Nadeau's Flow Chart of Technical Dive Planning

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The Nadeau's Chart of Technical Dive Planning basically covers the Where, Why, with Who, How and What-if's of each dive plan. We maintain that a detailed and well thought out Dive Plan should be constructed for each and every dive, from the Open Water Level to Deep Mixed Gas, Cave and Rebreather Diving. This is very important because divers sometimes take their experience for granted, presume a dive will workout fine and overlook some or all of the parts of properly planning a dive. When things go wrong and your dive plan did not include a contingency to cover that problem, resolving it becomes more difficult. This can increase a diver's risk and stress levels exponentially.

Determine Dive Objective
Where, When & with Whom

Plan the Fundamentals
(Using Daltons Law)

Determine Bottom Times
&
Decompression Requirements

Balance Oxygen
Exposure

Is this dive within my limits?

Calculate
Gas Management Needs

Select the Right Equipment

Is this dive still within my limits?

Contingency Planning
Stage

Is this dive still within my limits?

Assess Environmental
Conditions

Is this dive still within my limits?

In Water up-date.

Pre-dive Visualization.

Final OK - is this Dive a go?

DIVE

Step #1 <u>Determine Your Objective</u>

This part includes the *Where*, *Why* and with *Whom* part. First you must determine where it is you are going to dive, with whom and why.

Where? The dive site usually is determined by the Why part of this step in dive planning. For example, two divers want to do a cave dive and take some pictures (the why part of their Objective). They will need to find a cave and one with good visibility so that they can get clear pictures. Sometimes the site itself creates the objective, such as an unexplored Cave system. In this case the Where has determined the why 'i.e. to explore and survey a new cave system.' Notice how we can already begin to identify the basic **elements** involved in the dive and categorize them into one of the three **Ranges**.

Why? Diving on wall to 90MSW (297FSW) because you want to dive to 90MSW is not good enough. The *Why* part of a Dive objective must have true value and '2-*footitis'* is a logic that kills people. When mountaineers are asked why they climb Mount Everest they might respond by saying *'because it is there!'* Yet their response represents more than just climbing a mountain because it is the highest mountain in the world and has not been done by very many people. It represents personal challenge, it represents exploration to an area few have ever been, and it represents a trying ground for mountaineering techniques.

In 1982 Sheck Exley died attempting a world deep diving record. His '*Why'* was about more than just logging a new deep diving record in his logbook. It was about exploring an area of a site that no one had been to before; it was about putting to practice years of research, practice, training and dive planning and to establish new standards for cave divers. Much of what we incorporate as standard advanced diving philosophies comes from the work and experience of people like Sheck. When Keller completed his 305MSW (1000FSW) dive in 1962, he was aware of the high risk aspect of it but, the purpose or objective of his dive also represented a trail blazing pioneering effort.

Your *Why* might be simple or complex, public or personal, but it must justify all the risk that will be involved in the dive. Calculating just how much risk involves completing all the steps of a dive plan, for every dive honestly and openly.

With *Whom*? Selection of a dive buddy will usually be determined by the *Where* and the *Why*. Is your buddy qualified and experienced enough to do this dive with you, and are you for him? Do you dive well together? Do the two of you share the same interests and objectives? Both buddies must share the same objective or there will be problems. If there are two buddies and Buddy A wants to take pictures in a cave, and Buddy B wants to follow, there may be some problems such as who is going to run and lay the line? Each member of the team must have a very clear role to play in meeting a common objective.

Step #2 <u>Planning the Fundamentals</u> (Using Dalton's Law)

On every dive we must calculate the best gas for the planned depth and personal physiological limits. Dalton's Law is the primary tool we use to begin our Dive Planning sequence. This is first and perhaps one of the most important steps in Dive Planning. It begins the *How* of our Dive Plan.

What is my personal $P0_2$ Limit? Only you can choose what your personal limits are. Instructors, Divemasters and Technical Dive Supervisors can help advise you and instruct you on how to make an informed decision, but ultimately it is your responsibility. From our training we have learned that $P0_2$ limits should be adjusted according to our personal level of physical fitness, age, the type of diving we are doing and the environment we are doing it in.

> ***Example****: Joe Diver is a middle-aged man who is in fair shape and is going to do a no-decompression dive to 40MSW (130FSW). The water is cold (60°F) and there could be current. He chooses to subtract .1ATA $P0_2$ for the cold water and current and .05ATA for his age, level of physical fitness and the depth.*

1.60	*max $P0_2$ for recreational diving*
- .1	*cold water*
- .1	*currents (potential physical exertion)*
- .05	*age, physical fitness*
- .05	*depth*
= 1.30	*Joe Divers personal $P0_2$ limit*

Joe Diver will use a $P0_2$ of 1.3ATA as a maximum limit when planning his dives. This is a choice he has made and accepted. To others it may appear either conservative or aggressive, yet it is Joe's decision, and that is important.

