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All current news items, reports, articles, photographs, negatives, slides, or other submissions for the newsletter should be sent or phoned in directly to the editor:

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All other official dealings with the Cave Diving Section, including general information inquiries, publications orders, and training certification matters, should be directed to the Section's official, permanent address (POB 950, Branford, FL 32008-0950). Specify, if possible, which officer or program coordinator should handle your request in order to speed up the forwarding process. (For example, publications orders should be addressed: "H.V. Grey, NSS-CDS Publications, POB 950, Branford, FL 32008-0950.")

CALENDAR

Oct. 10-12 - Annual Fall TAG Cave-In at Sequoyah Caverns, Valley Head, AL. Contact Bill Hardman, Dogwood City Grotto, 1865 Ridgewood Dr. NE, Atlanta, GA 30307. [CDS Board Meeting???]

Oct. 26-27 - NACD Cavern Workshop for Open-Water Instructors, at Manatee and Ginnie Springs. Contact Steve Gerrard, 5714 Ed White Ct., Tallahassee, FL 32301, (904) 656-1223.

Dec. 28-29 - NSS-CDS Winter Workshop, at Branford High School, Branford, FL. Contact Workshop Chairmen: Wes Skiles & Mark Long, NSS-CDS, POB 950, Branford, FL 32008-0950. (See BOD phone numbers.)

23-00-265014-42

What is this number? Is this the new NSS-CDS Post Office Box and zip code in Branford? No. That's POB 950, zip: 32008-0950. Well, then could it be the number to call if you're a member of the Rescue/Recovery Team and you've changed your address or phone? Nope (ha ha!--tricked you!) --that's the National Crime Information Center: (904) 633-4159. Okay...then could it be...I've got it!--the winning serial number for a brand-new Tekna scooter! No, sorry. But it's still good news: the NSS-CDS tax-exemption number as a "Not-for-Profit" organization, thanks to the hard work and persistence of Treasurer, Joe Prosser.

The tax number means that we will be able to purchase all wholesale items for publications, etc., without paying tax. But it also means that we will have to charge Florida state sales tax on all items purchased in Florida. (Orders originating out of state will remain tax-free.)

COVER: Cady Soukup placing shrimp trap in Dai-ni Ngermelt Cave, an Aston collapse-type cave on the Island of Peliliu, Palau. Photo by Jeff Bozanic. Article to appear in UWS 12:6.

TWO NEAR-DROWNINGS AT MORRISON SPRING - reported by John Crea (Director of the School of Nurse Anesthesia at Bay Medical Center, Panama City, FL)

Saturday, August 3, 1985, a 21-year-old male was involved in a near-drowning at Morrison Spring. The day before, the victim made two open-water certification check-out dives with the rest of his scuba class from the University of Mississippi in Hattiesburg. The planned boat dive for the next day (Aug. 3) fell through, so the instructor directed his now-certified students to Morrison. The instructor told the students not to go into the main cave, but that it was all right to go in the small cave. (Crea describes this cave as being some 15-20' high, 90' in extent; maximum depth: 50'.) The instructor was certifying through NAUI. He stayed on shore at Morrison and did not dive.

John Crea got his original information at the hospital when the victim was brought in. But later had the opportunity to talk personally with the victim during his convalescence.

On the first dive Saturday, the victim and his buddy made a 30-minute dive in the small cave. They had no lights, no reels, no depth gauges, and no octopus second stages. Because they had no depth gauge, they estimated the maximum depth to be 80'. They had a surface interval of one hour, then went back into the small cave with fresh tanks (single 80's) for a second dive. (Crea observes in passing that while the actual depth could have been no more than 50' on either dive, with the profile they were operating under, they would have 28 minutes Residual Nitrogen Time accumulated. And 30 minutes is the No-Decompression limit at 80'. This would have given them a topping 2 minutes bottom time without doing a decompression dive.) 25-30 minutes into the second dive, the victim began to experience difficulty breathing through his regulator. (Both divers did have submersible pressure gauges, but apparently did not monitor them at regular intervals.) At this point, when the victim did look at his pressure gauge, it read zero.

The victim was naturally starting to feel very anxious. The two divers attempted to buddy breathe. The victim stated that the buddy panicked and that he, the victim, passed out from some kind of mask squeeze (and Crea suggests, also tachicardia from anxiety). The next thing the victim remembered was waking up in the Emergency Room at Bay Medical.

The buddy apparently surfaced and called for help. Other divers went in, found the victim lying on the bottom (at 50') unconscious, not breathing, with the regulator out of his mouth. The victim was taken to shore (a good 5-minute swim) and given mouth-to-mouth rescucitation. He started breathing spontaneously and was flown by helicopter to the hospital in Panama City.

He was treated for presumed air embolism and pressurized to 160'. There were complications from the near-drowning (ARDS - Adult Respiratory Distress Syndrome or "Shock Lung"), and the patient had to be treated with extensions, 100% oxygen and intubation. He was in the chamber for a total of 38 hours, in the Intensive Care Unit on a ventilator for four days, and afterward required hyperbaric oxygen treatment on a daily basis. (One of the nurse-anesthesia students who stayed in the chamber with the patient for the full 38 hours, subsequently developed joint pains and had to be treated herself.)

Crea says that in addition to the lack of equipment, training, and experience, the small upper cavern was silted out. He says that the sand is coarse and settles quickly and that it takes an awful lot of people kicking vigorously to blitz it out.

* * * *

On May 6, 1985 a 36-year-old female was involved in another near-drowning incident at Morrison Spring. The victim and friends stopped at the Spring on their way to the Florida Keys from Iowa. The victim was a certified open-water diver, but had not been diving in two years. On the first dive at Morrison, it was observed that she was extremely anxious and uncomfortable about trying to go through the mouth of the lower cavern against the strong flow.

On the second dive it was decided that since she had been so nervous and anxious, she should dive with a more experienced buddy. So she was paired with a YMCA open-water instructor. They had full single 80's and submersible pressure gauges. The victim had only a single second stage, however, the instructor/buddy had an octopus rig. In order to help the victim through the opening to the cave, a ski rope was rigged. The victim showed the buddy her pressure gauge at this point; she only had 1000psi left, and again was observed to be quite anxious and upset about going into the cave.

The buddy saw that she only had 1000psi left, but figured that they would have plenty of air to take a quick look around inside. 5-6 minutes later, the victim signaled that she was out of air. The buddy gave her the regulator he had been breathing off of and switched to his octopus for himself, and they proceeded to exit the cave. The victim became entangled in the ski rope at the mouth of the cave. The buddy managed to get her free, lifted up the rope and signaled for her to go under it, whereupon the rope became entangled in her tank manifold. The victim totally panicked, knocked the mask off the buddy's face, and snatched the regulator out of his mouth. The buddy did a doff-and-ditch, and made a free ascent to the surface where he hollered for help. He thinks he blacked out temporarily during the entanglement (and had to be treated at the hospital himself).

Other divers found the victim at the mouth of the cave, entangled in the ski rope, unconscious, with no regulator, and in what turned out to be full cardiac arrest. The victim had no pulse and was not breathing, so CPR was administered, which generated a spontaneous blood pressure, pulse, and autonomous breathing. (Fortunately, there were two paramedics at the site.)

The victim was transported to the local hospital (Defurniack Springs) and "stabilized" in the Emergency Room. Two hours later she was transported to Bay Medical in Panama City. Crea first saw her in the Bay Medical Emergency Room, where he ended up having to intubate her for treatment. Pupils were fixed and dilated, with a diagnosis of cerebral air embolism. The pupils became light-responsive after the victim was pressurized to 165'; treatment lasted some 6-8½ hours. After two days in the Intensive Care Unit, the victim became responsive, and no neurological or physical deficit was detected, except for total amnesia for the incident.

* * *

[The Editor would like to take this opportunity to encourage members and subscribers to report any accidents, near-accidents, or clear violations of established cave-diving safety procedures for the edification and future safety of all. All accidents and rescue/recovery operations should be reported immediately to Henry Nicholson (see Program Coordinators listing).]

24th CAVE DIVING WORKSHOP, Branford High School, Branford, Florida, Saturday, December 29, 1984

All photos courtesy of JEFF BOZANIC (Chairman of 23rd and 24th Workshops)

(Wes Skiles and Mark Long, Co-Chairmen of the upcoming Winter Workshop, are considering an optional food plan that will help provide more opportunity for socializing and hopefully prevent the Steamboat from having to try to feed 300 ravenous cave divers in the space of 30 minutes. More information in the next issue of UWS.)

