Transcript of George Irvine's Lecture to BAUE on May 18, 2002

Background

On May 18, 2002 George M. Irvine III gave a free lecture in Monterey, CA at the demo day sponsored by Bay Area Underwater Explorers and Manta Ray Dive Center. The following is a transcript of that lecture typed in by Nick Radov and edited by Gary Banta. It is based on video shot by Clinton Bauder and Leonard Tsai. Some of what George said has been edited for clarity; any errors are the editor's fault. Hyperlinks to other web sites have been added to provide some context for readers not already familiar with DIR.

During the lecture George used Jim Thompson's rig as a prop; it included double steel back tanks, a small argon tank mounted "wreck style" on the harness waist strap, Apeks regulators, and Halcyon back plate, harness, manifold, Explorer wing, Helios primary light, and Scout backup lights.

Transcript

George: This is a preaching-to-the-choir crowd today. Because there's you local guys and then Andrew Georgitsis up in Seattle with SCRET — so all I wanted to do today is go over some of the fine points. And then I'll go over the genesis of how this all came about and some of the things we ran into along the way. This will probably lead into the higher level parts of this discussion. So if you guys could jump in any time with questions and keep me directed we won't waste too much time with things you already know.

My diving history began as a fisherman. My father built boats and we'd go fishing all the time. I always wanted to see what was down there. It was that simple. But I was afraid too because I saw what was happening at the back of the boat: sharks eating everything. Eventually one of his boat captains who was a diver put the gear on me, handed me the gun and the bag, said "Don't hold your breath on the way up, let's go." So I started diving. Of course, I was immediately hooked. I started on the wall at Walker's Cay, which was just virgin, spectacular, untouched stuff. Anyway, I'd always been a swimmer, diver, snorkeler, I'd dive for lobsters, put a tank on, clean the bottom of the boat, change the wheels, that kind of thing. But I didn't really get enthusiastic about it as an activity until that guy took me down on the wall at Walkers Cay. I was hooked. Diving was just constant after that. I'd go out and dive twice on one boat in the morning, twice on another in the afternoon. The next day, I'd do it all again. Then I'd go out during the week. I just dove all the time. What we were doing is diving the walls, the reefs, and then the shipwrecks off of Florida. And there are a lot of them that are artificial reefs. But they were sunk for fishing — they weren't sunk to be dived. And what occurred as we dove the wrecks is that it got more and more difficult: you needed more gas, it got deeper and we started running up against all these obstacles.

At that point I went and took a cave diving class because I thought that would improve my skills, my techniques, my knowledge, so on and so forth. I was seeing these cave divers and they had all kinds of cool gear.

Audience: About how long ago was this transition?

George: 13 years ago, 14 years ago. I got lucky and I drew Alton Hall for a cavern instructor. I met Alton Hall on a boat in Fort Lauderdale while he was in law school. He was part of WKPP and his cave instructor was Parker Turner. So I went to Parker Turner for the cave. Turner was one of those guys that make me look like Jarrod Jablonski — a relatively nice guy. He'd get right up to you with his finger in your face and say: "That's stroke shit." The first time I met him I flew to Tallahassee airport and while he's still behind the security barrier he yells, "Take the cotton out of your ears and put it in your mouth". This is before I even met the guy. *[audience laughs]* Most people wouldn't put up with him. But he taught cave diving part time and he ran the Woodville Karst Plain Project and he taught at Florida State. He owned a bunch of oil wells so he didn't really need to work. I don't know why he taught diving but he loved it and he loved the project. He had all kinds of great ideas.

His dive partner was Bill Gavin an engineer for the Navy. Gavin is an incredibly clever, unbelievably skilled guy. Parker took his enthusiasm for what Gavin had showed him and translated it to the project. He was trying to do things that nobody thought was possible. It's too bad he's not here now to see what Jarrod and I were able to do with what he started. So while I began this training just to pick up some more stuff, I ended up liking cave diving. But by the time I got to cave diving I'd been diving forever but very focused on wreck diving. My goal in taking to Parker and Bill Gavin and these cave guys was to make it universal to all types of diving so that you didn't have to change anything. Ideally cave divers would want everything to be the same: everybody with the same response, everybody handling things the same way and having the same gear.

But it didn't necessarily translate to wreck diving. Interestingly though, anything that's important in cave diving (technique, skills, whatever) is far more important in wreck diving than it is in cave diving. Cave diving is a static environment; you don't have the moving parts. Wreck diving is far more difficult. So your discipline and your gear and your skills and all the things that are learned from cave diving are better applied to wreck diving, it's just that nobody ever applied them. You just look at little things like in cave diving like what happens if you put an argon bottle back here on the side of the tanks with the Velcro® straps. The risk is what happens if you go through a restricted passage with that passes the bottle easily in one direction but when you are coming the other way it can't pass because the bottle is in the way. So you have to be able to remove or move it if necessary.

In caves there's no issue with fishing line or wire or current that you have in a wreck dive, so you can mount the argon on the doubles. For wreck, you want it in close where it will not catch things. Obviously you want to have something universal so you just slide the argon over here on the hip or mount the bottle on the plate. You don't need a big bottle — a little bottle is fine. If all you are doing is this one type of diving out here, I would put an argon pocket on my drysuit rather then make a rig like mine or a rig that goes on the backplate. I don't like anything on the plate or up against me between the wings and me.

Where there need to be "distinctions" between wreck, open water, cave or whatever we want to make distinctions but still want everything to be identical. It should all still work the same but with a slight difference for the type of diving. For example, you put gloves on for the cold water you have here but you don't need gloves in a cave dive in Florida. So on and so forth. We did this with all types of diving.

What it basically comes down to is there is really just three things: gear,… With gear everybody needs to be the same and everybody has to have the same response. If there is a problem everybody needs to know how to deal with it. If I'm having a problem I need to know what your response is going to be. So these things fall under the gear. You need to practice the same diligence in your diving skills no matter where you're diving. If you're diving in a swimming pool or the siltiest cave or wreck — breaking down, rusted out wreck full of wires, and monofilament, silt this deep, and this much room over your head… You need to treat that just as if you're diving the swimming pool. You need to dive the same way where ever you are diving: do the same thing all the time. Same response, the same gear, the same setup and the same result every time. You can't vary it.

A lot of these things can be lumped into the different categories. Safety can be put anywhere. Buddy skills are massively important and you can call them gear, you can call them technique, or you can call them repeat performance. Wherever you stick these things, the basic idea is that everything has to be done the same way over and over again. You don't want to show up and have to drive on the left side of the road. Imagine an ambulance driver goes to respond to a call and they tell him, "Today you're driving on the left side of the road. Tomorrow we're driving on the right side of the road." I can't drive in the Cayman Islands. I can't do it! I just can't do it! I'll pull out and I'll look left and I'll get run into. So I don't drive in the Caymans. I want it to be the same every time. You must always have same response to the same problems.

The genesis of the system in the Woodville Karst Plain Project was a similar development to what we were trying to do in the ocean. WKPP had these massive cave systems that people were exploring, and exploring on air, and doing it in a basic Star Wars bar-scene fashion. A couple of guys were extremely tough and talented: Sheck Exley, Bill Gavin, plus a couple other guys. Exley never gave anybody a hard time. You could show Exley the stupidest thing you've ever seen and he'd go, "Oh, that's a great idea." Somebody would have something totally stupid and he'd go, "Oh, that's wonderful." He'd tolerate all these guys around him that were just albatrosses around his neck and the poor guy couldn't get anything done. It was amazing what he did get done but that was just from sheer toughness. He would start a project and he'd have 30 people all gung-ho to go and they'd all show up with different gear and different ideas and do different things. They'd get lost in the cave, screw it up, and cause a charlie foxtrot for Exley. But by the time he got through exploring he'd be by all by himself. He'd be the only guy left. When he did his record dive at Chip's Hole, Steve Irving (one of our guys) had just shown up to do a dive. He said there were eight aluminum 80 stage bottles floating butt-up in the spring and Exley was asleep in his car. The guy had done his record solo because none of the other idiots showed up. And he was too tired to get his stuff out of the water so our guys took it out and put it in his truck and he was still asleep. But how do you do things like that? It would take these guys months and months and months to do something and then Bill Gavin would come along with his handful of guys that did everything the same way and they were slick and they'd knock it out in one shot.

I got lucky, I got in on it early. Everybody around me got killed and I ended up being Gavin's partner. Everybody else got killed or quit. It like, how do you become a Marine captain in Vietnam? Just stay there a couple days. Everybody else will get killed and you'll be captain. That's basically what happened with me. I got stuck and elevated into a position that I didn't belong in really. But, I was lucky again. I told Bill: "Tell me anything I'm doing wrong, show me everything, teach me everything, I'll do whatever you say." And I did. Gavin used to say, we'd go in and explore these caves where all these other guys had given up. And Gavin would always say, "This is where Exley weenied." It really wasn't where he weenied, it was just he had no help, and where it went deep. So the obstacles we had to overcome were teamwork, how do you get

around depth, and then how do you get around distance, and then how do you stay warm. How do you do all these things?

Well Bill was a civilian Navy engineer with a team of engineers. One of the projects was the Mark 19 rebreather, which now has been cloned and copied into the Cis-Lunar and a bunch of other rebreathers. The Navy never used the Mark 19 because there was no mission for it. They use the standard Mark 16 and others like that. The other area Bill Gavin worked on was thermal. So he tested every kind of drysuit and underwear — everything in the world. His recommendations are why Navy SEALs use what they use and why Navy divers use what they use. He did masks and regulators and other gear. Another project he did was vehicles. He did all the secret vehicles — the ones you never see or hear about. Not the SEAL delivery vehicles (those are a big torpedo), but the secret vehicles.

At WKPP we had four other engineers who worked with Gavin at Navy, so we had the benefit of all this information all the time. We had a platform that we could start from and had the benefit of all his background data and information. So we knew what wouldn't work and we knew what should work and tried to apply it.

When Parker died, Bill took over. When another guy got killed on a dive I took over. Bill's attitude was, he told me, "We can't make these people do everything the way we want them to do it because they're volunteers." And I said, "We have to make them do everything the way we do it or they're going to get killed!" Once I took over I just made everybody do things the same way and of course that was massively unpopular. The gear and equipment manufacturers hated me. Everybody had a big fit about it but it worked out. With the gear, originally it was people with independent tanks, it was people with stuffed hoses, there were people with lights all over the place wherever. Everything was different.

What we did was setup the system. The manifold we now use on doubles wasn't available when we started out. There was a center port Scubapro manifold. It had a center port and a side port and but there was no isolator. People put three hoses on the center port and just the long hose on the right. Then they would do stupid things like turn the right post hose off so they wouldn't lose gas. And of course if you turn the hose off and then knock the knob off you can't turn it back on. What I immediately did was split the hoses up with the center port. Gavin didn't care about the isolator because he said, "Well, that's the luck of the draw. If you lose your manifold, then you lose your manifold. There's never really been manifold failures." It's not a manifold that's going to fail. What is going to fail is a combination of regulators – either dislodging or free flowing — and the knob causing you to lose control of the gas. What we wanted to do is start building the system at some base.

The best place to start your base is with your backup regulator. Obviously you want that around your neck, you want it tight up around your neck. Because it's upside down and the pressure's passing over it — it's going to want to free flow. So you want it up tight against your neck. You can always use the stretch cord as a means of holding it in your mouth. If you don't feel good like you might tox you put your backup on put the band around your head and pull the elastic tight to hold it in your mouth. If you did tox, I don't know if it would save you or not but it certainly gives you piece of mind. If you think you don't feel good then you've got it in your mouth and maybe that's enough to keep you from triggering tox. In any event it's better than falling out of your mouth. So the backup needs to be right here against the neck all the time. It needs to be permanently here, tied off here like this one is where you can't lose it. You can't have the thing fall away and then go for it and not be there, that's the worst possible thing. The backup needs to be there all the time in all configurations. In fact, this is the way they used to sell scuba gear. The

regulators used to come this way in the old days when I was in college. That's a long time — 27 years ago. Regulators came with a big thick thing like a piece of rubber inner tube around them. Commercial diving regulators always looked like that. So you start the system with the backup.

