	1,5	6 80
147	0	24:30	1,5	6 80
144	0	25:00	1,5	6 80
141	0	25:40	1,5	6 80
138	0	26:20	1,5	6 80
135	0	27:00	1,5	6 80
132	0	27:50	1,5	6 80
129	0	28:40	1,5	6 80
126	0	29:30	1,5	6 80
123	1	30:30	1,5	6 80
120	0	31:20	1,5	6 80
117	0	32:10	1,5	6 80
114	1	33:20	1,5	6 80
111	1	34:30	1,5	6 80
108	1	35:50	1,5	6 80
105	1	37:00	1,5	6 80
102	1	38:20	1,5	6 80
99	1	39:40	1,5	6 80
96	1	41:00	1,5	6 80
93	1	42:50	1,5	6 80
90	1	44:40	1,5	6 80
87	1	46:30	1,5	6 80
84	1	48:30	1,5	6 80
81	2	50:30	1,5	6 80
78	2	52:30	1,5	6 80
75	2	55:10	1,5	6 80

72	2	58:00	1,5	6	80
69	2	60:50	1,5	6	80
66	2	63:40	1,5	6	80
63	3	66:40	1,5	6	80
60	4	70:40	1,5	6	80
57	4	74:50	1,5	6	80
54	3	78:50	1,5	6	80
51	4	83:10	1,5	6	80
48	5	88:40	1,5	6	80
45	6	94:40	1,5	6	80
42	6	100:50	1,5	6	80
39	6	107:00	1,5	6	80
36	8	115:50	1,5	6	80
33	9	124:50	1,5	6	80
30	9	134:10	1,5	6	80
27	12	146:40	1,5	6	80
24	12	159:30	1,5	6	80
21	14	174:30	OC	50	20
18	18	193:30	OC	50	20
15	25	219:00	OC	50	20
12	232	451:20	OC	100	

Decompression Table Bailout

230 meters for 14 minutes

BAILOUT				
D	T	RT	MIX	
230	0	14:00	1,4	CC
189	0	16:10	6	80
186	0	16:20	6	80
183	0	16:40	6	80
180	0	17:10	6	80
177	0	17:30	6	80
174	0	18:00	6	80
171	0	18:30	6	80
168	0	19:00	6	80
165	0	19:30	6	80
162	0	20:00	6	80
159	0	20:20	10	70
156	0	20:40	10	70
153	0	21:00	10	70
150	0	21:20	10	70
147	0	21:50	10	70
144	0	22:20	10	70
141	0	22:50	10	70
138	0	23:20	10	70
135	0	23:50	10	70
132	0	24:20	10	70
129	0	24:50	10	70
126	0	25:30	10	70
123	0	26:20	10	70
120	0	27:10	10	70
117	0	28:00	10	70
114	0	28:50	10	70
111	1	29:50	10	70
108	0	30:40	10	70
105	1	31:40	10	70

102	1	33:00	10	70
99	1	34:20	10	70
96	1	35:50	10	70
93	1	37:00	15	55
90	1	38:00	15	55
87	1	39:00	15	55
84	1	40:20	15	55
81	1	42:00	15	55
78	1	43:40	15	55
75	1	45:20	15	55
72	1	47:10	15	55
69	1	49:00	15	55
66	2	51:30	15	55
63	2	53:40	21	35
60	2	55:40	21	35
57	2	57:50	21	35
54	2	60:10	21	35
51	3	63:20	21	35
48	3	66:50	21	35
45	3	70:40	21	35
42	4	74:50	21	35
39	4	79:00	35	30
36	5	84:30	35	30
33	5	90:20	35	30
30	6	96:50	35	30
27	8	105:30	35	30
24	10	115:50	35	30
21	11	127:00	50	20
18	15	142:50	50	20
15	20	163:30	50	20
12	182	346:20	100	

Bottles markings

All bailouts bottles MUST be properly marked with MOD. There are different ways to do so. One we choose is to mark the bottles with large numbers to be seen by your buddy and small one to be seen by yourself fro either side. Some examples below.

Moreover you can put mixture composition indications in a place not visible underwater, date of the analysis, signature of the person who did the gas analysis and owner name.

Bailouts who are staged on the main shot and on the decompression station MUST have also a carabiner with lock.



Bottle from the right



Bottle from the left



Upper marking



carabiner



Upper marking

APPENDIX 7

Briefing guide Dive Marshall (Planning phase-day before)

- Main objective/secondary
 - Location
 - Weather
 - Objectives
 - Participants/groups
 - Dive Profile
 - Decompression profile
 - Decompression tables and comments
 - Divers configurations
 - Surface assistance/support
 - Specific configuration/rebreather features
 - Support Divers

- Specific duties: Groups/individuals
- Communications - surface/in water
 - Normal
 - Emergency
- OC/CC differences – vedi apposita Check list
- CC – Basic knowledge

- EMERGENCIES
 - Surface
 - Mission Leader
 - Separated/lost Diver
 - IWR
 - Evacuation
 - In water
 - Hypoxia
 - CO2 hit
 - OxTox
 - Lost Diver / separated
 - In water DCI symptoms
 - Lost gas
 - Other

- DCI - surface
 - Groups / specific duties
 - Normobaric oxygen O2 – Techniques
 - CPR
- IWR – when and how
- Questions / comments

APPENDIX 8

Briefing guide Dive Marshall (Operative phase-diving day)

- Main objective/secondary
 - Dive Profile
 - Decompression profile
 - Surface assistance/support
 - Support Divers
- Specific duties: individuals
- Communications - surface/in water
 - Normal
 - Emergency
- OC/CC differences
- CC – Basic knowledge
- EMERGENCIES
 - Surface
 - Separated/lost Diver
 - IWR
 - Evacuation
 - In water
 - Hypoxia
 - CO2 hit
 - OxTox
 - Lost Diver / separated
 - In water DCI symptoms
 - Lost gas
 - Other
- DCI - surface
 - Groups / specific duties
 - Normobaric oxygen O2 – Techniques
 - CPR
- Questions / comments

APPENDIX 9

Color coded members T-shirts



APPENDIX 10

Dive Marshall Log Sheet

Dive Site/date	
Dive Marshall	
Dive Supervisor	
Surface Assistant1	
RIB1 Driver/Assistant	
RIB2 Driver/Assistant	
Bell Supervisor	
Firemen Team Supervisor	
Doctor	

	NAME	OC CC	Run Time	Time in	Time out	Time on duty	Max depth
DD1	Pim	Boris					
DD2	Mario	Boris					
DD3	Ale	Boris					
DD4	Was_Cedric						
VDS1							
VDS2							
DS1							
DS2							
MS1							
MS2							
SS1							
SS2							
Em_VDS							
Em_DS							
Em_MS							
Em_SS							
Stdby1							
Stdby2							