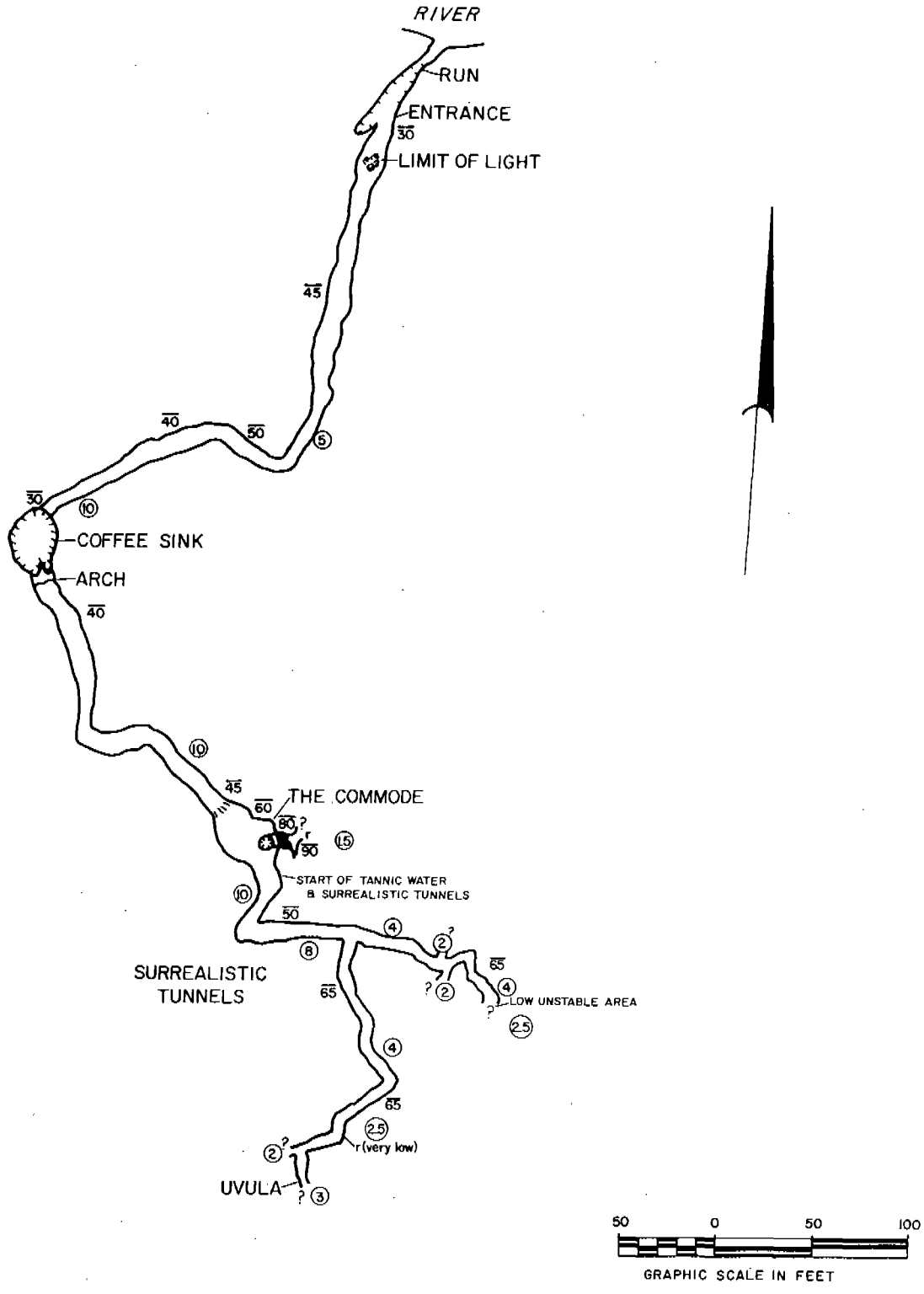
Hungry cave divers (is there any other kind?) going through the B-B-Q line and eating lunch on the high school lawn.

Workshop participants were invited to experiment with vertical rope techniques (Steve Hudson of PMI, below).

In addition the optional food-service plan, Wes and Mark have also been considering the idea of having several hands-on and in-water seminars on the second day of the workshop weekend, Sunday, December 29, 1985. 1985.

All inquiries about the upcoming workshop should be directed to Wes and/or Mark c/o the NSS-CDS official address: POB 950, Branford, FL 32008-0950; or they can be contacted by telephone (see BOD listings).

Publications will also be looking for several reliable and reputable volunteers to help man that table. We are going to have lots of things for sale this year: new T-shirts, maps for qualified buyers, etc.



COFFEE SPRINGS

MADISON CO., FLORIDA

MAPPED 1984
BY
GUY BRYANT
COURT SMITH

168m (557') EXPLORED

Drafting by Marvin Von Almen

THE EXPLORATION OF COFFEE SPRINGS by Guy Bryant

In June of 1983, Phillip Moore, a friend of mine who does some cave diving from time to time, approached me about a spring that a non-diving friend had showed him. The spring was located on the Withlacoochee River (North Florida) just downstream from the Bellville Bridge. According to Phillip's friend, the spring was once a rest stop along an old stage-coach route where the passengers could relax and drink coffee; hence the name Coffee Springs.

When Phillip first saw the spring, he immediately strapped on a single 72 and plunged in. He reeled about 15m of line into the entrance of the cave to a depth of about 12m. His visibility was about 12m. All excited, Phillip quickly reeled out and eagerly described the find to me.

A week later, Phillip and I made a visit to the spring only to find that it had quit flowing and was now syphoning dark tannic river water. The most unusual thing about this was that the river water level was very low and still falling.

We watched the spring for several months, hoping that it would reverse soon. During the fall of 1983 the rains came and the river flooded. This somewhat encouraged us because we figured that as the river began to fall, the spring would once again flow. We finally got our wishes in May of 1984. The river had finally dropped enough to allow the spring to flow with a visibility of about 3m.

Phillip used dual 72's and I used dual 80's. We submerged to find a really strong current. I tied the line off on a rock at a depth of about 3m and we eagerly proceeded to see what kind of find this spring would become. The entrance started at a depth of 12m. The tunnel was low and wide (2.4m x 5.5m). After about 30m in, the tunnel dimensions changed to 3m x 3.7m with a maximum depth of 15m. 102.4m later we noticed daylight from above in the poor visibility. At the same time we found an old coffee pot, along with other assorted junk on the bottom.

We surfaced to find ourselves in a fairly large sink about 24m in diameter. We decided to name it Coffee Pot Sink in honor of the coffee pot we found. We then went back down for some more line laying in the spring side of the sink. The entrance was very low and wide, and the bottom was covered with gravel blowing up in the strong current. It took quite a bit of effort to get into the entrance. We managed to lay about 23m of line before I ran out of line. We tied off and made a hasty retreat thanks to the current pushing us along. It took us about 30 minutes to lay the line and only 9 minutes of drifting in the current before we were back at the spring's entrance.

It was not until September 1, 1984, that I returned to Coffee Springs for further exploration. This time I dived with Steve Shaw and Court Smith. We all used dual 100's and put in at the spring's entrance instead of the sink hole. This was so that I could map the tunnel Phillip and I had explored on the previous dive. The visibility had improved to about 4.5m and to my surprise, the current was almost non-existent. We entered the cave and after about 30m in, Steve's BC developed a severe leak that forced him to exit. Court and I continued on to Coffee Pot Sink; then on to the end of the line.

Court began to lay new line for a short distance before we came to a pit which dropped off from a depth of 13.7m to 21.3m. The bottom of the pit was small, with a restriction big enough for one diver at a time to pass through. The pit sort of reminded us of a commode so we aptly name it "The Commode," The visibility at the bottom of the pit improved to about 10.7m. The restriction led to a small chamber with two holes in the floor at a depth of about 24.4m. These holes led to a small room at a depth of 27.4m and the upstream was choked with sand. When we looked through the sand choke we could see that the tunnel opened up to a size large enough to accommodate one diver. We even saw what appeared to be a clorox bottle on the other side. We decided that it was not worth the trouble to dig out due to the small size and silt. We then exited, mapping the cave on the way out. When we got back to the pit, we found a tunnel near the top that was full of tannic water. We decided to have a look at the tunnel on our next dive.

On November 4, 1984, Court and I returned to explore the tannic tunnel. We had planned to get in at Coffee Pot Sink, but a hunting club had leased the land and closed it off. So we took a canoe and paddled downstream from the Belleville Bridge. We again dived using dual 100's and quickly swam to the sink in almost zero current. This time the visiblity had improved to about 9m. Once at the tannic tunnel, which started on the south side of "The Commode" at a depth of about 15m, the visibility dropped to 3m. We continued on for about 25m in the tunnel, which was 2.4m x 3m. We then came to a fork in the tunnel and decided to take the tunnel on our right.