You want a regulator that feeds from right to left. You don't want to put this upside down. You really don't want to use the shower-head type regulators because you have all kinds of other issues. You don't want the reg feeding like that anyway with the hose sticking out or coming back from the wrong side. You need a regulator that you have the ability to take apart and clear the mushroom valve. If stuff gets it here (shells, sticks, debris) and you try to breathe it you're going to get water. You need to be able to take it apart and not have all the pieces go flying everywhere. You need to have a reg that is fairly contained. This Apeks is nice because it has a cap that acts as a ring so that when you put it back together it doesn't just mash the diaphragm and rip it open, pull it open again. What we used to do before we had these regulators is we'd break off this part when they were metal. Remember when the regulators were metal bodied? We'd break off the exhaust so you could get to the mushroom from that end and you'd have to try to shake it. Anyway, with the metal regulators you couldn't deal with that. But these current regs are really nice. You need to be able to clear the thing.

Audience: Which one do you have there George, I can't see it?

George: It's an Apeks. Most of regs (like Scubapro) work this way – the boxtop screws off to access the inside and the mushroom. Some of manufacturers got really clever. They put a little stop in the boxtop here so that the manufacturer's name stays flat. *[audience laughs]* A very clever addition by the dive industry. So you just have to cut that stupid stop out, otherwise you can't get it out. Scubapro put a screw in some of them to position the "Scubapro". So you just have to override some of this silliness in your regulator because you want to be able to get to them. You also want to be able to change out second stages if you get a bad second stage. If you're doing a stage dive in the ocean and your long hose starts screwing up rather than call the dive just turn it off, take the reg off and put it on one of your deco bottles and put the deco bottle reg on your long hose. So you leave them loose, finger tight so you can do that switch. You don't lose a dive. If you spend all that time, effort and money, you don't want to lose a dive. Just switch the second stages. So leave them loose.

This backup regulator comes from the left side. So we have to have the long hose on the other side. The long one is the one that we donate. We always donate what we're breathing, whether it's a stage bottle, a deco bottle. We know it's OK, that's the concept. We know it works. I just was breathing and it works. Knobs have to turn on counterclockwise. If the right post rubs across the ceiling it will turn itself on and then break on. It will either strip out the inside keyway or break that little brass stem if you rub it hard enough or hit it. This is loose; you just leave the spring a little loose so the knob rocks back and forth. You can't see it but see how this just rocks around, that's what you want to do so it has a little give in it. The idea is if this one fails it's going to fail in the on position.

Let's say you hit the ceiling, fail the left side by dislodging the regulator. Then you have the isolator, you can shut it off so you don't lose your gas, and you only lose part of your gas. If the right one fails in the on position we run the inflator off of it. Going back to the left side, now if the left side rolls on the ceiling it's going to turn itself off. So you're not to have access to that regulator but you're not going to know it while you are on the long hose. But you put your pressure gauge on the left because you want to split your hoses up. And you don't care if the pressure gauge gets stuck in the off position because if you look at your pressure gauge twice and it reads the same thing your gas is off. It's no mystery. You have your timer and you have

your buddy, and so you're not going to have 3000 psi and your buddy's got 2000. You're not having a good day or anything like that. Your gas is off. So that's not so critical.

Looking at gas all the time is a vestigial throwback to air diving. Because your spatial senses and short-term memory are immediately gone on deep air, you keep looking at your gas every few seconds. You think it was like 10 minutes ago. You can always spot an air diver because they'll have the pressure gauge clipped on their chest where they can see it more easily. They'll be referring to it constantly: "Is it still there?" *[audience laughs]* But that's an air diving. You don't need to see it. You know. You dive. It's just like decompression which we'll get to. Twenty minutes went by, you're at 100ft, how much gas should be in the tank? You just know.

Going back to the left post — if you roll it off and break it off you've lost your backup reg and you've lost your pressure gauge. But the wing inflator mechanism is over on the right hand side. You can still breathe your inflator as your backup. If you go to your backup and it's not working and you've got to deal with it while you try to turn it back on. Or if you go to donate and you have no gas supply from your backup it's because the right post is. So you put the wing inflator mechanism on the right post to give yourself a third shot — a third regulator so to speak. You don't rebreathe it. Don't dare do that. It'll knock you in the dirt with CO_2. It's a horrible feeling — CO_2. If you want to see how bad it feels try rebreathing from the wing from a couple of breaths and see how bad that feels. But that's why the inflator is on the right. Obviously the hose is long enough so that the corrugated hose and the wing inflator hose are oriented to the inside. You must be able to reach your nose and your drysuit and the inflator all at the same time.

Audience: Some people are trying to say you should have the hose through only one of those elastic retainers. What do you think?

George: If the hose is too short and this corrugated hose, and the inflator hose fitting is riding against the elastic retainer on the left harness strap it can unclick. Let's say your hose is way too short and you pick up wrong you can unplug yourself. So if your hose is too short people have to put it outside. But if it's not you can go on the inside. That's the reason people do it. Halcyon keeps moving the corrugated hoses around trying to position them. This one's in the center. I guess they moved it in the center and they haven't figured out how long they want the hose yet. The whole inflator as a unit needs to be long enough to reach the nose and suit inflator things while you're descending so you can add gas and clear the ears at one time. I notice that everybody around here has got this part right. The backup reg goes underneath the inflator hose and over top of the left harness strap.

But the other thing is you've got every hose except your pressure gauge basically touching your neck — and if it's free flowing you're probably going to hear it. Your buddy should see it but you want know it first. You can really hear the long hose if it's free flowing because for some reason it makes a much different noise. It's like that helium noise. Others are harder to hear but if it's against your head you'll hear them. The deeper you are, obviously, the easier it is to hear stuff like this. You can hear much better deep. If you're losing gas out of the backup reg or the long hose or the inflator you can tell. The high pressure hose is easier to spot because it's noisy when it's leaking — it's high pitch. It's just a pinhole. It will be screaming through a pinhole.

The rolling off of the knobs and breaking knobs would seem to be more of a scooter thing — also, more of a cave diving thing. But in wreck diving it's a lot more likely to happen, even without moving very fast just by turning, because hard, metal things are sticking down everywhere. In a wreck you're more likely to break your knobs, turn your valves off and hit hoses. So the overriding idea of the configuration is that everything is tucked inside — everything is in close. The hoses

are protected from flapping so they are not vibrating in the current. If hoses vibrate in the current the swages will wear out and you'll need to change the hoses all the time.

Audience: What's your thinking on hose protectors? Do you use them?

George: That's one of those tough ones because a hose protector is supposed to be a strain relief for the swages and in that sense it's a good idea. But the problem is then you don't see the swages and you don't know whether things are going bad or not. Usually where the hose will go bad is at the interface between the swages and the hose. You'll see it start to get ratty there if you are taking them and moving them each time. Bill Mee always had strain reliefs but he'd pull them down an inch or so after the dive and wash them off. I've stopped putting them on myself because I wasn't doing that. Then I'd pull one down and it would be horrifying. It would be green — you could see the threads on the hose and stuff, it was like all bulging out. But I was real paranoid, I used to change my hoses all the time. If you have them hoses like this setup here then the stainless won't wear out. With the right setup with everything tucked in there's nothing to vibrate them or work them. And of course you're real streamlined so and you don't catch on things. Part of the logic of the old system was to not catch on stuff and hang up. And, of course with the hoses, they used to stuff the hoses behind bungee cords and then have it clipped off like an octopus.

The octopus thinking from open water carried over grew up to be stuffed hose. What are you going to do with the hose? They didn't know — so they stuffed it. The problem is it takes two to stuff a hose. If it comes out you've got to have two guys to put it back. And of course it's a complete mess. And then there's the other issue of it doesn't work. You go to pull the hose out and it kinks and you can't pull it out. So you don't want to have that. Plus the biggie is you don't know the condition of the regulator on the hose. You don't know if something has gotten in there, a shell or something. Just jam some clam shells down his throat, choke him, and he dies anyway. If you give them something that you haven't been breathing, you don't know if it's working or not.

I know that these GUE guys make you do intense drills. They blindfold you and beat you with clubs and stuff like that. *[audience laughs]* But that's nothing like when it REALLY happens. When it really happens you'll feel adrenaline like you've never felt. And the only correct response — the only thing that's going to save YOUR ass — is to get to that guy and take control of the situation. And the only way you can do that with confidence is you know the donated reg works and you know it's going to work the first shot, you know you're going to solve the problem. And you've got to be cool. You can't be wide eyed and freaked, "Uh, here, take this." You've got to solve the problem and calm the guy down. Hold on to him. Make sure he knows he's OK. Because he's not out of gas, he just can't find his gas. It's like in the stock market: we didn't "lose money", we know who has it. *[audience laughs]* The problems that really happen are just cascades of bad planning. Its not really something trips the wire and whoosh, all the dominoes fall down because of bad response itself. The number one thing that occurs is something gets in the reg and blocks the mushroom and you breath water. So you can't effectively breathe because you're breathing water. That's the number one out-of-gas thing that happens. The other one is momentary — like on a stage bottle and it exhausts on you or doesn't work. Very rarely you'll get somebody who forgot to turn something on. Or wasn't turned on all the way it was just cracked on and then they breathe it while shallow but they can't breathe at depth. As soon as you drop down you can't breathe. You breathe at 10ft but at 80ft you can't breath anymore if it's not turned all the way on. That's pretty funny. Interestingly, real sharp buddy will see it. I saw two people, one of them claimed to be out of air and the other one was, "Ya right" and just turned the gas on. Didn't even bother with donating the hose, just turned it on because it had worked on the surface but not down deeper.

All the ones that I've had have been real scary and real. But they've never been out of gas. One I had where the guy had the reg got ripped out of his mouth going through a restriction. It caught on a rock and pulled the reg back behind him. He went for his backup and it had fallen out of the elastic and wasn't there. He then grabbed a stage bottle and but it wasn't turned on. And he's going all over the place getting frantic. So I just — whoosh — came in, gave him gas and got him calmed down. I inflated him a little bit because was sinking and got him calmed down. After that I was more scared he was going to call the dive. I didn't give a shit if he drowned. *[audience laughs]* I drove all the way here — don't call the dive. If you call the dive I'm taking my gas back – you're dead.

For backup lights, you guys know about the backup lights being under your arms — here. They're really under the arm, they're not up in the front. So you have nothing on the front of your body. A lot of people used to hang them off tanks or put them in their pockets. You can throw a fourth or fifth or sixth one in your pocket if you want to. The idea is when you deploy a backup you turn it on – FIRST — right? THEN you deploy it. That way if you drop it, you can find it because you can see it. But if you've got the backup anywhere else you're not going to find it. You're fumbling around with it. The best thing to do is turn it on. In a lot of cases you don't really even need to take it off the chest D-ring. A lot times I'll just leave it right on there if I'm dealing with something, until I've dealt with it. To put them back the easiest way is to force it back through the elastic from the bottom — especially with gloves on.

We put the primary light on the right side because we put the stage bottles on the left side. The long hose crosses the hip under the light canister. It's not necessary to have a canister light on the hip to use a long hose, it's just if you have stage bottles on the right you've got to be extremely particular about where the hose is. You don't want to clip the hose under the stages and locking yourself up on a donation. We don't put the stage bottles on the right side. We just put the light on the right. Also, we don't put the light over here on the left. Conversely we don't put D-rings on the right waist strap. If you want to run the scooter, for some reason, for some short distance with bottles on the right side just put a bungee loop over the waist of the belt and clip it to that and it'll blow back into position. So that way it's not permanent.