What is my maximum depth limit? To meet the objective of a dive might require a diver to reach a specific depth such as a wreck that starts at 27MSW (90FSW). To do this the diver must select a gas ($F0_2$) that will allow him to progress to that depth without causing his $P0_2$'s to exceed his personal limits. Another consideration is the depth itself. Is the diver trained and experienced to dive to these limits?

What is the best mix ($F0_2$*) for this dive*? By incorporating enriched air nitrox mixtures, (EAN) a diver can avoid or reduce decompression requirements. But enriching a bottom mix with oxygen also limits a diver's depth. The diver needs to know how to balance his depth and decompression requirements by choosing a gas mix that addresses both satisfactorily.

The same questions must be applied to decompression and travel gases as well. When diving with rebreathers, divers may need to consider a third dimension to Dalton's Law as their $F0_2$'s (not the supply but the inspired $F0_2$) are not necessarily fixed. And in advanced diving practices, divers will adjust the maximum acceptable limits during various points in the dive to meet particular needs.

> ***Example:*** *Joe Diver has determined he does not want to exceed a maximum* $P0_2$ *of 1.3ATA but he has only an EAN34 and the main Octopus Den he wants to photograph is at 32MSW (105FSW). His* $F0_2$ *limits him to 28MSW (93FSW) with his set maximum* $P0_2$ *of 1.3ATA. He may choose not to do the dive, he may limit his depth, or Joe might drop to 32MSW (105FSW) for a few brief minutes to take the picture and momentarily push his maximum* $P0_2$ *to 1.42ATA. Joe needs to determine whether or not he is adding substantial risk and stress by exposing himself to a* $P0_2$ *to 1.42ATA for a few minutes.*

At the extended range level, divers will adjust their plan many times, balancing one limit against another before deciding on a final plan. Experience, training, and good judgement allow them to do this. A responsible diver will not compromise safety or increase the level of risk to make a dive possible; he will compensate and prepare for it.

Step #3 <u>Determine Bottom Time and Decompression Requirements</u>

First a diver must determine how long he will need to meet his objective on the dive. With training, utilizing higher level oxygen mixes (like EAN50), divers are no longer restricted to the 'No-Deco Times' on their dive tables or computers. If a diver needs 20 minutes on the bottom to complete his objective and his dive tables limit him to 15 minutes, he can spend a full 20 minutes on the bottom and then complete any required decompression required.

What tables should I use? Traditionally recreational divers were taught to use one type of table, and that table (an Air Table) was produced by their training agency. Today divers have many safe and easy tools they can choose from to determine what kind of profile they want to follow. Some are hard tables that are based on different EANx mixes, some are hard copies in manuals generated from computer algorithms, and some are computer programs. Part of your diver education will teach you where tables come from and how they work. From there, a diver chooses which method he wants to use.

Step #4 <u>Balancing Oxygen Exposure</u>

A diver must consider how much oxygen the body is being exposed to, as oxygen is less forgiving than nitrogen. As a diver augments his bottom mixes and decompression gases with oxygen to reduce decompression requirements, he needs to ensure he has low-risk oxygen exposure levels.

A diver will want to run as high an $F0_2$ he can without exceeding his $P0_2$'s to keep the decompression requirements low. However, as dives get longer and deeper, a diver running high $F0_2$'s will also use up a high percentage of his CNS% (Central Nervous System) clock.

> ***Example****: Joe Diver is in warm waters using an EAN40 at 29MSW (95FSW). The conditions are excellent and Joe has decided to do a dive for 35 minutes. According to a set of Nitrox decompression tables (in this case we'll use IANTD 40% nitrox tables), this is not a decompression dive which Joe wants to avoid. After consulting with a Maximum Exposure Chart for Oxygen, Joe discovers that he has used 78% of his total allowable clock. This is acceptable, but even though the dive tables indicate it would be OK for Joe to return immediately for a second dive, his oxygen exposure requires that he remain on the surface for at least 45 minutes.*

Divers must monitor both their CNS and pulmonary oxygen tolerances (OTU - Oxygen Tolerance Unit) during every stage of a dive plan. If the numbers get too high, they must go back up a step and adjust their depth, time or gas mixes.

Step #5 Is the Dive Within Your Personal Limits?