We continued for about 27.5m until we came to a very low restriction which was 0.8m high by 1.2m wide. Court then gave me the reel and motioned for me to continue if I wanted to. I carefully studied the restriction and decided to give it a try. It was a good restriction for grabbing "danglies." I pushed through about 2.5m of restriction before it opened up to a 1m x 1m tunnel. Fortunately the restriction did not contain enough silt to cause any problems. I swam on for about 10m and came to a formation hanging from the ceiling that reminded me much of an uvula in a person's throat. The tunnel continued on but was very small, so I decided that this was a good enough place to stop.

I then motioned to Court, who had been following me fairly closely, to exit. We went back to the fork and took the left-hand tunnel. This tunnel went about 31m as a small 1.2m x 1.2m tunnel with a few leads too small for exploration. It reached a depth of 20m at a low, unstable-looking area. Upon looking at the ceiling in this area, we decided that this was far enough. Again, we mapped this area as we exited.

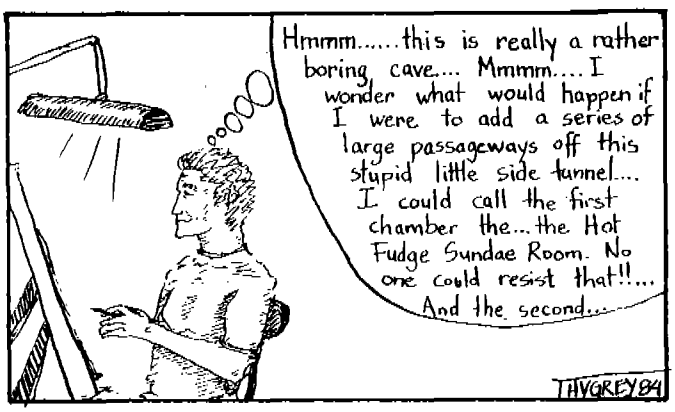
The tannic tunnels were very unusual in that they contained many unusual formations. There were many different sizes and shapes of black spheres along with several oblong globes randomly placed along the bottom. There were also many unusual globular formations jutting from the walls and ceiling. Also, there could be found isolated piles of sea shells in various locations along the floor, especially in the right fork. This was without a doubt, one of the most unusual tunnels I have ever seen. The place seemed almost like a dream.

When we finished the dive, Court remarked that it looked like something Salvador Dali would paint. That is to say, it was surrealistic in appearance. So we promptly decided to name the two tunnels the Surrealistic Tunnels.

If anyone enjoys restrictions, I would say that Coffee Springs has not yet been fully explored. There is still the possibility of laying line in the righthand surrealistic tunnel, past the "uvula" and also past the sand-choked restriction in "The Commode." However, these tunnels do not really appear to abe worth the effort to me, especially when there are so many easier and nicer things to dive.

* * * *

[Thanks again to Marvin Von Almen of Jacksonville, FL, for drafting up a finished copy of the map provided by Guy Bryant. (Marvin asked to commission a special cartoon of himself sitting at his drafting board. I said, "What's funny about that?" He said [such confidence!], "You'll think of something." Six months later....)]



CAVE DIVING IN FLORIDA, 1970 - 1985: THE MAIN PERSPECTIVE by Milledge Murphey (in collaboration with Bill Main)

[Author's Note: The following narrative was procreated from discussions the author had with William H. Main and from notes provided by Bill Main concerning his diving career during the years 1970-1985. Main's accomplishments are justifiably legend, and his story reflects, I am sure, similar life-style modifications made by other cave divers as they have succumbed to the lure of Florida's subaquatic caves. Main's singular achievements in exploration, equipment design, modifications, and maintenance, and his unwavering desire to cave dive have produced not only numerous cave-diving firsts, but more importantly, a chronology of some of the major developments in Florida cave diving records during 1970-1985. This then is the story of Bill Main, and in a larger sense, the story of Florida cave diving during this most eventful period.]

Main is an explorer of submerged caves and continues his exploration of virgin passages as this narrative is being written. When others swim or motor through the main passages of many of the underwater caves in Florida, they are in all probability following in the fin kicks or blade rotations of the man after whom all Main passages everywhere are unknowingly named: Bill Main. In this author's opinion, no cave diver now active in diving deserves this oblique accolade more than does Main.

As I observe him, Bill is the absolute master of the cave-diving craft. His equipment design, configuration, maintenance, and his technique are unique and near flawless. Additionally, Main is now, and has for some time been, at the very limit of the cutting edge in the sport of cave diving. He has literally "done it all" and has done so without personal publicity or notoriety of any kind; he simply continues cave diving, and does it with extraordinary knowledge and ability. Having made these statements regarding Bill, I offer the following narrative, which consists of a report of verbal, log, and not sources directly from Bill Main taken during May and June, 1985.

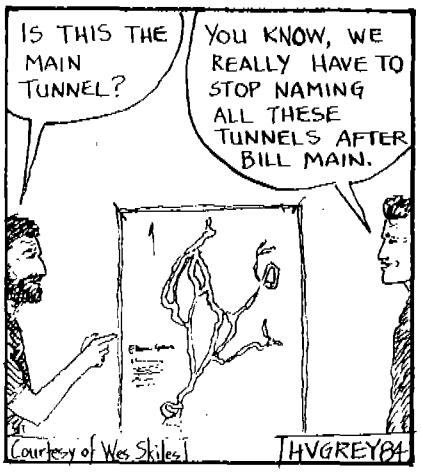
Events in Florida cave diving, much like events in space exploration, have occurred with accelerating rapidity during the past fifteen years. Exploration of subaquatic caves has been continually enhanced by technique developments, equipment inventions and modifications, and by a select few cave explorers among which are included: Tex Chalkley, Larry Collins, Paul DeLoach, Dave Desautels, Doug Duerloo, M.D. (deceased), Lamar English, Mary Ellen Eckhoff Exley, Sheck Exley, Sandy Fehring, Bill Fehring, Greg Flanagan, Steve Foreman, Bob Friedman, Bill Gavin, Bob Goodman, John Harper, Paul Heinerth, Louis Henkel (Sollenberger), Louis Holzendorff (decesaed), Woody Jasper, Terry Leitheuser, Jim Lockwood, Bill Main, Dave Manor, Frank Martz (deceased), Gene Melton, Tom Mount, Clark Pitcarin, Wes Skiles, Court Smith, Jamie Stone, Kirby Sullivan, Dale Sweet, Dana Turner (deceased), Roger Werner, Ray Wester, Dennis Williams, John Zumrick, M.D., and others too numerous to mention. No attempt has been made to list all Florida cave-diving explorers, however, the foregoing list is certainly representative of those persons who have initially discovered, mapped, and layed line in the caves which cave divers both now and in the future will dive. (Absence of any name from this listing does not in any way imply that the individual, inadvertantly omitted, has not been a cave explorer of significance.)

In working closely with Bill Main to develop the material which follows, I was impressed by his comprehensive knowledge of cave-diving events and the persons who were participants in them. Among the many knowledgeable and proficient cave divers with whom I have come in contact during the years falling between 1970 and 1985, two divers stand alone in my estimation: Douglas Duerloo, M.D., my deceased cave-diving buddy of the past, and Bill Main. Thus to discuss events from the perspective which Bill has acquired is an entirely appropriate way to approach the subject of cave-diving events during the years when he has been most active, 1970-1985.

Main began scuba diving during 1967 in a rock quarry near Dickerson, Maryland. His first dive was solo as were many others during his early cave-diving years. His equipment was purchased from Sears Catalog by mail and included a Nemrod single 71.2 cubic-foot tank and double-hose regulator. Soon after his initial dives he began having difficulty obtaining air fills and in getting rides on dive boats due to his lack of a recognized scuba certification. He solved the problem by taking a NAUI basic scuba course during 1967, in Virginia.

Thus began a diving career which was initially spurred by the 16-year-old Main watching Lloyd Bridges on the highly successful Seahunt television series. Undoubtedly, many other divers of this era began scuba diving in a similar fashion. Another aspect of Main's early diving was his 30-mile each-way trip to obtain compressed air on Washington, D.C., which was indicative of his intense desire to dive even though it was difficult during the early years.

His next equipment purchases included a U.S. Divers Mistral single-stage regulator and a Mae West-type B.C. He participated in some spearfishing and also did some ice diving in Maryland prior to traveling to the Florida Keys during 1969. While in Florida he dove Molasses Reef, and on the return trip to Maryland, stopped by Crystal River and dove the cavern at Banana Island Springs. His first cave dive also occurred during 1969, in a nocturnal dive into a mineshaft and quarry. He used a 200-foot length of rope to tether himself for this first penetration. During the years 1967 to 1972, he dove in rivers, quarries, bays, and inlets in addition to some ocean diving off the New Jersey, Maryland, North Carolina, and Florida coasts. During these dives he penetrated several wrecks and also made several ice dives, including one close call during 1968, under 3½ inches of ice in a quarry near Frederick, Maryland.