Also there's no D-ring holding your light on the strap. The light needs to be able to come off in cave diving so that you can un-key yourself at a restriction. You go through a restriction that passes the light one way but you can't get through the other way. You just loosen the belt and slide the light off to clear the restriction.

In ocean diving the light is ballast. It's also a ballast thing in cave diving; you need the weight as part of your weighting system. In ocean diving, worst case would be if you jumped in with full tanks but nothing's working and you got to swim it up. Then the light is something you can get rid of. With doubles you don't have a weight belt so the light is your ditchable weight.

The knife is always where you can pull it like a gun, right in the middle, just whoosh. Because if you need it you need it NOW! I had to cut a scooter loose one time. I jumped off the boat in Key West. We were trying to put buoys on a wreck called the Kendricks at 325ft or 315ft. Nobody had seen it, it was just on the depth sounder. Billy Deans wanted me to go down and figure out where to hook, the buoy and the line. Then run up to the surface and tell him what the wreck looks like, is it safe to dive, did the other people want to dive. When I jumped in, I had some bullshit scooter. It imploded on me at about 80ft. It turned on wide-open as it imploded. Losing it buoyancy, it turned into a 50lb anchor plus another 50-60lbs of thrust dragging me down faster than I could clear my ears. I couldn't breathe fast enough to clear my ears. And I couldn't get rid of the thing; it was pulling me from the crotch strap. I couldn't pull it up enough to unclip the clip. So I just —

whoosh — cut it loose. I had trying everything, I was trying to clear my ears, trying to inflate, trying to get it and turn it off but I couldn't. So I just cut the damn thing loose. I would have blown my eardrums if I didn't cut it loose right then. If I had to find the knife up my sleeve I wouldn't get at it right away. When you need it you NEED it. When you get hung up on a wreck — you've got to deal with something fast. So it needs to be right there in the center of the belt.

Audience: What kind of knife do you use, a Z-knife?

George: Use something that's got a serrated edge on one side. Something serrated. Got to be some kind of serration or it won't work well. A lot of people use this kind of knife. I cut the end off them so they'll fit in the case better and then I just grind it into a screwdriver while I'm at it so now I have something to adjust things like my light handle.

The crotch strap: I heard some guy today say he didn't use his crotch strap. The strap is how we tow a buddy scooter diving. If you have a scooter failure or out of gas situation — grab the crotch strap. Get your hand all the way between the legs then just put your head down and ride. The scooter also pulls you by the strap. So the distance from the back of the scooter to the strap ring needs to be a constant. This means you have a fixed distance from the backplate to the D-ring that has the scooter attached, but the part of the loop that the belt goes through is relatively loose so you can lift your tanks up on your back to get at the valves if you need to.

Audience: When you're towing people with scooters do you actually clip on something because it's really hard to hold on to that metal ring for any length of time?

George: You don't hold on to the ring, you hold on to the whole strap. Put your hand all the way underneath the strap and hold on and put your head down. You can hold on to the ring for a short run but you don't want any leashes or anything, you want an instant solution. The crotch strap holds the rig down so it does not ride up on you when you are vertical on the surface The gear won't be riding up. I'm amazed the crotch strap is not on all scuba gear. The worst thing is to have a quick disconnect in the front because then that's what breaks when you have to tow your buddy or something. That's what will break. We obviously don't put any, quick disconnects on the gear anywhere. It should be adjusted so you can get it off. You can get your rig off on the surface by flipping it over your head.

One big thing, and I know you guys all know this, is the way we do the weighting. The buoyancy compensator is a fine tuning device. It's not like a lifejacket or anything like that. There's no such thing as redundant buoyancy or backup buoyancy or backup any of this stuff. The drysuit is not an inflation device, it's not a backup anything. Drysuit is to keep you warm. What you must know (wherever you're going to diving — open water, cave, whatever) is what it will do with no gas in it roughly 10ft. Let's say its a decompression dive where you have to stay at 10ft and but you have no gas in your back tank(s). Can you stay down? What you do to know is you jump in the pool and figure that out to start with. You get a baseline with a couple hundred psi in there and see if you can stay down with all the gear you're going to wear during your dive, your drysuit, your insulation, all the things you're going to wear. That will tell you how much weight does it take to offset my basic stuff. In the case of saltwater there's more buoyancy. So maybe you'll have a weight inside in pockets or you'll have a steel plate, whatever it takes to offset the drysuit insulation with empty tanks.

Then you've got the weight of the gas. Obviously we dive gas — helium — we don't dive air really. Because of that you're not going to get into situations where you have 22lbs of weight in

the tank. But if you do you better be ready for it. So you want to take your worst-case weight, full, and see how negative you're going to be. You can also do this in a swimming pool. If you want to see how you gear is, take a fishing scale and hang your gear in the water and see. Then try it full and see what it does. Put it on; see what it takes to offset your drysuit insulation because it's going to be different for everybody. A guy in larger size insulation is going to need more weight to compensate for that than the same size guy with medium insulation. I'm talking about medium as in the cut, not the thickness, because you have more material with a larger size undersuit, no matter how big the diver is. So you have to know for each person what exactly does it take? It takes 22lbs for me to offset my DUI TLS-350 in fresh water with C-4 (400 gm/m^2 Type B Thinsulate®) under it. If I wanted to go in the water with my DUI I'd have to put a 22lb weight belt on to be able to get down from the surface. That'd be neutral, so go from there. Whenever you get new stuff, new light, the little lights, change bottles, do anything different just check that because that can be critical.

So you want to get in a position where you're not relying on anything for a buoyancy bailout. On the other hand you, don't want a whole bunch of gas in the wings so they're jacked up which is going to slow you down, cause more drag and be more unstable in order to stay up. You just want to be fine-tuning your trim. You want to be able to put enough gas in your drysuit to stay warm but you don't want to have to jack it up and jack wings up because you're too heavy. Conversely, when you're up low on gas or whatever and you've got maybe some stage bottles on you don't want to be having trouble staying down and not being able to put enough gas in your drysuit at the end of the dive when you need the warmth the most. That's a big part of this whole system. That's why we don't dive steel tanks with a wetsuit. Body cavities compress, all the materials compress, everything compresses, you get down and you can't get up. I bought a set of Genesis 102s 12 years ago when they first came out. Jumped in with my wings, harness, got to 250ft and completely lost all my buoyancy. Dropped to the sand at 300, luckily there was a floor, and I crawled up this wreck, all the way up the wreck, up the tower of the wreck, until I got back to 260 or 250 and then I could gain equilibrium. Burned off a little gas. It's ridiculous, you don't think it's possible. It's amazing how negative your body and everything gets when you compress. That was a real shocker. So it's generally better to have aluminum tanks with a thin wetsuit and a weight belt so you have droppable weight of some kind. And with salt water and a drysuit and 104s, you don't have the same issue. But anyway, these things have to be thought through for every type of diving. That's a big part of the system. It's also a big part of being slick and being quick and not being over or under weighted. With stage diving using aluminum bottles you can float the bottles up on your lift bag, your deco line, your up-line, whatever you're using. You can fire the bottles up if they become too buoyant at deco. That's what we do. We just let them go, stage bottles or deco bottles, let them ride up the line.

Going back to where we came from with this, the need for speed and efficiency and conformity was everything. It was absolutely amazing the dives that we could get done, this cave diving. With all these cave systems in Florida, Bill Gavin and I would go in there and just 1000ft into the cave — there was the end of the line. It was ridiculous. JJ and I, or JJ and other people, and combinations of other people were able to explore stuff – all because of wreck diving. There were these cave guys who'd been around forever couldn't do anything and all of a sudden we could do it no problem. You can see that up here in California and up in Seattle and stuff. You don't get the abortions and the miscues that you get when everybody is doing their own thing. But that was where it came from: wreck diving. I was a wreck diver so I kept steering it that way, made sure it worked for both systems.

On a more serious note, figuring out some of the rest of the system wasn't quite so obvious. It wasn't easy. We stopped air diving when one of the guys got killed. We stopped using nitrox or

any kind of air when we figured out we weren't getting the job done. We stopped allowing people to do different things when one guy got killed doing something different. I can just go down the list. A lot of the things we changed were because somebody got killed. Air diving was the first. Bill McFaden got killed and Gavin said, "That's it. No more air diving." That was 1988. That's when we stopped air diving in WKPP. Then JJ and I stopped the nitrox.

We were using nitrox at 150ft, like traveling decompression gas a mile into the cave. We'd go in on the nitrox, then put it down, go to mixed gas, drop down to 300, explore cave, come back and do our deep stops up to the nitrox. But we'd get back to the nitrox bottles and they'd be laying all over regs would be off them, they weren't clipped to the line, they were still turned on, and they were like falling down in a crack. JJ and I kept writing each other notes, "Somebody screwed with our bottles." Somebody came a mile into the cave and dumped our bottles. *[audience laughs]* This is what we really thought. Finally after it happened twice wondered, "Who's the idiot that did this?" Then is was clear – it was us! So we stopped doing it because we were just kidding ourselves. At the same time we couldn't figure out why our guys couldn't set us up 3000ft into the cave and put our stage bottles down. Perfectly good divers, it would be a charlie foxtrot every single time. They come back, JJ and I would be going into the cave, they would be all sprayed all over the place 200ft apart. Came around a corner I see one up in a tunnel over there, one tank over there, and another over here — all in different places. It was the same problem — in relatively shallow water the narcosis doesn't bite you in the ass. It just is there and screws you up. You think you're OK, you don't feel anything, but you're just completely off the wall. These guys could never get the job done, the bottles would never be in the right place. So we finally figured it out. "Wait a minute, this narcosis stuff is pretty powerful".

Up to that point Gavin had made a rule: you can't breathe air below 150ft and you have to have vertical clearance to a hundred and something. But see, back then we didn't know you didn't need that crap for decompression. We were just finding this out. We were trying to stick nitrox mixes and air in there because we didn't know. When we did know, we upped the helium, lowered the oxygen, and went to helium-based gasses for decompression, traveling and everything else. And everything was fine. But we had to come about the decision the hard way. We had to screw up a lot of dives. It was not like incompetent people doing it – it was JJ and I doing it.

You guys know the other two sides of the air story. There is just no way to decompress from that crap properly. You just can't get a good deco. No matter what you do it doesn't decompress properly. Probably because it causes damage in addition to the fact that it is already present heavily in the body anyway. You're trying to decompress on lower levels of nitrogen against nitrogen with only the oxygen window. It just doesn't seem to work in practice as well as you would think it does in theory. The other problem is the damage caused by nitrogen. It causes the red cells to get rigid. It causes them to be incapable of folding when they go through small capillaries. That triggers a whole immune response and triggers stress receptors. The body to try to shunt the area off, isolate it and treat it as if its an infection or an injury. In the process of doing that, the body's reaction is inappropriate for a compressed situation. The body then blocks blood flow to key areas. It locks gasses into key areas and so as you come up you get damage from bubbles which the body then responds to. You can't recompress because you've just created damage — so you're just recompressing damaged tissue. You're not solving any problem. You have to go right to oxygen treatment which, by the way, is the really what everybody else was doing for decompression. Damaging themselves severely, treating it with oxygen. Correct treatment, but why take the beating? We suspected this was the case were able to confirm it with more and more data.

So Jarrod and I started elevating the levels of helium in the decompression gasses and starting the decompression at deeper depths. We just experimented with it until we didn't have problems anymore. Since then, some of the theoretical work has validated it.

An important part of gas diving is the gas mixing. GUE teaches gas mixing the same way WKPP does it, don't they? Same thing.

Audience: Ya.