A diver must continually evaluate throughout a dive plan whether the dive plan is within his limits. At this point a diver must ensure that all of the logistics of the dive plan are acceptable based on his training, experience and stamina.

> ***Example:****; While planning a dive to 32MSW (105FSW), Joe Diver discovers he needs to spend 30 minutes to film an Octopus at the bottom. His decompression requirements for using air as a bottom mix is 19 minutes at various depths. Joe knows that he gets cold after 45 minutes so this dive, even though it works out OK on paper, will be too long for him and increases his risk of hypothermia. Joe has a number of options. He can use a 50% decompression gas that will shorten his dive by 5 minutes (TBT=44 minutes), or he can use a higher EANx for a bottom mix like a EAN32 assuming it does not exceed his personal* $P0_2$ *limit.*

In the above example, the solution seemed clear, yet determining whether a dive is within your personal limits or not can be more complex than it appears. Divers need to be critical of their dive plan as it develops. What if Joe lost his decompression gas and had to resort to his bottom mix to complete a safe profile? Joe's dive is now longer than 45 minutes and he will get cold and predispose himself to DCS (Decompression Sickness). Is Joe even trained to use EAN40 or EAN mixes up to 50%?

Step #6 Gas Management Planning

Once a diver has determined how long he wants to dive for, how long his decompression (if any) will be, and what kind of gas he needs, he will then need to determine the volume of gas supply he will need to complete the dive safely.

- i) First a diver must determine what gas rules he wants to use (i.e. ½ + 200 or Rule of Thirds).
- ii) Next the diver must apply his RMV (Respiratory Minute Volume) to the profile to determine how much gas will be needed during each stage of the dive.
- iii) Then he should compare the team's RMV's and incorporate compensations for different breathing rates by incorporating a SAC (Surface Air Consumption) ratio factor. As mentioned earlier, there are a number of tables and formulae that help one calculate these values.
- iv) Finally the diver must calculate what size tanks he will need to do the dive.

> ***Example****: Joe diver has an RMV rate of .45 cubic feet per minute (cfm). Joe wants to dive to 27MSW (90FSW) for 35 minutes using EAN40. This is a no-decompression dive in open water above 39MSW (130FSW); therefore, Joe may use the rule of ½ + 200. Using an 80cuft tank would mean that Joe can use up to 45.4cuft of his supply before tapping into his reserve. After calculations were done, Joe found he needed a total of 58.7cuft. Joe needs to either shorten his dive or get a bigger tank.*

Step #7 Choosing the Best Equipment for the Dive

Based on the objectives, a diver must now make some decisions about the type of gear he will need to complete the dive. As discussed, equipment configuration and selection is a personal thing to each diver. It would be incorrect for us to believe that there is only one type of equipment or set up for each dive. A diver, however, needs to justify why he has chosen the configuration and equipment for that dive. This includes:

- ☑ Size of tanks needed
- ☑ Redundant equipment
- ☑ Type of thermal protection
- ☑ Rescue/self rescue equipment

Divers cannot compromise on their equipment selection because they either cannot afford it, or it is unavailable. This is how a lot of accidents happen.

Step #8 **<u>Is the Dive Within Your Personal Limits</u>**

Once again a diver must continually monitor a dive plan to determine if it ever reaches a point where the logistics are beyond his capabilities. The last few steps involved calculating gas needs. If a diver finds that he needs more air, the answer might not be to go to bigger tanks.

> ***Example**: Previously we determined that Joe Diver will use almost 60cuft to complete a dive to 29MSW (95FSW) for 35 minutes. Joe chooses to increase his tank size to a 120cuft bottle with a pony bottle. Joe now needs to assess whether the heavier and bulkier gear is not going to affect his diving style, breathing rate or control in the water. If it is, he will have to go back and change another part of the dive plan.*

Step #9 **<u>Contingency Planning</u>**

This is perhaps one of the most difficult and important aspects of dive planning and why we addressed it specifically at the beginning of this topic. Divers must practice an intimate query process when assessing risk and deciding whether a particular dive plan is acceptable. When things go wrong and your dive plan did not include a contingency to cover that problem, resolving it becomes more difficult. This can increase a divers risk and stress levels exponentially.

While training in an extended range diving course, you practice solving many problems at the same time, such as sharing a gas supply while trying to resolve another problem. The fact is, problems accumulate quickly once the first one starts, especially at depth.