Later, during 1972, he began serious cave diving, and while he was in a Jacksonville, Florida dive shop he asked if there were any clear lakes nearby which were suitable for diving. He was told about Orange Grove Sink, and promptly dove there the same day. On this initial Florida cave dive he hit the reserve on his J-valve while still inside the cave passage. He also dove Peacock Slough on this trip and it was at this point that he purchased his first set of souble cylinders, a pair of 71.2 cubic-foot tanks with a single-port manifold, and backpack.

He now found himself driving to Florida cave sites four times per year to dive in the crystal clear cave waters. It was during this time that his diving partner was Hank Hotsko, and the pair began figuring out appropriate dive techniques and equipment on their own, as they continued diving the popular sites surrounding Branford, Florida, including Orange Grove, Peacock, Telford, Ginnie, and Devil's Ear. During 1974, Main and Hotsko, while searching for the Florida Room in Little River Springs, went past the three-way split turning on half plus 200 pounds. Bill was using a ScubaPro Mark I on his rig this time. By 1975 Bill had been inside most of the

THE MAIN PERSPECTIVE: Murphey (con't)

spring caves in the Branford area with penetrations of 1000 feet and more. He first made it to the Big Room in Devil's Eye during 1975; this is indicative of the number of advances which have been made during the past decade.

During 1976-1977 Bill dove with the late Paul Meng (at this time Paul was still in residence in New York) and was spending 1-2 months each year cave diving in the Branford area, even though he still lived in Maryland. Finally, during 1978, Bill moved to Florida, and for six weeks after the move he dove daily near his first Florida home at O'Brien.

Later, during 1978, Bill took NACD training from George Brkich and Dennis Basile. It was at this point that he began stage diving, and Bill reports that Greg Flanagan first conceptualized and used the back-mounted flotation device (BC) and the aluminum back-mounting plate at about the same time. Further, it was during this period that Bob Goodman and Ray Wester developed the Goodman sealed-beam cave-diving light and light head with the red-top liquid nicad cell battery pack (twelve cells in line) in an O-ring sealed cannister. It was also at about this point that Goodman developed the cave-diving belly bag which bears his name to this day.

During this period, Bill dove five or more times per week, solo, for six weeks, and discovered (in his interactions with certified cave divers) that they would not dive with (buddy with) non-certified divers. At this point Bill had logged approximately 350 cave dives, and, during 1978, once cave diver, Doug Clark, told him of the (previously mentioned) impending NACD cave-diving course under the leadership of George Brkich and Dennis Basile. Bill flatly states that the NACD course he took during 1978 was excellent, complete, and informative. During it he met Marvin Reece, who in turn introduced him to Greg Flanagan (a Univeristy of Florida student at the time). Reece took Bill on a dive during which they staged to the split in Devil's Eye.

During 1979, Greg Flanagan attempted to convince Louis Solenberger (Henkel) to instruct him in cave diving, however, arrangements were not consumated and Greg ultimately enrolled in what Bill believes was probably the first NSS-CDS cave-diving course, which was taught by Sheck Exley, assisted by Mary Ellen Eckhoff (who was in training to become an NSS-CDS cave-diving instructor under Exley at the time). Bill also became a certified cave diver under both the NACD and NSS-CDS programs during this period.

Early in 1979 Bill began diving with John Zumrick, who taught him many advanced techniques and introduced him to a number of other experienced cave divers. Further, Bill states that, while Dale Sweet was probably the first person to use back-mounted flotation in cave diving, Greg Flanagan's aluminum back plate was used to hold the back-mounted BC in place. Flanagan is also cited by Main as being first to use the battery pack for the Ikelite Modular X, modifying it to accommodate 12 dry nicad "D" cells and alter the General Electric "F" cells, which Bill believes has been the major recent breakthrough in cave-diving light battery packs. It was also during 1978 that Bill began diving regularly with Sheck Exley.

Bill states that among the events which profoundly influenced his cave diving were his initial NACD course during 1978, and his diving liaison with Sheck Exley and John Zumrick. It was also during this period (1978-1979) that most of the "big dives" were becoming single-stage or multi-stage dives and new line was being added by the 100's of feet almost daily. This rapid exploration period was to last through 1981 and included the opening and mapping of many of the presently know passages in Florida.

Bill began diving with Bob Goodman for the first time on June 10, 1979. Goodman is remembered for his superior cave-light and BC designs as well as his exemplary exploration efforts in the Tallahassee area. The team of Zumrick, Goodman and Main first penetrated Sullivan Sink on July 8, 1979, and Main single-staged Sullivan (solo) on January 5, 1980, adding 600 feet of line to that left by the three-man team during their earlier dive at the site. This lengthened the permanent line in Sullivan to 2400 feet. On February 10, 1980, Zumrick and Main returned to Sillivan, adding 400 feet to the end of the line with a resulting total penetration of 2800 feet.

Bill makes a point of mentioning that the first mile-long penetration he heard of in florida cave diving at that time was made by Dave Manor and Louis Henkel at Manatee Springs during 1979. Other names mentioned by Bill as being very active explorers during the 1978-1981 years were Jamie Stone (who pioneered scooter and Aqua-Sun light use in cave diving) and John Harper, also worked in this area and was involved in adapting nicad batteries for scooter use. John Zumrick, Dale Sweet, Steve Foreman, Sheck Exley, Mary Ellen Eckhoff, Main, Louis Henkel, Dave Manor and Paul DeLoach were others who contributed greatly to cave diving during these halcyon years, according to Main.

One prominent dive which Bill recalls as having occurred during 1977 or 1978 was made by Louis Henkel, Dave Manor, and Terry Leitheuser in the Green Sink System. This team dove beneath the Suwannee River and crossed a county line in an underwater passage of Green Sink; both events being firsts according to Main.

To return to the saga of Sullivan Sink, Main solo double-staged at the site on February 23, 1980 and added line from the terminus at 2800 feet to 3200 feet. It was at this point that Main recorded in his long "hope to stage soon on motor." Obviously, as his experience and ability increased, he was preparing for longer, deeper and more demanding cave dives.

March 22, 1980, found Main, Zumrick and Paul DeLoach at Jackson Blue Springs for a five-stage dive. The dive was completed without incident and was a maximum staging effort for Main and the team at that time. April 18, 1980 was the date when Main discovered a new (at that time) section in the Devil's Eye system in the area past Hill 400. He was diving with Greg Flanagan at the time of this discovery.

Mary Ellen Eckhoff and Bill dove at Die Polder Sink on April 27, 1980, and Mary Ellen dove to 290 feet in the cave. This was the deepest cave dive by a female at that time according to Main. Another female diver (Ryschkewitsch) also made very deep dives at Eagle's Nest at about this same time, although Bill was unable to report specific depths on her dives as he was not present for them and consequently does not have them recorded in his log.

During May, 1980, Main and Flanagan were diving in Manatee Springs in a series of dives for the U.S. Army Corps of Engineers, and on June 6, 1980, he and Clark Pitcarin swam to the end of the line (4120 feet) in Madison Blue Springs and added 790 feet of line on a triple-stage dive. Soon thereafter, on June 20, 1980, a significant dive occurred at Madison Blue Springs when Bill Gavin and Main set up a dive by swimming in two stage bottles each at the site. They breathed off one stage bottle so that they could go the distance to "plant" the other bottle which each carried.

They each placed one cylinder just beyond the Rocky Horror area and another at a linear penetration of 2800 feet, then exited. The following day, Saturday, June 21, 1980, Main, Gavin, and Mike Bowen began the primary assault together. Main carried one cylinder, breathing its contents, to the beginning of the Potters Delight area at 2000 feet plus, which is a considerable feat in terms of breathing rate. Gavin carried a full stage bottle to this point without using it. Bowen had only double 104 cubic-feet cylinders as his total air supply. At this point, Main exchanged his partially consumed single-stage bottle for the full sylinder carried by Gavin. Gavin and Bowen turned the dive (as planned), and exited the cave, taking Main's used stage bottle with them.

Main then placed his full stage cylinder at the entrance to Potters Delight (to be used on the return trip) and switched to his full supply of air contained in double 104 cubic-foot cylinders, which were still unused on his back. Main then swam, breathing very conservatively, through Potters Delight and Rocky Horror, picking up the stage bottle which he had set up the previous day in the area just beyond the Rocky Horror section of the cave. Switching to this cylinder, Main breathed it to 2800 feet penetration, then dropped it and picked up the other fresh cylinder previously placed for this purpose. Continuing the penetration, Main breathed the final stage bottle to one half of its capacity and once again switched to his double 104's. He continued carrying the last bottle (discounting the fresh cylinder left at the beginning of Potters Delight) to a penetration of 4912 feet, which was the end of the line and the point at which he dropped the cylinder. He then continued swimming, adding line to a maxi-

THE MAIN PERSPECTIVE: Murphey (cont'd)

mum penetration of 5355 feet, at which point he encountered a breakdown restriction, and, checking his air supply, found that he was a half plus 200 pounds. He turned the dive at that point and successfully exited the more than one-mile distance. The resulting dive profile included a three-hour dive followed by a 3½-hour decompression period.