George: Same thing. We had to make people dive gas and we had to make them mark the bottles the same way. The biggest killer of smart people in gas diving is breathing the wrong gas. I don't know if you guys remember this, there used to be an Apple computer decompression program. I had to review it for a magazine so I had to look at all of the deco programs. I had to find somebody with a Macintosh and load the stupid thing on a Macintosh. Anyway, this guy is a bright guy. He wrote a decompression program for a specific computer when Windows wasn't even around and it was color and beautiful and graphs and all this stuff. But the guy killed himself breathing the wrong gas while doing a body recovery of somebody else that was breathing the wrong gas. Here's a guy that had two sets of doubles sitting in his garage, unmarked. One of them had 35% nitrox in it, the other one had trimix in it. He picked up the 35% and did a 200ft recovery dive and toxed. It was a failure to mark tanks. A failure to be diligent about it. And this is a smart guy. Every smart guy I've seen get killed by something "small" like unmarked bottles. They aren't getting killed by no analysis — its unmarked bottles every time. Bobby Maguire killed himself. He took his 70ft deco bottle for a ride at 150ft, unmarked. I did a body recovery in Fort Lauderdale for a girl in an IANTD class. I find her on the bottom. Of course, its the usual stupidity, she's got the 80% and whatever other gas they've got. I looked at these two bottles and — they're not marked! ABSOLUTELY nothing — nothing on the bottles. Not anything. She just breathed the 80% gas at 130ft and toxed. Before she even got to her oxygen, just whoosh. That was some "system" where they tell them to put the high oxygen on the right and the low oxygen on the left. That doesn't work. You can only kill smart people with dumb things like that. If you lay it out you're not going to kill them.

Beyond standardized marking, what is really important is to standardize gas. Everybody dives the same gasses. Everybody has to have the same gas. Gavin and I had that conversation with Exley. Exley would dive some stroke mix and he'd screw up the dive and Gavin would be writing me, "We just broke rule number one, ha ha ha." And I'm like, "Not funny Gavin. It's a waste of my time." And then he'd go, "Well you've got to tell him he can't do it." And I said, "You're Bill Gavin, you've been diving for 18 years, he's Sheck Exley, you tell him." *[audience laughs]* So over here's Sheck, "Could you dive the same gas?" "Oh, you young guys, you just can't take it." I said, "Sheck, you're the same age I am. Gavin's a little younger, that's not the issue." Gavin said, "If I have a problem I don't want to go to your stroke mix." And he goes, "Oh, OK." So he stopped doing it. But he had to be told something to let him off the hook logically. And logically you don't want to have everybody with a different gas. It just doesn't make any sense. You want to have same decompression gasses, you want to get used to doing the same schedules, you want to get used to the shape of deco, what should know what deco looks like, how should it be performed, what works best. The way we iterated into decompression was by trying several different things. On the gas mixing front and on the gas marking front we had to first find what we thought were appropriate mixes. But tanks in transport are always marked. They're always labeled. They always have a date, what's in them and what's the date of that analysis.

To mix a set of tanks the best bet is to take a couple pieces of tape. You add a gas. Turn the knob off when you've added whatever number of psi. Turn the knob off but don't disconnect the

whip until you write the date and whatever psi is in that tank of that gas. A hundred psi of oxygen or whatever it is. That way if the phone rings or something you're not going to come back, "What's in the tank?" Most of the time, if you do go away and not mark it down, you screw it up, you're just going to have to go mix it again. The worst case is it could be deadly. But the whole system has to go together. Ten you put the other gas in. You write it down, the helium, whatever. And the date is already there because you just did it. If it's a different day it doesn't make any difference because now you write the other date. So then you put your air or whatever, or finish by boosting with a Haskel pump and do to finalize the mix. Now, before you go anywhere with that bottle you need to analyze it. You analyze it and write the date and the analysis. Tanks full — take the other piece of tape that had so many psi helium, so many psi oxygen, whatever, and just put it over a valve so you know the tank is full. So now you know the tank is full, it's analyzed, it's got the date.

Now for deco and stage bottles — there's one of these you can see here. Look at this bottle, "70". That's all it says on it, "70". It's got the guy's name on it. That's all it says. In the case of doubles you want to keep the contents tag on when you're traveling. You go diving, get out of the water, if you don't put something back on them or tape them up then whenever you mix them again you need to analyze them or empty them. It's best to put a piece of tape back on, write what your mix was, helium percent, oxygen percent, and the date. And then put 2000psi or whatever's left. You can make a decision later on: do I want to boost on top of this gas? What do I want to do? Do I want to dump it, start over? Whatever. But you don't ever walk around with unmarked bottles. There's always information there. That information has to be trusted. You can't have several pieces of information, it has to be one place, one piece of information, because that's everything.

You don't have to keep analyzing your gas every five minutes either, like "Was this really…?" In the case of these dedicated bottles, the bottle has its Maximum Operating Depth (MOD). So you do the same thing, two pieces of tape, add one, write the date before you disconnect, write it down. Add the other, put in the air or whatever, analyze the gas. You've put the right amount of oxygen in, the right amount of air or whatever you're going to put in there for a 70 bottle, which is going to be a 50% oxygen bottle. You've done these steps carefully. You've analyzed it, dated it, marked it as full. When you go to deploy that bottle there shouldn't be any question here. All you need to know is that: 70ft. So when you get to 70ft and you want to go to that bottle, you need to locate the bottle looking for 70, locate 70, get the regulator off, put it in your mouth, or put it around your head. Now you need to relocate 70, relocate the bottle and turn it on. If you can breathe you've got the right gas. Tap it, make sure there's no crap in it, breathe it. Breathe the right gas. So now you're squared away. Now if you're nervous you can do secondary and tertiary checks. You can follow the hose back, you can turn the valve off and see if it stops breathing. It's like when you leave your house and ask yourself: "Did I really lock the door?", so you keep going back to checking it. Or you can rig your door so it locks every time every time you shut it.

But in any case You don't want any more information on the bottle but 70 and your name. You can see this bottle I am holding is perfect — the name in no way interferes with the identification on the bottle. Jonathan Gol killed himself with and unmarked deco bottle. The bottle turned out to be just helium. The first time I saw that guy I was floating on the surface of the spring with Jarrod. I'm looking down and I see what I think is "70" written on a bottle. It's over away from everything. And I see another one, Bob Sherwood. I see an "80", right. What it was, the "80" was "BOB" where the rubber was over the other "B". *[audience laughs]* And the Jonathan Gol "70" was where the rubber was over the "GOL" upside down. So I was thinking , there's a 70 bottle over here, an 80 bottle over here. "What is this? Who are these strokes?" It's because they had their stupid name up next to the label. But this tank I am holding says "70", so it is perfect — there's no question what this is. If it were oxygen the only thing we have to do differently is put "Oxygen 20" just so you don't throw an oxygen bottle at 70ft because a "20" could look like a "70", or a "120".

That would be even a quicker death if it were at 120. That's the only time we have to write anything different and that's simply because this is the most deadly one, obviously. Again, this whole system isn't a cave diving thing. It's a cave diving WKPP discipline. It's a wreck diving thing because in WKPP you drop the bottle at its depth on the way down. You never carry a bottle past its depth. Wreck diving you got no choice. You've really got to be good wreck diving. Your system has to be bulletproof.

So there is a system and basic identification and there are your second and third and other ways of checking it. I think GUE makes you do everything, a whole list. But whenever you're changing gasses you need to be looking at your buddy. So you want to do a quick, automatic change and be heads up. You don't want to be fumbling with yourself and in your own little world. Because gas switches are where regulators fail, you're going to breathe water, wrong gas, cluster-fuck, can't get something turned on, lose buoyancy, something goes wrong. All these things happen on gas changes both in a cave or in the ocean so look at your buddy when he's doing it. Pay attention because that's when he's going to need you. But gas, this is the most important thing. I've been the worst stickler about gas in our project because gas identification, marking and mixing because it's certain! You don't get <u>any</u> second chances with gas.

I'm sure you guys practice. I know that you get taught to practice drills and I know you're taught protocols for how to deal with the problems. But a big thing with WKPP is how we deal with "situations". What we try to do is save our back gas and use our stage bottles. Conserve that back gas. If something goes wrong and you need to move, you need to travel and you need to share gas, you get rid of the empty bottles and you want to have all your shit in one sock. You want to be able to ride and have all your gas. So that's why we do that. It is a lot nicer on a complicated wreck dive to know you can dive out a stage bottle and if something goes wrong, you've got a full load of gas on your back. It's a little more annoying and less slick to carry a stage bottle but it's a <u>lot</u> better when something goes wrong. So we tend to work that way. We don't breathe part of the back gas and then part of the stage bottles and have a little gas here and a little gas there and then have a problem. We tend to consolidate, for dealing with a situation. When it comes to getting somebody out of a situation with a scooter we have the towing protocol, grab on, head down. Generally if you're trying to deal with somebody that's out of gas for real — let's say the guy really does lose his gas — you want to keep him busy. So you let him ride the scooter and let him tow you. You want the out-of-gas guy in front anyway because he isn't going anywhere without the gas and he can't leave you behind. So you put him in front of you anyway. You want to be in touch contact. You want the out of gas guy in front. You want him busy. He needs to be driving or navigating or thinking or doing anything other than worrying about the fact that he doesn't have any gas. Because that's how he's going to kill you — if he's worried. We identify protocols like that and you guys should too in your diving. What are we going to do if this happens? What are we going to do if we go down here on this wreck and we come out and the dumb-ass captain is nowhere to be seen, the engine won't start and he's 20 miles down range. What are we going to do? You've got to know that. You got to think exactly what you're going to do. How you're going to handle that situation. The way you handle that situation is don't dive with him. *[audience laughs]* But you have crew on the boat, they call the Coast Guard and stuff. All these little things have to be figured out. With ours it's a little easier because again — cave diving — it's a static environment. It's not a dynamic environment. You guys are in a dynamic environment with a lot of moving parts. You have to have all your stuff figured out.

Originally Bill Gavin told people information, asked them to do things, of course they ignored him and tried all kinds of other different things. But I just make them do it – "because". Some of the little key tricky stuff that we found out is because of the length of our dives. When you have a long dive with a huge mandatory decompression, if you make a mistake you can't just get out of the

water. You really have to think through how you're going to deal with situations — what's going to happen? One of the worst is thermal. The worst thing that happens to us is ripped seals or a ripped drysuit that floods the drysuit. That's why we always use argon for the cave dives because argon in a flooded Thinsulate works better than dry Thinsulate with air. *[audience laughs]* Think about that one. Of course the Thinsulate has to be of the compressible type. There's several different kinds of Thinsulate — in general the stuff you get for camping gear, outdoor for hunting and fishing and things like that, is not the under-pressure Thinsulate. It's not meant to be walked on or compressed and it won't hold gas the way the stuff that's meant to be compressed will. So you want the good stuff. Generally you can tell because it costs twice as much. It's real simple. If it's too cheap, it's no good. It can't possibly be what you want if it's too cheap. In real life, when you flood a suit and it's got the good stuff in it, the buoyancy won't change. You'll still keep gas in the fibers, along with the water. But it won't change your buoyancy. And a key, obviously, is for us not to lose our buoyancy —not to need to jack the wings. Because then we're slow and then we're using more gas and then the lights are going to die and then we're going to have to be on the line with a backup light and then we're going to use more gas. You start having all these effects.

For you guys in the ocean you don't want to flood the suit and have the damn thing turn into 20lbs negative on you — over and above everything else. So you want to be careful about that. Although it's not a common thing to have happen, you have to consider it when you're trying to do more complicated dives. You start getting into these 300ft dives, there's decompression that must be done yet the water is freezing cold. So you want people to conform to the right kind of gear in every respect. It's all about "situations".

You guys are way ahead of the curve because you're learning from people that are using the right stuff in the first place. Like a backup light, you guys aren't getting a bunch of mutant backup lights. Everybody seems to have the same backup lights: three C-cell inline twist-on backup lights. They work and don't break when you turn them on at depth like the other ones. They also aren't overdriving the bulb — so the bulb doesn't burn out when you need them. They have the right shape, they hang in the right position. We used to have a big problem with people experimenting with things like that so we had to mandate – "OK, you've got to use this light".