> ***Example:** Joe Diver is cruising along inside a cave when without reason his primary regulator first stage blows an o-ring and begins to bubble gas out violently. As he stops to switch regulators and attempt to isolate the leak to one side of his manifold by executing a valve shut down, his ankle snags the main guide line leading out of the cave. He does not realize that he is hung up on the line and before long has snapped it. By the time he completes the gas shut down and re-orientates himself with the cave, the visibility has been reduced to less than a foot or two and his gas supply is a fifth of what he started with. He spends a few more critical minutes looking for his buddy, his heart rate and respiration increase as he is trying to navigate a cave passage with little visibility. He eventually decides that he needs to re-locate the broken line, consider repairing it, or at the very least determine where the end that leads out is located. Within seconds of the first problem occurring, this diver has found himself alone, lost in a cave with zero visibility and a low air supply.*

Potential problems are not always clear and the fact that they can lead to other problems, adds an undesirable complexity to contingency planning. If performed honestly and correctly, contingency planning will often reveal a diver's inability to make a dive safely.

Step #10 **<u>Is the Dive Within Your Personal Limits</u>**

Once an honest and complete assessment of what problems might occur, and a contingency plan has been drafted to deal with it, a diver must evaluate whether he can manage it.

> ***Example**: In an open water training class we train on how to remove and replace a mask that has been knocked off. This is under the watchful eye of an Instructor in very controlled conditions and when we are prepared to do the skill. But when Joe Diver is cruising a long a wall at 30MSW (99FSW), in current with decompression obligations accrued, and his buddy kicks off his mask in cold water, can he keep his act together and find his way to his first deco stop and complete his required time? If Joe has a free flow, can he reach and shut down his valves quickly enough? What about at depth where narcosis inhibits his problem solving abilities.*

Step #11 **<u>Evaluation of Environmental Conditions</u>**

This step is pretty straight forward - divers need to gather as much information about the dive site as possible. These include…

- ☑ Currents
- ☑ Bottom Topography
- ☑ Water Temperature
- ☑ Thermoclines

- ☑ Tides and Slack Considerations
- ☑ Marine Life
- ☑ Boating Traffic
- ☑ Marine Forecast
- ☑ Industrial Hazards

A diver must consider whether any of these factors will have any effect on the dive plan and increase the risk of the dive. Should modifications be made or should any additional contingencies be considered to handle Environmental Problems.

> ***Example****: Joe Diver is doing a deep wreck dive when a freak and sudden storm blows up. The dive boat has to pull up anchor, the swells become fierce and the currents pick up. Joe, unaware of the topside problem, can't find the anchor line. He blows a lift bag and is carried off in the strong current. The Dive boat cannot see his bag due to the swells and by the time Joe surfaces, both shore and boat are no where in sight and the seas are very heavy. What if Joe drifts into the middle of a major shipping lane?*

We can run an endless number of scenarios but the fact remains; the more we are prepared for, the less our risk. By incorporating Environmental Assessments into our Dive Plan, we continue to secure a safe and enjoyable diving experience.

Step #12 Is the Dive Within Your Personal Limits

Many Environmental conditions are often deciding factors whether a diver can complete a dive, or whether he has to modify it. After evaluating the environmental conditions and taking into account that Mother Nature can show her ugly side at any given moment, are still certain the dive plan is within your personal limitations?

Step #13 In-Water Update

This is a diver's last opportunity to determine whether any aspect of the dive plan has been compromised during its implementation. In-water updates should include your present emotional, physical, mental well-being in addition to your surroundings.

> ***Example****: Joe Diver discovers that upon entering the water, he has a steady stream of bubbles coming from his first stage. At first it appears to be not a major problem but at depth when the regulator is subject to work, it could result in a regulator failure. The dive should be aborted before it begins.*

Step #14 Pre-Dive Visualization

Visualizing how your dive plan is going to go can help reinforce all aspects of the dive just before you drop below the surface. It is a great way to relax, focus and establish a steady healthy breathing pattern. Many times a pre-dive visualization can reveal problems overlooked in earlier stages of your dive planning. It is also when your intuition speaks the loudest.

Step #15 Final OK

This gives every diver on the team a chance to check with each other and determine if the dive is a 'go'. Dives should also be aborted during initial descent if any concerns arise in the early stages of the profile. For divers engaging in an extended range activity, this opportunity allows them to call a dive before being obliged to decompression.

These 15 steps might seem very involved but they really are not difficult to follow. Use the following flow chart as a summary of what I just discussed. In fact I would even go as far as recommending you copy it into your log book or permanently on the back of a dive slate for reference. Consider what dive management means to you by reflecting on what responsibilities a manager actually holds. Be critical and honest about your abilities and your equipment. Finally, never forget that your actions affect other people as well.