During July, 1981, Main and Sheck Exley decided to explore the Manatee Springs system upstream from Friedman's Sink. They planned to proceed beyond the terminus of the then "end of the line," which had been placed by Louis Henkel and Dave Manor during 1978. Exley and Main believed that this penetration was in excess of one mile from Friedman's Sink and on July 24, 1981, a Friday night, Main and Exley swam in a two-stage-bottle set-up for the extensive penetration they planned.

The following day, July 25, 1981, they swam in more set-up stage bottles and finally, on the following day, Sunday, they made a remarkable five-stage dive, swimming to the end of the line at 5324 feet adding 600 feet of new line to a maximum penetration distance of 5914 feet. The dive took three and a half hours, with a four and a half hour decompression period, and on July 26, 1981, Main soloed in to successfully recover one of the stage cylinders from the previous dive.

On July 30, 1981, Main again soloed in to recover another of the cylinders and place a full cylinder. Then on August 1, 1981, Main and Exley installed additional fresh cylinders in a second set-up effort. On August 2, the pair began the "big push," which was a six-stage effort. Main called the die due to extreme fatigue caused by drag over his back-mount BC and dry-suit bulk.

On August 8, the pair again attempted the assault, and, swimming successfully to the end of the line at 5900 feet, they added new line to the incredible distance of 6867 feet. At this point Exley called the dive as he had reached his air turn-around point (probably due to the increased drag caused by his two buoyancy compensators). Main, who was still 500 pounds from his turn-around point, had switched from his usual back-mounted BC and dry suit to a front-mounted BC and dry suit in order to maximally streamline himself, thus effectively extending his range. The extremely strong flow in the Manatee system had caused a noticeable drag on his wide back-mounted "wings" on the first (five-stage) dive, and had resulted in Main becoming exhausted and calling that dive prematurely. Thus, on the second (six-stage) push Main changed to front-mounted BC and dry suit, which effectively solved his drag/exhaustion problem. Later, Exley and Clark Pitcarin set the world's penetration record on a seven-stage dive at this same site.

On December 21, 1981, Main and Bill Gavin swam to the then end of the permanent line in Little River Springs (about 2600 feet) and added 30 feet of line to the permanent line from one of their safety spools. The dive was 100 minutes in length at a depth of 100 feet, resulting in a stage decompression schedule of 7 minutes at 30 feet, 23 minutes at 20 feet, and 66 minutes at 10 feet. Main states in his characteristically oblique fashion that at the maximum penetration point of the dive, the passage was extremely low and silty. (Author's note: It certainly is that, with minimal flow and a jelly-like maximally unstable silty floor in the passage.)

Again, on September 25, 1982, while diving with Bill Gavin in Thunderhole, new line was added to the end of the permanent line in the upstream section of this spectacular system. On October 10, 1982, Gavin and Main discovered a previously unexplored section of the Telford Springs system at the end of the then permanent line and placed an additional 500 feet of line. The following day the pair double-staged into the newly discovered section of Telford Springs and added an additional 1000 feet of new line, thus totalling 1500 feet during the two-day push.

Numerous dives with new line additions continued during the remainder of 1982, 1983, and 1984. Sometime during 1984 Wes Skiles discovered 1000's of feet of new tunnel in the Bonnet system and placed line there. Then on March 31, 1985, Vaughn Maxwell and Main, using the new Tekna DV3X diver-propulsion vehicle, penetrated to 3900 feet upstream in Indian Springs near Tallahassee, Florida, in a total elapsed time of only 29 minutes. The return trip took only 22 minutes and both divers were suitably impressed with the speed of the DPV's. Later, on April 14, 1985, Maxwell and Main motored to the Wakulla Room in Indian on a single-stage DPV dive, with an elapsed round-trip time of 70 minutes.

The next dive of significance for Main was in the company of Bill Gavin in Devil's Eye Spring. On May 18, 1985, these two divers, using the Tekna DPV's, motored to within 200 feet of the Henkel Restriction and followed the gapped line 200 feet to its end. They then pushed through the restriction and added line for several hundred feet to a large room. They then added 360 additional feet of line and stopped only because they had run out of line.

Again on May 19, 1985, they entered the system and rode the DPV's to the 2900-foot penetration point, parked the scooters, and swam to the end of their newly placed line. They then tied off to the end of the permanent line and added 680 feet of new line. With passages still going in several directions they once again stopped due to running out of line with which to mark the newly penetrated passages.

As this text is being written, two additional dives in Devil's Eye have resulted in Main and Gavin (May 25, 1985) using DPV's and single-stage cylinders to add more line in the new section on the upstream penetration in Devil's Eye. They eventually discovered that the passage ended in breakdown, at which point they tied off their newly installed permanent line and ventured into a syphon tunnel, adding line as they went. This passage appeared to continue, and on May 26, 1985, Gavin and Main swam to the Big Room in the new section, thoroughly explored the room and added line in several areas of the room and passages emanating from it.

This chronicle sheds light on the state of cave diving in Florida during the period of 1970-1985, from the viewpoint of one of the leading, advanced cave divers. No effort has been made herein to cover all dives in detail or to mention every event of significance in the political, organizational, training, research, legislative, or other special area of interest in cave diving.

Rather, the focus has been on a cave diver and cave diving at the absolute state-of-the-art cutting edge in Florida. With this as the purpose, a description of events in present in the hope that the extent and flavor of present-day cave diving has been gained by the reader.

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FACTORS TO CONSIDER IN THE DESIGN, SELECTION, AND APPRAISAL OF "HOMEMADE" CAVE-DIVING EQIPMENT - by Roger Werner

About the Author:

Roger Werner began cave diving in 1978. Since that time he has logged over 500 cave dives, totaling over 700 hours (logged) in the water. Roger has specialized in exploration, particularly in finding of connections between known sections of caves, and in locating new entrances to caves. He has accomplished this through careful surveying, and study of existing maps and maps he has made, and through the thorough scrutiny of known passages for side tunnels. Since 1978 Roger has discovered and mapped an additional 2000 ft of passage in the Peacock Springs system (Suwannee County, FL), 8000 ft of passage in Blue Spring (Madison County), and has connected two additional entrances to the Madison Blue system. Two completely new cave systems have been discovered, and second entrances have been located in each of these. Most recently, Roger has been involved in the design and manufacture of cave-diving lights and reels.

Abstract:

It seems that almost every cave diver goes through a "light-building" stage. It is not uncommon for a new caver to balk at the high prices of (nearly) custom hand-made equipment, thinking "I can build that myself--that's only a little bit of plastic, glue and screws, ..." Such a person soon discovers new meaning to the phrase "easier said than done!" Some craftsmen actually succeed at making equipment and continue for a while to supply the cave-diving community with equipment, until they eventually learn that when they count their overhead of tracking down suppliers, picking up materials, making mistakes, etc., they are working for peanuts--if not actually losing money. If they try to raise prices enough to reap a reasonable return for their time, effort, and investment, there is always someone ready to compete with lower prices. As a result, much custom cave-diving equipment is being built be persons with comparatively little of the experience and knowledge required to properly design equipment with the quality and reliability which the caving application merits. Secondly, much of the market for caving equipment consists of new cavers, who don't know what to look for or specify in the equipment they buy or do not appreciate certain features enough to pay their added cost. As a result, many features which should be incorporated in cave-diving equipment, are frequently omitted. Equipment often sells on its salability rather than its functionality or reliability. In a business environment it is simply not feasible to include features which the market does not support, i.e., which do not increase the salability of the product. The serious caving community will indeed always be indebted to those few dedicated craftsmen who, despite such an adverse business environment, have provided well-designed and well-built equipment at affordable prices.

An item such as a primary light is so essential to the enjoyment of cave diving that a new cave diver cannot wait for a substantial amount of experience before selecting one. It is hoped that through this presentation enough information can be gathered together into one place to aid the inexperienced diver in making an intelligent selection of equipment, and if such equipment is not available, he will then be able to specify a good design and/or intelligently discuss design issues.

PART I
GENERAL FACTORS TO CONSIDER IN APPRAISAL OF DESIGN AND CRAFTSMANSHIP

FUNCTIONALITY AND RELIABILITY

Functionality and reliability of equipment are such obviously important qualifications of equipment for cave diving that this report will not dwell on them.

USER-FRIENDLINESS or "SLICKNESS" OF DESIGN

HASSLE FACTOR: IS IT EASY TO USE?