In our stuff, besides the gasses and thermal, propulsion is a big thing. With propulsion we just want everybody to have the same stuff. So I standardized it and we started making it and we made it all the same. Before that, Bill had some scooters and I had scooters and Lamar English had stuff as well. I'd make parts for Lamar English and he'd put the scooter together differently than Bill and mine. Where I have the gold connectors he'd put wing nuts. Of course with the wing nuts, temperature would change, they'd stop conducting, the scooter would get intermittent. So we had to standardize everything. Scooters failing would be horrifying because we are scooter dependent.

Decompression was the last obstacle. We had propulsion. We had warmth. We had gas. We were ready to go. We could do massive distances — just huge distances. But, all of a sudden, we were losing guys — they were falling out. First of all, because they were trying to do dives without enough gas. Bill Gavin was a great kamikaze diver. He would use all of his gas. He would go well past thirds and he would lay every bit of line he had on him. And then he'd pull out his safety spool and lay that and then come ask me for mine. I'd be sitting there, "Pffff." *[audience laughs]* No, you can't have my safety. He would ask though, every time — predictably. Parker Turner told me Gavin's going to do this and that. That he's going to get low on gas and something is going to go wrong and you're going to end up towing each other out and running out of gas at deco. I can remember that I got out of the water one time after one of those *lay-the-safety-spool-lines-with-*

200psi-in-my-doubles-and-no-other-gas dives. I was sitting there breathing a breath of back gas, a breath of oxygen while trying to decompress out at 10ft. I didn't have enough gas for anything because of that kind of silliness. That was ten years ago.

But what I did was say NO!! We're not going to do it that way. We're going to put in safety bottles. We're going to add bottles to the dive. We're going to be a little slower but we're going to have more gas. We're going to overkill the gas. We're going to dive four stages, and use no back gas instead of three stages and a third of back gas. That's the way we started doing it right.

But all these guys had quit saying, "Well, I'm not going to go any further into the cave than that. That's crazy. I'm not going to go that far to lay line." Gavin quits, "I'm not going to go more than 6000ft." Jarrod and I are sitting there like, "6000ft? We want to be *set up* at 6000ft." So all of a sudden we turned what looked like bungee jumping into something easy by adding gas to the dive. It was Bill Gavin's own logic. Bill Gavin used to ask me, "What would you like to see in this dive to make you comfortable?" And I'd say, "Well, more gas, safety bottles at this point, another scooter." Bill didn't like to tow a bunch of bottles and didn't like to tow an extra scooter. I always ended up towing scooters. He wouldn't tow one. And I like to use my scooters like stage bottles. Burn them a third, switch them, burn them a third. All my scooters will always get me back to all my other scooters at any given point in time. I can *always* get out. And I *always* have scooters on me. But if I have one with full batteries and one with dead batteries and then I break the props on the full batteries I'm screwed. However, if I have two scooters with equal battery power, then I'm in good shape. If I break one I've still got the other one. Then I can get back to where I came from, where the other scooter is. So on, and so forth. So we just instituted these kind of things. Again, by the original guy's own logic, we just took it to another level that you can extrapolate into your type of diving.

The other thing, besides distance and all these other little simple things, was decompression. Nobody could figure out how to get around that. Gavin's going, "We're already doing nine hours of decompression, I don't want to do any more decompression." So that's where we went to work on the decompression. And I told our advisors, Bill Hamilton and others "You've got to shorten the decompression for me. Show me this." "Well if we do this, we can do that." Because these guys have seen it all. "Well when we tried this years ago at COMEX or at Navy this is what happened. Actually, if you decompress this way and that way you can." Do you guys want to talk about decompression, is that what you'd like?

Audience: Ya, ya.

George: Is there anything you want to get to before we do deco? Because usually deco is a never-ending topic. Is there anything else?

Audience: If you can also talk about deco from like ocean perspective with shorter exposures and local modifications.

George: Right I'll do that. Going back to how we worked it out – the first thing we found was when we used air for decompression we weren't getting clean deco. We were getting damage. We went to helium in the deeper gasses. That solved the not-feeling-good problem, the sub-clinical hit, feeling tired, whatever. At the same time we lowered the partial pressure of oxygen in the deep gasses. The reason being is you don't want to spike your PPO_2 at depth and tox — when you can't recover by being taken to the surface. If you tox at 20 or 30ft, it's going to be a bad day but you're not going to get killed, you're going to live through it because you're saturated

with oxygen. If you tox at depth because you spiked your oxygen and you just started decompression you're obviously not going to live through a shot to the surface from 200ft. What the Navy found was that in multi-day diving and long exposures, that a sudden spike in the oxygen would trigger a tox regardless of the level. So they tend to back off. What we did was back off the bottom partial pressures. We backed off the deep decompression-gas partial pressures. So we don't go beyond a certain point, at depth, in partial pressure. All of our other deco gasses may start at 1.6 partial pressure and decline from there. For repetitive diving, you merely move your bottle to the next stop up. In other words a 70 bottle would start at 60ft if on a repetitive dive. Two dives or multi-day diving you would generally move the bottles up higher because again you don't want to spike your PPO_2 on a multi-day or a long exposure.

The other thing we found was that taking back-gas-breaks at depth, prior to gas switching was needed to do to reduce the possibility of reacting to a spike and make us more capable of tolerating and using the higher partial pressure gas for a longer period of time. For example, coming up to 120ft I want to pick up that 120 bottle. It's 35% oxygen. I want to get that 1.6 and I want to sit on it for a while. Well, I can't do that if I'm already choked up. But if I've done my 130ft stop on low PPO_2 back gas, and then go to the switch, then I can sit there. Because the 130ft stop on any other deco gas isn't going to do me any good because it's low partial pressure — it's the end of the string of stops, and sitting there forever is just a waste of time. I need the gradient to be increased by going up and I want to sit on a higher partial pressure but I want to be ready for spikes.

Going back to depth, what we found was if we didn't do deep stops we got skin bends. And the other thing we got bent in odd tissues that would then later swell and cut off circulation. You'd get paresthesias in the extremities. You'd wake up at 2:00 in the morning sweating and your arm is numb. That kind of stuff. And the way we were able to figure it out was by diving odd profiles like where a cave would come up rapidly and there would be a lot of overhead clearance like a bell shaped room. In other caves there was an entrance where the cavern had a lot of overhead clearance above the floor depth. We get sloppy and start switching bottles and moving around and then next thing you know you thought you're at 180 and you're at 100ft. So you say "What the hell, I'll just drop, grab my 120 bottle". That's where we're getting these hits. What I call hits — nothing was happening right away. You didn't feel that bad, but you would get these problems later like skin bends and paresthesias and other odd symptoms. So we figured it had to be from bubbles that were trapped in tissues at depth that weren't being eliminated later. And generally hours later these bubbles will grow bigger as they pull more gas into themselves. Four or five hours after the dive, they'd will reach maximum size before they dissipate in the tissues. They pull other gas into themselves and get bigger. That would be enough to cut off circulation or squeeze a nerve or pressure something to cause that feeling of numbness. You didn't have a brain hit — that would have been instantaneous. Right away. So it's not a central nervous system hit, it's a central nervous system result. It ends up being same as, as far as the symptoms without the overt damage.

So we started experimenting on where to stop and we determined that 80% of the profile is the correct starting point. So if it is a ten atmosphere dive, 80% of the profile is eight atmospheres — 240ft roughly — for your first stop from the 300ft dive. So we started implementing that. We also would implement a slow ascent for wreck diving, stopping every 10ft consciously to get a 30ft ascent rate. Thirty-foot ascent rate is merely stopping every 10ft for 20 seconds, not counting the time to move. Consciously stopping yourself as you hit 10ft increments will give you a good clean ascent rate. Once you hit the first deep stop, you extend the time out from the 20 seconds according to the bottom time. Twenty seconds is the minimum and five minutes is the maximum (for saturation). Hitting your first deep stop, you may only go 45 seconds — not even a minute.

You don't drag it out. You have a maximum and minimum time. You want do these deeper stops conscientiously. In doing that we eliminate all kinds of problems, like trapping gas in the tissues as bubbles, and you also eliminate the need for so much deco in the shallower stops since you are not trying to correct a problem in the shallow stops created by missing the lower stops.

Then we switch to a gas. When we do switch to a gas with a little higher partial pressure we want to be able to sit on that gas and take advantage of the oxygen window. They found out a long time ago that you could mix 20 different gasses together, argon, neon, krypton, helium, nitrogen, whatever you want, and X percent of oxygen, and the only thing that mattered for decompression was the sum of inert gasses or conversely the percentage of oxygen or the oxygen window. We take advantage of that higher oxygen window when we switch a gas to a higher partial pressure and sit on that stop a little bit longer. A decompression program will tell you that you need less time there because your partial pressure is higher. But then it will tell you that you need more time higher up because your partial pressure is lower. Even a Buhlmann program will tell you that if you do more time at one depth, it will move your ceiling and tell you your next stop is 30ft away. You can tell the program you want to stay at 100ft for 25 minutes on 35% and it will tell you your next stop is 10ft. Well obviously that doesn't make sense. The ceiling will effectively move away. What you want to do is take your series of steps, work the higher partial pressure step and then shorten the lower partial pressure steps. And at your lowest partial pressure step breathe back gas. Why not? Clean up. Keep your oxygen exposure minimized. And so forth all the way up the column.

When you get into shallower depths, pure oxygen is going to be better than any other combination of gasses as the depths decrease. You can't beat it with anything else because the partial pressure is maxed out. All you've got is oxygen. Some of it is metabolized. If you really wanted to decompress yourself, the best possible gas would be no gas. No gas would be your best gas, a vacuum against a gas interface in the tissues. No gas against gas, you're going to have the maximum transfer. What you need is the next best thing to no gas which is oxygen — plus the amount that is metabolized — which gives you an imbalance of some of the inert gasses on either side of the tissues because of the metabolism and a greater propensity to move across. Also the presence of a higher dose of oxygen will also make it easier to break up bubbles, easier to dissipate bubbles, harder for bubbles to grow. The main thing you care about is tissue bubbles — you don't care about blood bubbles because the lungs will filter out the blood bubbles. The lungs catch the blood bubbles. As you come up to the shallower depths you can off-gas the tissues into the bloodstream, in bubble form. You don't want to do that deep because there is a risk of generating tissues bubbles that grow on the way up and you can't go back and fix it. If you speed your decompression, use the gradient more in the upper phases of decompression — especially when you're on higher partial pressures of oxygen — and let the gas bubble into the bloodstream. If you do make a mistake it's a lot easier to go back and correct it to 40ft than it would be to 180ft.

Audience: Do you want to mention how important it is to get checked for a PFO?

George: The lungs are and incredible filter of all kinds of garbage. Fat globules, tissue damage that breaks away, all kinds of other things get caught here. Bubbles get stopped in the lungs. The capillary beds of the lungs get so small it stops them. It's one area where if you do block the flow of blood, since it's still being directly exposed to oxygen it doesn't damage the lung tissue. If you block the flow of blood some place else that doesn't have a supply of oxygen — it dies. If you treat somebody with oxygen right away — especially at an elevated partial pressure where oxygen is dissolved in the fluids of the blood and in the tissues and you can surround an area with oxygen — you can keep it alive. But effectively this area right here in the lungs is always

exposed. It filters out the bubbles and allows you to off-gas in bubble form. In fact, when you get out of the water you are generally off-gassing violently at your last step, say, 10ft to the surface. That last decompression step is huge. Because that's how you get the last of the gas out, by relieving that pressure. You're bubbling into the bloodstream and the lungs are catching it.

If the lungs don't catch the bubbles or they get around the lungs you get central nervous system hits, cerebral hits and spinal hits. Bubbles will not come out of tissue into arteries. Arteries are a working mechanism — tubes. They'll end in capillaries. The capillary areas are where the arteries turn to veins and get into bigger and bigger and bigger vessels going back to the heart and lungs. Whereas the arteries coming from the heart are the bigger vessels going into smaller and smaller ones. So if you send a bubble down through the arteries it's going to go until it catches something and then it's going to block the surrounding tissue. Generally the first place blood goes right out of the heart is right up here in the brain and to the spine. The brain, spine, and heart. The spine and brain are where that bubble catches usually. So you get these spinal hits and brain hits and they're instantaneous if bubbles get by. Bubbles can get by if you had larger vessels some place in your lung matrix. Then it would just go right by. People with that defect can't dive at all — they get hit *[snaps fingers]*. They look at water and they're bent. There's no way around it. You can't give them anything that will stop it. The other defect is the valve across the atria of your heart, simply because it's open before you're born. This is because in the womb (A) you're not breathing, and (B) you're getting all your oxygen from the placenta. Once you're born the lungs are used and the left side pressure increases and pushes the valve shut. Then the blood goes from the right side to the lungs and back through the left side. If that hole doesn't heal up — in roughly 30% of the population it's either somewhat open or opens or can open or there's a defect. If it's just an ongoing hole you won't be able to dive because you'll get bent every time. If it's just a mild one you may never know about it until 2000 dives later and then you get wheelchair bent.

It's a good idea to get tested for it. The other thing is to treat yourself as if you have a PFO all the time. In other words, don't do anything to press the bet. In other words you don't get out of the water from 50ft. You don't ascend straight-line to the surface. You ascend slowly over the last little bit so that you give a chance for that gas coming into the blood stream enters in a nonviolent fashion while there's still pressure on you and you still compressed somewhat. Get that gas out of the tissues with some pressure on you. You don't just let it fly. Because if something gets by, it's going to be bad. So you just follow some general cautionary things. You don't exert right away. It's best just to lay around on the surface of the water. You don't want to be bending over or coughing or doing anything that would press against the heart in any way. Picture the heart with a vertical wall between the atria. You do not want to cause pressure to be put on that wall or along its length either, since this will flex the wall and allow any unsealed flap to open. You don't want to tempt fate. People that get central nervous system hit bent are getting it that way.

The other way to get it to do a dive and then to another quick dive down and come back up again. In other words, you've done a dive, you're getting out of the water and you are bubbling. Now you remember, "Oh, I left my oxygen bottle at 20ft." So you jump down with your mask on, grab the oxygen bottle and come right back up. Well, as you go down you compress the bubbles that are coming on the venous side enough to get by the heart, by the lungs. It just takes you a couple seconds to go down, a few seconds to go back up. Now they're expanding on the arterial side, and lodging in tissue. That's how we bent a bunch of support divers. That's how we found out about it. These guys didn't even do a dive, they'd be in a chamber. All he'd done is get oxygen bottles and be bent like a pretzel from that bouncing. Free diving after a dive, that's a classic one. Bent free diving. Central nervous system hit free diving.

Audience: How long do you sit in the water after a dive, does that help?

George: Well just anything to give yourself a little time to get that shower of bubbles.

Audience: But in terms of the pressure.

George: At any given pressure, on let's say pure oxygen, you're only going to get rid of to a certain amount of inert gas without lowering the pressure. We found that number to be 150 minutes for saturation. After 150 minutes you're wasting your time. You have to move up. In the case of a shorter dive it may be after 10 minutes you're wasting your time. But as soon as you move up, whoosh, here comes a bunch more gas that you weren't able to get down lower. That's why you want to make your last ascent slow and you want to spend more time. Just sit there, chill out a little bit, you don't want to do anything.

Audience: In a practical boat diving environment what do you actually end up doing?

George: What I do personally? My preference would be to flip my tanks off and clip them off on a float line, throw a line back with a buoy, a ball on it. I like to clip my gear off and just chill out there, hold on to it.

Audience: So are you continuing to breathe a deco gas at that point or just breathing air at the surface?

George: No, it doesn't do you any really good to breathe the deco gas because the gas is coming out by lack of pressure unless you were to get hit. Say you were to blow bubbles by — then it would be real nice that you were breathing the oxygen. Ya, it would help a lot. Because that's what you're going to need to do if you do get hit. It's not going to save your ass from happening.

Audience: Well I'm just saying, in effect, would you have the concept of a deco stop at 0ft?

George: Ya, it is, it is. That's your most important stop, the 0 feet deco stop. All these guys almost never get hit in the water. It's usually when you they out. A few minutes later, wham. Also, in a lot of people that are not in good shape — not vascularly fit — this bubbling, off-gassing will continue for hours and it won't even peak for an hour after the dive, or something like that?

Audience: A little over an hour?

George: Then it may be up to four hours before it starts to dissipate. But you can build up the size of the bubbles for four hours. The bubbles can be building themselves up before they start to contract. That's why people get bent four hours later.

The best way to test that theory on yourself is to dive with an injury. About four hours later it will hurt like a son of a bitch because you've got a badly perfused area that's guarding itself and shunting itself off. Bubbles will form at the site and draw gas into themselves and expand and it will start hurting four hours after the dive like clockwork. A bruise, a cartilage injury.

Audience: So somebody with a lot of scar tissue would have a lot of trouble off-gassing? Depending on where it was, perhaps.

George: Well, it depends on how it's set up. But ya, they could. A lot of that stuff doesn't have pain receptors and they'll never know it anyway.

Audience: That's true.

George: In some cases they would always feel the same thing in the same spot every time. But if its well after the dive its caused by a previous injury. Whereas effect felt immediately after the dive would be something that was caused by the dive.

Audience: I was hoping you could walk us through an example of how you would do something that we commonly do here like a boat dive. For a dive on the Cypress Sea charter boat, we'll go on what they call an *advanced trip.* You do three dives in one day, maybe between 90 to 130ft on the bottom. It's not terribly deep but you're doing three dives. You bring one set of doubles and maybe one or two small stage tanks. You have maybe an hour and a half between dives. Could you go through how you would plan which gas to bring and how you'd decompress from 30 – 35 minute bottom times or maybe a little longer on the shallower dives?

George: OK, well one of the things that seems to determine ability to tolerate decompression is your degree of vascularity on a capillary level. Not like big veins sticking out on your arms — I'm talking about what you can't see. What you can't see is the vessels that are created by working out. Working out, depriving the tissues of oxygen and nutrients causes angiogenesis. It causes vessels to grow and gives better perfusion. It will be harder to bend those people or hurt those people or injure those people. There are certain tissues that just aren't perfused, like fat. Fat just might have one capillary per cubic millimeter. Nothing. It's like trying to take a stick of butter and decompress it. It's not going to work. On the other hand you don't care if you damage it, you'd like it to get damaged and get rid of it. So you have everything in between, every kind of variation in between.

You have to determine what exactly is going to work for you personally. The biggest thing is the shape of the decompression. If you do the right shape of decompression you're going to be on the right track. Then you just need to fine tune it for the person. You don't want to change the decompression by doing a ton of oxygen at 20ft and altering the gradual ascent shape. That's not what I mean by change. But maybe just be a little more meticulous about certain stops and steps — make sure you do everything by the book. Whereas a guy that's like really well vascularized can probably get away with screwing up and not getting hit. That's how you fine tune your own deal by being meticulous.

As far as these multi-dive days, the biggest risk is really not getting bent, the biggest risk is oxygen exposure, oxygen damage and of course tox. You want to plan your dives so that you're not loaded up with oxygen too early in the game. If you do, when you get to your last dive you can't use it if you need it, so to speak. What I tend to do is to use the deeper deco gasses on the first dive and add the shallower deeper gasses after we do more dives. So let's say it's a two-dive day — two 250ft dives. I'll breathe my 70ft bottle and deco out without oxygen on the first one and I'll add the oxygen to the second one. I generally won't do a full-blown all-gasses-deal each time because I don't want to build up the exposure. The other thing, when you're diving repeatedly, if you approximate the correct deco on the way up — just approximates it — you're in pretty good shape.

You don't really have all this residual stuff during the surface interval. It doesn't really count. It doesn't really work that way. You can go back in the water and do it again as long as you're not bouncing. Remember what happens when you bounce. Once you get out of the water you're still cascading bubbles. You've started that process. You get back in the water, go down and come back up. When you relieve the pressure that process is going to resume and you're going to cause yourself problems. It's actually better to do deeper dives. But it's especially important if

you're doing a second or third or whatever dive *is that you stay down and ascend properly*. You don't bounce it. You stay down and when you do come up that you do it meticulously. You really don't have to do a whole lot more deco on the second or third dive because you've pretty much taken care of it by the first dive. And if you're in real good shape, you're going to be fairly clear after 30 minutes or so out of the water. And even if you're not in really good shape you're going to be, for the most part, clear. And you're not going to do any better if you're not in good shape. You get into that four-hour bit. If you go back in the water and recompress you're probably better off than if you're just sitting out of the water not diving. So you're not really going to have to, let's say, do twice as much or three times as much deco. I've done that for years, repeated dives and back-to-back dives, and it's never been an issue. But I also ascend real carefully. I think the bigger issue is tox.

We did a whole series of body recoveries in Palm Beach where we didn't have enough divers and I had to dive repeatedly. I did a lot of back to back to back 250s with not even an hour in between them, maybe 30 minutes. I did the same deco on each one and it didn't make any difference at all. I started with 50ft and then I do 50ft and oxygen, some of them we did 120ft and 50ft depending on what it was. We had to stay right on the bottom because that's the only way you can see — so it was all rectangular. You can't see down. and it's too dark, so you have to look sideways. On these offshore trips I'd always carry extra oxygen just in case there was a problem and I had to get back in the water.

Audience: So say you're doing a dive with a single decompression gas. Then would your normal choice be a 50% mix or pure oxygen? Which road would you go, assuming you had one deco gas?

George: Well, you have to size up where the real risks are. If you're diving a shallow dive, obviously the oxygen would be the gas because you just don't have a good starting point with the other gas.

Audience: Shallow being? Would you calibrate what you mean by shallow?

George: Well you just make up your own scale. If you're doing a nitrox or a triox dive that's under a 100ft and it's a short dive, then oxygen will be your first choice after that then you'd be adding 50/50. As the dive gets longer the decompression becomes more mandatory then, paradoxically, you'd want to go to the 50% gas because you want to start the deco sooner. The reason being if something goes wrong or you need to get out of the water. If you've had a long run and mandatory deco you want to be able to get out without getting injured. And the deeper you start your decompression gas the less risk there is to getting out of the water higher up. So the sooner you've worked well into your decompression process the better. So that's where you have to assess which gas you want to use.

Audience: So a 140, 21/35 dive it would probably be a just 50% if you had only one gas on a shorter dive.

George: Yeah, I would go with the 50% because you don't want to wait to 20ft to start decompressing. You don't want to be in a situation where you have mandatory deco on a gas you have not yet switched to — in case some situation develops. Because if something goes wrong what are you going to do? You haven't done any real beneficial decompression. Generally you add the deeper gasses in as a matter of exposure and as a matter of how much advantage using the deeper gas gives you in your upper end of your deco — keeping it short. The open ocean is a

greater problem than the problem of carrying the additional gas. If you have a longer or deeper exposure, take the deeper deco gas and get a dive-master or safety diver to bring down the shallower gases

Audience: So what would your profile actually look like if you were going to do 135ft on 21/35 back gas and then 50% for decompression with 30 – 35 minutes on the bottom? Could you just kind of walk us through that, what it would look like?

George: Yes, I'd do the 30-foot ascent rate and probably make the stops more conscious about 90ft — 100, 90, 80, consciously. I'd sit on the 70ft for a while, maybe 3, 4, 5 minutes. And then just do like 2 minutes, 2 minutes, 2 minutes, out like that.

Audience: Then the idea of stopping at 70ft is to open up the oxygen window?

George: Yes. We do a lot of is scooter diving on the reefs. We'll get on at 100ft, scooter at 100ft for 20 to 40 minutes, and then work up the reef and run at 50ft for another 20 or 30 or 40 minutes. Now you just have a little bit of deco to get out. It's amazing, just spending some time. And it's a lot cleaner than if you just deco-ed up, spending the time at that one depth.