Equipment should be easy to use. All unessential hassles should be eliminated by the design. The more hassles one can eliminate, the more enjoyable cave diving will be. Examples include polarized/keyed connectors for charging lights and a minimum requirement of tools for servicing the equipment. For example, it is easier to change a lamp if no special tools are required, than if one has to go get a screwdriver or wrench. Electrical contacts should be corrosion free and reliable. All electrical systems (both batteries and chargers) should include fuses to protect the systems in the event of inadvertent shorts. Such fuses should blow very rarely, but should be easy to replace when they do. Any assembly required at dive setup time should be kept to a minimum and, when unavoidable, should be simple.

IS IT COMFORTABLE TO USE?

Reels are a frequent cause of fatigue. They should be designed so that one can easily and quickly wind up 200 to 400 ft of line without undue fatigue or cramping.

LINE TRAPS, DANGLE/TANGLE FACTOR, STREAMLINING, BUOYANCY

In order to minimize the effort with which one moves through the water, equipment should be well streamlined. This is more important with higher speeds or currents. It is not easy to make a small reel or sealed-beam light head. Bigger lamps and reflectors yield more light but are harder to push through the water.

The author has yet to see a primary reel which does not abound with line trap areas and/or dangle far from the diver. A diver should be able to mount equipment snugly, with a minimum of danglies.

It would be best if all equipment could be neutral. That way it could be worn anywhere on a diver's system without upsetting his buoyancy or balance. It is a rare light which is neutrally buoyant. By including a longer canister, a light may be made neutral without increasing its cross sectional area and drag. Neutrality of equipment becomes more important as one tries to carry more stage bottles and/or dives at greater depths.

NEUTRALITY AND BALANCE

One cannot overstate the importance of neutrality and balance in cave diving. Although it is possible to dive with negative equipment, by putting more air in one's BC, the only real savings here is in trading additional rigid volume (e.g. longer light canister) for additional soft flexible volume (bigger BC inflation). The net result may in fact be more cross-sectional area and poorer streamlining (in addition to being further limited in other negative things which one can carry, such as stage bottles). Non-neutral equipment limits one's freedom to rearrange his rig. Neutral equipment may be worn anywhere without altering neutrality or balance. Non-neutral equipment alters balance every time it is added, deleted, or moved. Any danglies should probably be slightly negative or slightly positive so that they will hang in one position and not drift about.

GENERIC?

Will you be able to service it or will you have to find the maker every time it needs service? If it is a light, can you get lamps (or reflectors or test tubes) for it or do you have to look up the original maker? In other words, does the item have critical parts which are not readily available, without which the equipment is nonfunctional? Think of the auto parts you have had to buy at exorbitant prices from the dealer simply because you had to have them, and there was no other source. This is one of the advantages of buying home-crafted equipment over that which is mass produced by the big diving equipment companies. Home-crafted equipment is often easier to modify and maintain (e.g. you don't need injection molded parts). Naturally there will be some parts to any specialized cave-diving equipment which are not readily available at your local hardware store (e.g.

Equipment - Werner (cont'd)

light head bodies). This is where the manufacturer earns his money--by footwork to locate sources, and by going to considerable expense to own or access expensive machinery or to contract out the machine work. Hopefully such specialty parts are not likely to fail.

DOES IT LOOK GOOD?

In addition to the properties of FUNCTIONALITY and reliability, if others (especially non-divers) are to see one diving, it may also be important for equipment to LOOK good. This, of course, is not as important in any practical sense as functionality or reliability, but may be important for the impression it makes on non-divers (e.g., land owners, business and government officials). The only ways in which a non-diver can judge your competence or professionalism are by what he sees on the surface. If your equipment looks jury-rigged, he may begin to doubt your competence and the wisdom of letting you dive for him (or in his spring, etc.). Such impressions can have far more reaching effects than any amount of accident-free experience.

It is also well known in business circles that appearance and packaging often have more impact than other factors on salability. Bear in mind that good looks is nice to have, but do not be blinded by it.

Much can be done in the way of cosmetics with just a little extra attention to finishing surfaces at manufacturing time.

CRAFTSMANSHIP

Are there cracks around screws? Holes which are tapped too deeply, or screws driven in past the thread will tend to have cracks radiating from the screw in acrylic (Plexiglas). Polycarbonate (Lexan) looks very much like acrylic, is more flexible, and has a much greater resistance to cracking. It should be specified where cracking is a problem and high rigidity and hardness is not required.

All edges should be deburred. All machined plastic surfaces should be buffed to transparency.

"O" rings should be held in place by their groves. (If you don't think this is important, try imagining what it would be like if every time you took you regulator off a tank, the tank orifice "O" ring fell out.) This is a hassle factor consideration. With a good design, one will be able to visually verify all "O" ring seals.

Acrylic joints should have a minimum of bubbles and slop. Ideally, there should be no bubbles in a glue joint, but a completely bubble-free joint is rare. No glue should be visible on surfaces away from the joint.

Acrylic should be free of cracks and crazing (networks of minute cracks which one often sees in acrylic--particularly as it gets older, or has been subjected to greater stresses).

Welded aluminum is not necessarily water tight. Small pin-holes can be sealed with paint or other sealers. Generally, a weld should be uniform with no blobs or holes.

IF IT ISN'T PERFECT, CAN YOU MAKE IT PERFECT?

Many modifications may be made by the mechanically inclined consumer. This is frequently easier, simpler, faster, and less expensive than commissioning custom work. Examples of such simple modifications might include: changing the knob or cranking radius on a reel, modification of a reel handle, changing regular or alien screws out for thumb screws, drilling holes for mounting clips, or deburring sharp edges and points.

PART II
FACTORS TO CONSIDER IN THE DESIGN AND SELECTION OF A PRIMARY REEL

WINDING RADIUS

The speed with which one winds up line is a function only of the (1) angular velocity with which one turns the crank and (2) the radius on which the line is being wound. The winding radius is the distance from the center of the spool (spindle) to the point where line is actually winding onto the spool. As the line builds up on the spool this radius increases (and should never be greater than 1/2 inch less than the spool radius). As line comes off the spool the winding radius decreases--down to the spool core radius when the spool is empty. When the winding radius is small, one frequently finds himself winding furiously and taking in very little line (or taking line in very slowly). Small winding radii are tolerable for short stretches when one has plenty of time (such as gaps of 20 ft or less), but for long hauls it is good to be able to take in line fast--especially when there is a high current pushing you toward the line (e.g. Devil's Eye, Little River, Madison Blue). Also, the faster you can wind up the line, the easier it will be to maintain tension, thereby avoiding reel jamming and entanglement problems.

Winding radius is also important when laying line. Line will unroll more easily from a reel with a larger winding radius because the spool does not have to spin as much to lay a given length of line; hence, less drag is imposed on the diver laying the line. This is especially noticeable when the diver is near the end of his line and is in a hurry!

CRANKING RADIUS

The cranking radius is the distance from the center of the reel (spindle) to the knob or part one holds to turn the spool. There is in fact a relationship between this radius and the maximum speed with which a diver can comfortably turn the reel.

Generally, a smaller cranking radius facilitates faster cranking (more revolutions per second) but at the same time makes it more difficult to maintain a reasonable tension on the line. Ideally, a cranking radius should require only wrist motion. A cranking radius so large that it requires elbow motion, or even very extreme wrist motion, can quickly become tiring--but a very large cranking radius is usually accompanied by a large winding radius, thereby requiring fewer turns of the reel! Alas, one reaches a point of tradeoff between a large reel, for ease of winding up the line, and not too large, for ease of cranking and for good streamlining, anti-dangle, etc. Most knobs may be easily remounted by the mechanically inclined consumer, to effect different cranking radii.

KNOBS

A third factor to consider is the shape of the knob. A thin knob is easier to grab and hold than a large knob, but tends to wobble more. If the knob is mounted in such a way that a wobble does not interfere with line being wound up on the spool or degrade the reel's integrity, some wobble may be desirable.

Some gap reels come with cups to hold a finger tip instead of knobs. Consider which finger or fingers you would be using in such a finger-cup. It is nice to be able to switch off drive fingers for long hauls. Middle fingers and thumbs work well for such finger-cups. The finger-cup drive is only appropriate for gap reels and distances less than 200 ft (preferably less than 50 ft).

SPINDLES

Reel spindles may be either fixed or turning. Reels with fixed spindles hold the spindle securely at one end. The spool is mounted on the spindle (usually turning bushings mounted on spool), and a cranking knob is mounted directly on the spool.

Reels with turning spindles have bodies which hold the spindle in bushings on both sides of the spool (stationary bushings held in the reel body). In order to turn the spool, it is necessary for a crank to be attached to one end of the spindle outside the reel body, and for the spool to be keyed to the spindle inside the body. The crank turns the spindle, and the spindle turns the spool.