Audience: Is that all on back gas?

George: It's like a 30/30 or something like that, yes.

Audience: And do you add helium to your deco gasses only when you start doing "real dives"?

George: You need Helium on the deeper dives because otherwise the gas won't work as well, won't breathe as easily and you don't want the narcosis, you don't want the damage.

Audience: So are "deeper ones" like 190 gas or 120 gas?

George: 190 gas. Jarrod also puts it in the 120 gas. The other thing you guys got to look at is open ocean — the moving parts theory. It's nice to have helium because you're going to be functioning properly on that gas. Say you had a problem, you go to your back gas to deal with it. The problem is the gas is going to stick with you for a couple minutes, so if you're not clear headed you might not respond properly. If you're doing a difficult, tricky dive you'd probably want to throw some helium in that 120. If not, keep in mind you're not going to be "all there" at 120 on nitrox. You're going to be a little bit impaired.

Audience: Well if your first gas is really the 70ft stop with 50% is there any point, from decompression perspective, to have anything except nitrogen and oxygen? Would you ever consider adding helium to the shallow stop, or is there no point in that?

George: Helium is friendly, it's easier to breathe, there's less CO_2 build up. It's amazingly easier to breathe. If you go to the hospital and you're on a respirator or you're operated on its all heliox, it's not air. They don't give you air, it's just so much easier to breathe helium.

You just reminded me of something with stage bottles and deco bottles. Part of the whole game plan is whenever you're finished with one you need to get rid of it. In other words, you're breathing the 70 bottle and you're going up to the oxygen stop. Take it out, go to either backup or

long hose. Long hose is great because you can donate. But the backup is OK but you got to be paying attention. You need to take that 70 bottle, stow the reg, turn the bottle off. Any bottle that's not in use has to have a stowed reg and be turned off otherwise it messes up your bottle identification scheme. You need to put one away before you pull the other one. Don't get cute. Don't get fancy and try to do everything faster or on the fly or float the bottle because that won't work in a current anyway. But you can do it in a cave if all the bottles are the same. You can float the bottle but it's not worth it. Because what are you going to do if something goes wrong? The other thing is you need to clip off your light when you're doing switches because you don't want that light cord in the middle of a gas share.

Audience: When you're stowing of the reg, obviously you still leave the hose charged so there is gas in the hose and the reg is pressurized even though it's turned off when you stow it away, right?

George: It's nicer for your first stage or it will back water all the way there. You've got to blow them out when you're coming up anyway. Otherwise you get the salt in the first stage. It's more of an issue salt water diving. Fresh water diving you don't really care if there's water in the reg, doesn't really hurt it. Doesn't really hurt it in salt either, it's just the effect of salt crystals when it dries up. It's real important to never have a live bottle. That's how the guy Sherwood Schile killed himself. He left all the regulators hanging over his neck. He didn't stow them. When he got to the third bottle he got stuck in restriction. The scooter kicked on underneath him, pinned him between the floor and the ceiling. And at the same time he ran out of gas on the stage bottle he was breathing, or thought he did, or it fell out of his mouth. So that's one issue and the other issue, of course, would be breathing the wrong one because now you've complicated it by having a live snake in the room. And the third reason would be everything tangling up if you have to respond to a problem. It's best to be meticulous, clip the light off, go through the bottle check, do everything slowly and carefully and you end up faster. Pay attention. Keep heads up.

Back to decompression. Oxygen tends to cause vasoconstriction resulting in less gas transfer from the tissues to the vessels. The lungs to try to protect themselves from the oxygen — they'll swell up, fill with fluid and try to add layers of cells to the interface to protect themselves against the oxygen. This all happens within 12 minutes or so of pure oxygen breathing under pressure. So what we do when we get to the oxygen phase of deco is switch back and forth between oxygen and back gas. Don't run 30 minutes on oxygen and then take a break, it's too late. You need to switch inside of 20 minutes to prevent the reaction from gaining full steam on the one hand, and reverse it and correct it on the other. You want to reverse the effects somewhat. We end up doing 12 minutes on oxygen, 6 minutes on back gas, 12 minutes on oxygen. You don't need to do exactly 12, you don't need to do exactly 6 — you can modify that around that range. But it wouldn't hurt to do say — 3 and 10 or that kind of thing. Just don't go out to 20 minutes. Just mix it up. You don't want to make it absurd for a short dive, but definitely don't — even on a short dive run the time out. It will cause oxidation damage to the lungs and it will reduce your effectiveness. With the damaged lungs you'll be breathing pure oxygen and not off-gassing at all. No deco at all.

Audience: On an ocean dive with the kind of profiles that we dive, would it really only be the O_2 bottle? Just the 20ft stop?

George: The procedure for other dives needing a gas switch is do the last step before a bottle switch on your back gas. So at 80ft you'd be on back gas, at 70ft you switch to your 70 bottle. That gives you a similar effect, it's not as low a PPO_2.

Audience: And if you're going to switch to O_2 you would do the 30ft stop on back gas?

George: Sure. During the last part of it — the last 3 – 4 minutes of the stop – go to back-gas and stow your other bottle. Get it put away. Move to your oxygen at 20ft.

Audience: So a back-gas break helps the logistics too. So you don't have to be stowing something while you're deploying.

George: Yes — exactly. It's interesting, the quickest, most efficient guys you'll see in the water are actually moving slowly and meticulously. It's really funny. And Bill Gavin was a master of that. While other people are scrambling, Gavin would slow-mo. Yet he'd be waiting for you.

Audience: You mentioned using either the long hose or the backup reg while you're stowing the bottle and going to the next one. If you're on the backup reg and there's a problem, then the reg in your mouth can't be donated. If you haven't put a break away clip on your long hose (which we've decided, is not necessary unless you're on the rebreather) then you may have a problem donating. So should we always go to the long hose then do that switch, or what?

George: I do in the cave. I always go to the long hose to be sure, and for all the reasons you're saying. I think it's better to go to the long hose. You can start with the backup if you want, then unclip the long. It just takes you a second or so? But the most important consideration is that the time to expect a problem is in a switch. So you need to be ready for it. If you've put your bottle away and you're on your backup reg and your long hose is clipped off, then you're going to have to break it off or go for it with a glove. I prefer to use the long hose, definitely. You've got to be thinking that way all the time anyway. You have to be fully aware, no matter what you're doing.

Audience: You said a lot about the shape of the deco. I have a question that is closer recreational profiles but a bit beyond. We're doing 90 to 100 ft dives with, say, 40-minute bottom times. If we go a little bit deeper we may have some obligation but we may not have any other gas — just back gas. How do you actually come up with the right profile? You've done it so much it's sort of second nature but how do you get to that point?

George: Well first you have your ascent rate. Get the ascent rate right just by stopping on 10ft increments. First get that part down. Now you know that at 80% of the profile you want to consciously do a stop. You want to call it a stop in your mind even though it's not huge. Then just work your way up in almost even stops and even amounts. They don't have to be longer and longer and longer. They can just be even amounts. As long as you do that, the slow ascent and those even steps, then you can stop a little longer right near the surface. That will give you the shape that you're looking for. The things that change the shape of a curve on a longer bottom time, with complicated gasses, are also a function of using those gas switches and spending more time at the bottom. Whereas with the dive you're talking about, you still have to do decompression but you don't need to do it in increasing steps. You just need to do it. So you can call it linear decompression if you want.

Audience: Really it's just more of an ascent rate thing than anything else.

George: Yes. You can do a 500ft dive with no deco gas, except near the surface, you wouldn't be able to breathe (since a 500 foot gas would be hypoxic near the surface) and do it with no deco gas and no overt stops if you just descend and ascend properly. If you ascended at the proper

rate you could go 500 and not stay there, you just hit the right profile and come right back up again. Nothing would happen if you ascend properly.

Audience: On the shallow, recreational dives — multilevel profile kind of stuff — we see a lot of people rely on dive computer for that. How do you explain to people that it's not necessary or useful to use the computer?

George: One, is you want to learn the why-and-how and the shapes of decompression. You can use a deco program. Deco program are nice. You can simulate over and over again and see what things look alike. And it's close enough. It's going to show you the important changes of shape over time. The problem with all these wrist computers or even the computer programs is the *weenie factor* that's built in.

These guys believe they lower their liability if they make it longer — that it's better or safer. It's not. It's worse, in most cases. Not to mention the exposures to the gasses. So what I tell people is that first of all, there's no decompression computer that's correct anyway. It's not right! It's wrong decompression. And the other thing is that the best of those decompression computers, on an intermediate bottom time, will give you way too much deco, even though you multi-leveled. It'll give you more deco than a rectangular profile. I just go rectangular in my mind and the multi-level is part of the deco. In my mind I do it rectangular. I don't start cutting off time because I was at 80ft instead of 90ft. Do the bottom time and come up. Part of compensating for that bottom time is when I leave for a new multi depth I'm only worried about the decompression from that depth because I've already handled the other one. So the computer is actually worse. Also, if you do a shorter dive, the computer is not giving you adequate decompression. It's giving you inadequate deco because it doesn't understand that the human physiology requires a certain amount of decompression on <u>any</u> dive and it ignores that.

Audience: So is that minimum deco really the ascent shape that we just talked about?

George: Yes. These dive computers will tell you "no–stop-time". Well there's no such thing as no-stop-time. It's crazy. So you can get these massive no-stop-times. If you look at some of the Suunto models, you can do dives to ridiculous depths. Dives to 150ft with no deco. Or if you look at a Buhlmann computer, you could probably do a 100ft on air for 27 minutes with no deco and go straight to the surface according to Buhlmann. Well obviously we <u>know</u> that's not right. So something is missing here. Talking to people with dive computers, tell them they're probably not doing <u>enough</u> deco or they're doing the <u>wrong</u> deco for the shape of the dive they did. And in any event, they're not doing the correct deco. They're just kidding themselves because they're not learning anything. There's no bottom time or deco savings.

They think, "I'm saving some deco because I did a multi-level dive and my computer kept track of it." Well that's not the case. They're just kidding themselves. There's no advantage. Like Parker used to say, "Deco is your friend." There's no advantage to not doing the square deco. If you do it correctly it's going to end up shorter than any program will ever tell you that you should have done. Plus the other thing, is that you need to learn the stuff. Because what happens when the stupid battery dies or the sensor is wrong or the computer is stuck? What are they going to do? Dial 9-1-1. I mean these idiots on the recreational boats have their computer and if the computer breaks, they get out of the water. Suddenly they don't feel good and they get the captain to call the Coast Guard. Because, "Well the computer broke, I must be bent." It happens in Lauderdale constantly. They start screaming, "Bent!" It's a riot. I don't like to be on the boat when that happens, its just a waste of time. But it happens continuously. Like if I told you I put cyanide in your water, you wouldn't feel good.

Audience: So the "minimum deco" concept on a shorter dive was "ascent rate". So when you start getting into where the deco planners start showing some real deco at 10' and 20' and 30', you probably want to pad it up a little bit on those fairly short dives compared to what the computer programs say.

George: Yes, even on that. Because the model has to choose how it's going to work and it doesn't account for human physiology — that's all. It just doesn't account for it.

Audience: The appropriate padding would be just to do the same thing, 80% from the bottom and then ascend.

George: Yes, then change your stops around according to knowing what gas you're using. In other words, program tells you, you need *less* time at higher partial pressure because of the higher partial pressure. But you know you want *more* time because of the higher partial pressure. So you take it off the shallow stops and go to back gas for a break. So rearrange the time.

Audience: But it's nothing really more than that. It's not a huge pad.

George: No, it's just that the programs don't account for some of the extremes. Bruce Wienke's program is really close to being perfect as far as the shape, except it doesn't take into account human physiology. So it gets up to 40ft, let's say, on a real big dive, and it will have some massive stop at 40ft where you have your lowest partial pressure. You're not doing yourself any good. Well we know that we can accelerate that and press the gradient and cause off-gassing into the tissues in bubble form. He's trying not to create bubbles. So we can modify that by creating bubbles and using the human physiology to speed up the decompression massively without causing any problem whatsoever. So that's where a really good model varies from reality. Some of you guys are using Variable Permeability. That one accounts for all kinds of poorly perfused physiology. With that one, you can move things around according to your physiology and then add the other tricks in — add the deep stops — add the other stops.

Audience: This question is totally off track, I was just wondering what's going on with Wakulla Springs? Have you guys been diving out there?

George: We've had a tough time of it. We got hit with some hurricanes last year. We had massive back-to-back nine-inch rains. Then we got hit with a lot of cold fronts all winter so we haven't been able to do anything. But it should clear up for summer. We've got a couple more dives we want to do in there unless it breaks open. We have some leads to work but they're way the hell back. 17,000ft back. So we got to set the cave up. We were set up to 17,000ft last time we dove back there but the thing went under and we haven't been able to get back. And we've got rebreather drive bottles sitting there that hook up to any rebreather, but they're from the older rebreathers, not the new rebreather. So we have to go back and redo all that.

And then we're going to try and work on Leon Sinks, which is a more difficult system — big, deep, but it's siphoning hard. And you don't have the big open basin so it's a difficult place to decompress and you have to decompress in the water the whole time. One advantage is the basin stays warm. In the summer it will get up to 80 degrees sometime so you don't get cold. You don't care about being in the water but you have to get up above 20ft on the oxygen. You have to do your oxygen shallower if you have no habitats.

Audience: When you set up the tanks deep into the cave how long are they good before you'll have to pull them out and put new ones in?

George: Well it depends on the item. The Scubapro regulators will last indefinitely and they'll work indefinitely as long as they're wet. Others brands will fail. The seat will fail. The tank valve is a problem. If it's a bad tank valve you can't turn the damn thing on or off, can't do anything with it.

Audience: Why wouldn't you just use the DS4s, something dry sealed down there?

George: Well we want to use those regs on the bottles and breathe them. Scubapro sold us regs super cheap so we bought a ton of them and we use them on the staged tanks.

Audience: If you had a chance of changing that stuff out for something would you?

George: Well if I had my druthers yeah, I'd get Apeks regulators. One thing though about the Scubapro — both the piston and the G250 — they don't even make them any more. That combination seems to tolerate being left in the water forever for some reason. Now out of the water, you can't dive with them twice without changing the seat because as soon as they dry out they won't work. I keep mine in a big wet box. It's a sealed box so they're all moldy but they're wet and they work. Jarrod and I didn't dive for a while and we're both failing Scubapro regs right and left because they were dried up. You've got to water them down. I throw them in the pool and throw them back in the box. I dunk them all in the pool and throw them in a plastic box with a lid. Leave them like that.

To answer the question in a more intelligent fashion — as we dive over the bottles we check them. We have the setup divers check each set. They go in with extras and they swap out the bad ones. We have them check each bottle, make sure it turns on and make sure it has gas in it.

Audience: We probably need to kind of wrap it up because I think the room is closing. There's some of those argon mounts there, you can give out to anybody if they want them.

George: Yes, these little things that you made up go on the waist belt. All of these gear variations you don't want to find yourself modifying your gear in such a way that if you go to do something else you got to un-modify your gear to do it. You want something that's universal. That's why all the solutions I try to find are ones that won't be altered. It won't make any difference where you are or what you're doing, you'll be able to operate.

But dedicated rigs are nice. Like today I came with my little back plate harness that I use for open water diving in Fort Lauderdale with my wetsuit. I went to put it on, but since I had a drysuit on I had adjust the webbing three or four inches to give myself more room. But if I were doing this often enough, I might have a back plate that's just for diving with a drysuit attached to my single tank wings. All my other gear is all interchangeable, identical. In other words I got another four back plates: I got a steel and three aluminum. The steel for when I'm using Faber tanks with a drysuit, you can't tell them apart otherwise. I got several sets of regulators. You can't tell them apart except one set has an inflation hose where I don't need argon. But otherwise they're all identical. But if I want to do a wreck dive I just grab the wreck argon instead of the regular argon. If I want to go to Mexico and cave dive where it's warm I take the harness in a little bit for the wetsuit versus the drysuit. But I don't want to have stuff that has to be changed. But if you guys are going to dive one thing all the time you should probably set something up that's dedicated to that and separate it out.

Whenever you do something different you got to make sure you're not screwing something else up. You have to make sure that the fine points like, for example with the argon back here on the plate that you've got to have enough room. The left D-ring has to be far enough forward or its going to be impinging on your stage bottles. It has to be far enough forward so that it's out of the way. See if the ring is way back, it doesn't make any difference what you're holding your argon with, it's in the way. These little details have to be right.

Also, the ring doesn't need to be way back because the bottle is going to be up tight anyway. You actually want it to be down so that when the bottle is pulling against the ring it's not way up in the air. What happens is you're trying to go through into a wreck or something and you don't like where you're going, you back up and it's like a car jack. It, whoosh, stops you if it sticks up, grabs the ceiling and can't go anywhere and you got to pull the bottle back down and back up. Plus you want it down anyway. But it's just like little tiny things that cause, you start changing them and then these little things get carried away.

You guys think of anything else?

Audience: One more. Some of these guys are doing deeper, longer dives, I occasionally play safety diver for them. I just go down the line as they're coming up to decompress. I bring extra deco gas in case they need it or something. I'm just wondering, when you're doing your ocean dives how do you like to use the safety divers, what do you like to have them do?

George: Well I want them to come down and check on me and have an extra bottle of gas in case the shit's hitting the fan. And bring me my other deco gas. It makes it a lot easier. First of all, as a diver coming up, I know the boat is on cue, it's right up there and everything is squared away. And if there is a problem it can be handled at that point. Billy Deans is the best example. He always ran safety divers and had them drop down with extra gas. He caught people breathing the wrong gas, toxing and saved them because he had those guys in the water. Billy's got a lot of saves. He's got no losses when ran that operation in Key West whereas everybody else has constant losses.

Audience: Given a choice on a small boat, would you rather have somebody in the water or somebody up on the boat to keep track of the boat?

George: Well you've got to have two guys on the boat, can't have a solo boat operator.

Audience: But we've got little boats, like four people max.

George: I know. Well you still want to have two. What you do though, is like you got two guys in the boat if you got mask and fins sitting there ready to go. So the guy is ready to go in the water to deal with a situation. The other thing you can do is you can stagger your teams. So you'll say one team goes down first, and the other goes second. Well I'm on the second team, I come down and check on the guys on the way down. And if something is wrong we're not going to dive. You stagger it that way. We rotate. Don't put everybody in the water at once. I don't like to put everybody in the water at once unless it's only a few guys.

Audience: But then would you have the second team go back down to meet the first? Then would you have the first team go down to meet the second team at any point or just have them on the boat ready to go in case there's a problem?

George: Have the teams on the boat and agree on how you're deal with and how they're going to know if there's a problem or not. But if you do have a problem, send somebody back down that's already been diving you're going to have to make sure they ascend properly so you don't bend them. Don't bounce. You want to stagger your teams to be able to manage the situation better. It's nice if you can get people to come out on the boat and help and then do their dive.

Audience: A question I wanted to get to but it's getting a bit late now: we have Lake Tahoe here at 6000ft. How would you deal with diving at that altitude?

George: I basically ignore it. *[audience laughs]* You can calculate altitude in the programs and all. Your body adjusts right away anyway just so it all becomes relative again. Stay at Lake Tahoe for a couple days, your body is at 6000ft and stays there. So it's not going to be like you're going beyond decompression steps when you get out of the water. It not you could be beamed to Lake Tahoe and do a dive and come up. But I pretty much ignore that altitude silliness. They make too much of it, I think. But I went skiing at Lake Tahoe, and didn't have any problems. *[audience laughs]* I didn't get bent. But I really don't know. I mean, I don't know of anybody that ever had any issues with any of that. But they always have some special deco. But I've never seen any problems. I really don't know, though. It's out of my realm, other than I don't believe it. From what I know of decompression I don't believe it's a problem. That's got to be a cool place, though, to dive.

Audience: It's nice once or twice a year, it gets boring. Nothing to see.

George: Really. Sure looks beautiful from above, looking down on it, blue water.

Audience: Crawdads and blue water.

George: Really?

Audience: There's the wall.

Audience: There's a wreck in there somewhere isn't there? Pretty deep.

Audience: There's a couple of them.

George: We got anything else?

Audience: Well, I have one. It's kind of broad and it might take us too long so I'll start it and then if we want to discuss while we're walking out. One of the things that we often try for is accelerating our deco to get out of the water sooner because conditions vary on us quite a bit. It might be cold, seas are getting rough, so we want get out as quickly as possible. But there is a line, there is a minimum deco, and I think we're still trying to find where that is. And I'm wondering if you can help provide a little bit of guidance about the profiles and how we might really find the minimum deco so that we don't accelerate out too fast. And I think possibly one of the areas we accelerate too much is the intermediate range and I think, especially with the dives we're doing — from 160 to 200 for 20 to 25 minutes. I think you would actually advocate a lot longer deco than we end up doing and I was wondering if I could get a little bit of feeling for what type of deco shape you would look for in that range.

George: One of the best ways to accelerate the deco is to be meticulous about the deeper portions. In other words, just make sure you've seen the depth gauge click off its 10ft increments. The other way is to sit on the intermediate step that has the highest partial pressure a lot longer than otherwise and subtract it from the other steps. That hold pattern in there will give you a massive advantage. It's going to make the upper shortenings insignificant. If you're sitting at 70, pare down the 60, 50, 40, 30. Pare them all down. And then from 20 to the surface, if you've got oxygen or even if you don't, I would just divide those 20 feet up, let's say, to 7 — those 13ft up — and assign a number of minutes you're going to do per two feet or whatever, per foot, half a minute or whatever it is, quarter of a minute, 30 seconds, 20 seconds, or whatever, and work your way up that way. But the basis of minimum deco is you're letting the body catch up. You got the deep portion where you don't want to trap any bubble and the shallow portion where you don't want too much gradient and off-gassing during the last part of it. And then at some point along the way, get a partial pressure advantage — some meaningful advantage — and spending some time with it. Then I think you can smooth into a pretty straight line ascent and really cut it down big time. But I think if you choose how you ascend with the deep stops, get some time with the gas advantage, those elements will have eliminated the need for a lot of the shallower, longer stuff. And you've also put yourself in a better position to deal with situations as they arise.

Audience: Right. So we generally do most of that. We start our stops 80% from the bottom. We get to the 70ft stop, we spend five minutes there. But then after the 70ft stop a lot of times we accelerate that, possibly too fast, because the O_2 window is still kind of open. At the 60ft stop we would often do one minute there, 50ft stop another minute there, and then 40, two minutes, 30, three minutes, the 20 and the 10 together would be about another 12 minutes or so. I'm talking like maybe a 160 for 25 profile type thing.

George: Well I would rather add back into the 60 and 50, shorten the 40 and 30 and 20.

Audience: Right. So you would go up to two or three minutes on the 60 and 50?

George: Yes, I might. Because you need the time. You're trying to catch up, you're body is trying to catch up. You want to give it some time there with that high partial pressure. Think of it this way. Think of it like at 70ft you're dealing with the bottom time and then everything above it you're dealing with the 70ft. Break it into two dives and it will be clearer to you what you really need to do. In Buhlmann terms as long as you're sitting at 70ft, that ceiling is going to go up rapidly. Then it's going to stop — and then it's going to start coming back down. Let's say you stayed there for four hours, you'd have a 65ft stop. So it's a parabola. You can try it on the computer to see what I'm saying with that. Give yourself more comfort.

[applause]