In either case the spindle should never wobble, and there should not be any chatter in the bushings. A spindle held on both ends will never wobble, but this sort of reel is more difficult to untangle when line

Equipment - Werner (cont'd)

jumps over the spool and gets wound around the spindle inside the body. Several designs exist to prevent or minimize wobble of fixed spindles. Such reels are easier to untangle when line wraps around the spindle because you have complete access around one end of the spindle. The spool is also easier to remove, since it is not keyed to the spindle. Since fixed spindle designs are much simpler than those with turning spindles, fixed spindle reels tend to be less expensive.

Chatter is a noisy vibration which often occurs at high speeds--usually when laying line (when the winding radius is getting small) and nearing the end of one's line. Chatter tremendously increases a spool's resistance to turning; hence, it is to be avoided whenever possible. Whether or not a reel has chatter is usually a function of the bushings and amount of clearance between moving surfaces (spindle, spool, housing).

TENSION IN LINE WITH THE ARM HOLDING THE REEL

Some of the most fatiguing designs include reels with which the tension of the line being wound up is not in line with the hand and arm holding the reel. Such an arrangement imposes a constant torque on the hand holding the reel in order to hold it straight to receive the incoming line. Even laying line with some of these reels can be tiring. In fact most of the reels I have seen lack this important alignment. I have yet to see a good solution to this problem. A spool mounted on one end of a stick is definitely not a solution, and in fact, immediately calls attention to the tension-alignment consideration.

LINE

A primary reel which holds at least 400 ft of line will probably be sufficient to get one to the first permanent line in any cave in Florida. Most gap reels will not hold this much line. A primary reel should also hold as much line as possible at a reasonable winding radius. Beyond the first 300 ft off the reel, a small winding radius and more line is preferable to running out of line at a large winding radius (especially when only 10 ft from the permanent line!). Also, when appraising spool core diameter, bear in mind that spools with larger cores are stronger than those with smaller cores (another tradeoff here!).

If you look long enough, you will hopefully occasionally find some virgin passage. In such cases it is very nice to have a reel which holds lots of line. It's not nice to have to turn around on line! Such line should be KNOTTED EVERY 10 FT. As a cave surveyor, I have no patience with those who fail to knot their line and lay unknotted line. Such a person has no right to look at any map. Laying knotted line is the first step of surveying. Surveying is the first step of mapping. Maps are very handy tools for looking for connections and shortcuts and learning the topology of the cave. Though there are relatively few cave divers who actually survey and map underwater caves, I know of none who are not interested in looking at the maps. Surveying and mapping is also never finished. There is no end to the detail which one could include with successive studies. Also, many well-trodden passages could do with resurveying. To lay unknotted line in any tunnel, new or old, is to do a disservice to the cave-surveying and mapping community and to all those interested in maps.

Now that the importance of knotted line has been established, let us consider the ramifications of knots in the line. First, the line is made bigger by the knots; hence the line guide (if there is one) must be large enough to accommodate the knots as well as the line. If one uses a solid-core braided line, the increased size of the knots will be much more significant than if a hollow braid or twisted line is used. The bulk of the wound line on the spool is only slightly increased.

To those who claim that the knots weaken the line: it probably does. But, consider the tension with which you lay the line vs. the unknotted test strength of the line. Most line laid in underwater caves in Florida is laid with a tension of less than 15 pounds. If line is chosen so as to be easily seen, this consideration alone brings us up to at least no. 18 line (170 pounds) and probably to no. 21 line. With line that strong, knots every 10 ft will not seriously jeopardize its reliability.

To those who would have used knotted line, but "didn't expect to be laying line": Why did you have unknotted line on your reel in the first place? One rarely expects to find virgin passage. It is something one should be prepared for--or not lay the unknotted line at all.

In order to avoid the dilemma of the diver with a gaping trunk passage in front of him and a reel full of unknotted line, it is best to carry only knotted line on all reels. Frequently when at the dive site, it is not convenient to knot line and load reels. Also, when you go back to the gaping trunk passage the next day, you will (hopefully) need more knotted line.

In order to have plenty of knotted line available for all occasions, I propose the LINE BANK reel. This is a reel capable of holding perhaps 3000 ft of pre-knotted line, which may be easily transferred to a diving reel. Such line may be knotted during the evenings and days when you wish you could be diving but other circumstances prevent it, but there is still time to knot some line--and you can enjoy thoughts of cave diving while doing so.

EASE OF UNJAMMING VS. PROBABILITY OF JAMMING

Returning to the subject of primary reel design: Many designs have been proposed to mitigate the problem of jamming. With many of these, it seems that the more anti-jamming design a reel has, the less often it jams, and the more difficult it is to unjam when it finally does. At one extreme is the fully enclosed reel, with the least likelihood of jamming, and no access to the spool in the event of a jam. Such a reel must have very close tolerance between the spool and the shroud that covers it. This tolerance limits how small (and hence how much) line you can hold on it. At the other extreme is the spool on the end of a stick, which is virtually jam free. If the line jumps over the spool, you have complete access to it. However, the stick is very fatiguing to hold (both winding up and laying the line).

Experience has shown that one of the best ways to prevent reel troubles is to ALWAYS keep tension on the line. When laying line, this is done by dragging a finger against the spool. When winding up, if you get ahead of the line (the line goes slack), you should stop until your reel has caught up with the line and you again have tension. (This is where winding and cranking radii are important!). Lack of tension is an open invitation to any line to jump over the edge of the spool. Another feature to consider is that the spool should never be loaded to within less than 1/2" of the outer edge. Line is just as inclined (frequently more inclined) to go over the side as between the sides of an overloaded spool. (One may cheat on this loading rule if the line is not to be wound up again (to be laid only). Still try to avoid loading beyond the radius of the spool, and make sure that it is tight!) For routine getting in and out of caves, any line beyond this last 1/2" radius can be a jamming nuisance, and should not be counted in rating how much line the spool holds.

CONVENIENCE VS. NECESSITY OF BEING ABLE TO HOLD LIGHT AND REEL IN THE SAME HAND

Many cave divers like to be able to hold a light and a reel in the same hand. This is certainly convenient, but by no means necessary. It is certainly better to hold a light in the hand holding the reel than in the hand doing the cranking (to avoid the light beam bobbing up and down--emergency flash style). However, there are other solutions. Granted one is heavily task loaded while cave diving. It is difficult enough for two hands to do the work of five, and it is convenient when one hand can do two things. Frequently though, divers let

Equipment - Werner (cont'd)

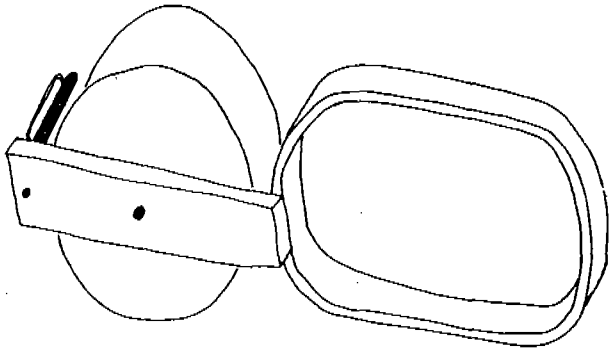
themselves get locked into one style of light or one style of reel just in order to preserve the light/reel combination. Other solutions to the light/reel problem include a Q-lite in the hood and light provided by the buddy.

IF AT ALL POSSIBLE, TRY OUT A REEL BEFORE BUYING IT

Probably the best way to appraise the ease of use of a reel is to try it out. Try winding up 100 to 400 ft of line at Little River or Devil's Eye speed. Can you wind the line, maintaining tension, at a reasonable speed? Is it tiring--where? Are these minor problems which you can easily remedy yourself, or is there something fundamentally wrong with the design?

A MODEST PROPOSAL

The design pictured in figure 1 is new and unproven, but note how it puts the reel hand in line with the line tension, and may be used with either a test-tube or projector light head (held on top) or a Goodman (sealed-beam) head (held sideways on the back of the handle).



PART III
FACTORS TO CONSIDER IN THE DESIGN AND SELECTION OF A PRIMARY LIGHT

CALCULATIONS

Batteries are rated in volts (V) and amp-hours. The volt is a unit of electrical "push." The voltage rating of a battery and that of the lamp it drives should be the same or nearly the same. If the battery pushes the bulb too hard (battery volts much greater than rated bulb volts) the bulb will burn out. Amps are units of electrical current. The amp-hour rating of a battery is a measure of how long the battery will provide a given current. For example (ideally) a 10 amp-hour battery will provide 1 amp at its rated voltage for 10 hours, or 10 amps for 1 hour, or 2 amps for 5 hours, or 5 amps for 2 hours, etc. How much current (amps) actually flows is a function of the resistance to that current. Resistance to current flow is determined by the load, which in lights includes principally the lamp, the battery at high currents, and to some extent the wire. In an ideal battery, the voltage will be constant throughout battery discharge and charge. Batteries are not rated in amps. Almost any cave-diving battery will provide anywhere from 0 to 100 amps for varying lengths of time.

A water analogy to the battery system exists in most municipal water systems. The vertical depth of water from your kitchen faucet to the level at the top of the water in the city water tank is virtually constant. How fast the water flows out your faucet is a function of that depth and your faucet valve position (resistance to flow). Given constant valve position and constant water depth, the flow rate is virtually constant as you drain the city's water supply, until the tank empties. Then, as the pipe up to the tank empties, the pressure begins to drop, and it is only then that you begin to notice a drop in current. (Of course the city will probably commence charging the tank before you notice this drop in flow).

Electrical resistance is measured in ohms, and the resistance element in a light is the lamp (bulb). It is primarily the lamp resistance, and also smaller resistance contributions from the wire, contacts, and battery, that determine the current when the light is turned on. The current which a lamp will draw may be determined by dividing its rated power, in watts (W), by its rated voltage. For example, a 30 watt 12 volt lamp will draw 30/12 = 2.5 amps when driven at 12 volts; a 250 watt 24 volt lamp will draw slightly more than 10 amps when driven at 24 volts. If the lamps are overdriven (or underdriven), the actual current (amps) will be proportional to the voltage applied, and the actual power (watts) will be proportional to the square of the voltage. For example, the same 12V 30W lamp, driven at 15 volts, draws 2.5A x (15/12) = 3.125 amps. The watts output by the 12V 30W lamp at 15 volts would be 30W x $(15/12)^2$ = 41.875 watts. Note that at the same power, a lamp rated for half the volts draws twice the current; e.g., a 30W/12V lamp draws 2.5 amps when driven at its rated voltage of 12 volts, but a 30W/6V lamp draws 5 amps at 6 volts.

More useful quantities in rating batteries and lamps are "Watts" and "watt-hours." If one multiplies a battery's voltage rating by its amp-hour rating one gets its rated capacity in watt-hours. This is a measure of the total amount of energy the battery can store. Notice here that a 10 amp-hour 12V battery (120 watt-hours) has twice the capacity of a 10 amp-hour 6V battery (60 watt-hours). Ideally, a 100 watt-hour battery (of any voltage) should be able to drive a 1-watt lamp (of the same rated voltage) for 100 hours, or a 2-watt lamp for 50 hours, or a 25-watt lamp for 4 hours, or a 50-watt lamp for 2 hours, or a 100-watt lamp for 1 hour--given, of course, that the lamp is rated for the same voltage as the battery.

To match lamps, burn times and batteries, one must first match rated voltages (at least closely). Burn time is then a function of battery capacity (watt-hours) and lamp power (watts).

BATTERIES

It would be nice if these formulas worked exactly in the real world. Unfortunately, they don't work exactly. In addition to the lamp, part of the resistance to electrical current occurs in the battery itself. Some energy is spent in just getting the current through the battery. At low currents (low-watt lamps) this "wasted" energy is less significant. At higher currents (high-watt (bright) lamps), it becomes more significant. It is most significant in lead-acid batteries because they have relatively high internal resistances. Nickel-Cadmium batteries are highly-desirable due to their very low internal resistance, among other factors.

At this point let us distinguish between the rated battery capacity (figured by multiplying rated volts times rated amp-hours), and the actual battery capacity yield. Such yield varies with the discharge current. The higher the current, the less the yield. At very low currents actual battery yield may exceed its rated capacity. Most battery manufacturers will provide graphs showing the actual yield vs. discharge rate. Bear in mind when considering lead-acid batteries that most of them are rated at 20-hour discharges (uncommon in cave diving). For a lead-acid battery, 1-hour discharge yield is usually slightly more than half the 20-hour discharge yield (e.g. 9 amp-hours yield for a 1-hour discharge (9 amps for 1 hour) vs. 15 amp-hours for a 20-hour discharge (0.75 amps for 20 hours)). Due to their low internal resistance, the actual yield for NiCd batteries tends to be more constant (less dependent on discharge rate). Most NiCd cells are rated at 1-hour or 5-hour discharge rates. It is also not uncommon for a cell's actual performance to vary from its specifications.

An actual yield of 80-120 watt-hours is usually adequate for most cave diving lights. We have cave sizes and decompression to thank for these numbers. It seems

Equipment - Werner (cont'd)

the very big rooms (where one would burn a very bright lamp) tend to be very deep (where you won't be down long anyway). The shallower caves tend to be smaller, in which cases a 30-watt lamp is usually adequate; hence, one may use a dimmer lamp for the longer, shallower dives. There are a few caves which do merit brighter bulbs and more than 150 watt-hours of battery, but these seem to be in the minority. One must also bear in mind when sizing the battery that the brighter lamps are much more expensive and tend to have shorter rated lives than the dimmer (more sensible) lamps. The memory effect on NiCd's will tend to eliminate any rarely used capacity, hence a NiCd pack should be sized for a capacity which will be used. Lead-acid batteries should be selected with a rated capacity about twice the actual yield needed in order to compensate for the internal losses.

LEAD-ACID BATTERIES

Several types of sealed lead-acid batteries are available. One must distinguish between conventional and "deep-cycle" batteries. Conventional batteries, such as the one in your car and motorcycle batteries, are designed to be maintained at full charge at all times--never to be run down and then charged back up. For cave-diving lights one should use DEEP-CYCLE batteries. "Deep-Cycle" batteries are designed to be used (run down) and then charged back up. Common deep-cycle applications include marine batteries, recreational vehicle (RV) batteries (golf carts, etc.), portable lights, cordless tools, and many others.

The primary advantage of lead-acid batteries is their low cost.

Disadvantages of lead-acid batteries include (1) their relatively high internal resistance. For example, a 12-volt, 7.0 amp-hour motor cycle battery (84 watt-hours, rated), will drive a 30-watt 12-volt bulb for about 2 to 2.5 hours (note that this is not a 20-hour discharge rate), but a 100-watt 13-volt bulb for only 5 minutes (it died soon after this). A 6.0 amp-hour, 12-volt gel cell (72 watt-hours, also lead-acid , but a deep-cycle system) performed about as well with the 30-watt (closer to 2.5 hours), and drove the 100-watt bulb for 25 to 30 minutes. Another problem with the lead-acid systems is (2) they must never be stored in a discharged state. When such happens, a lead sulfate layer hardens on one of the plates. As a result the battery is very difficult to charge again. Thirdly (3), lead-acid batteries are rated for relatively few cycles (150 to 200 for most manufacturers--fewer for deeper discharge cycles). However, due to their low cost, lead-acid batteries may be most appropriate for many divers.

NICKEL-CADMIUM BATTERIES

Advantages of Nickel-Cadmium batteries include (1) a very low internal resistance (less wasted capacity); therefore, they are capable of driving the brighter lamps for longer periods of time. (2) They are capable of many more cycles (thousands if not abused); and (3) they may be stored for long periods of time (years) in any state of charge. After a long period of storage a NiCd cell may exhibit a temporarily diminished capacity, but it should return to near-full capacity after a few cycles. A major reason for the NiCd cell's longevity is the fact that its electrode plates never change phase. Both plates remain solid and don't dissolve and plate back during discharge and charge as do the plates in a lead-acid battery. NiCd plates merely change oxidation states. Most NiCd cells used in cave-diving lights have come from government surplus and still perform outstandingly. If we had had to buy them new, few of us could have afforded the lights they come in.

Disadvantages of NiCd cells include their very high cost. Many divers complain of a "memory" effect with NiCd's . Maybe I have just been lucky, in that I have never experienced that with mine. According to GE, "memory" is a problem primarily in situations where the battery is discharged to the same state and recharged repeatedly. Perhaps the depths of my discharges have been sufficiently randomly distributed. Another disadvantage might be that NiCd's do not hold a charge well for long periods of time (month(s)). My personal experience with sealed NiCd's has been that they will hold a charge all right for about a week at room temperature and months in the refrigerator.

Vented Cells ("Wet NiCd's")

The most common cell used in cave-diving lights is the vented NiCd cell (or "wet" NiCd's). Upon charging, these cells will vent hydrogen and oxygen. For this reason, water must be added periodically. (This diminishes their "hassle-free" rating--especially for the 6-cell batteries with 3 cells stacked on top of 3). For all electrolytic systems, it is best if the water is as pure as possible. Tap water and spring water are not appropriate. Distilled water is better, but even distilled water is not completely pure. De-ionized water is recommended. Several kinds of water are sold in grocery stores (including spring water, mountain-stream water, distilled, ozonated, organic-free, and de-ionized), so it is important to check the label.

Due to the high corrosiveness of the electrolyte (KOH) used in NiCd cells, all wiring should be stainless steel (no copper).

It has been a common practice in the cave-diving community to wait until setting up for a dive to charge a NiCd light. Such fast charging frequently leads to a breaking of the separator between the plates in the cells. Once a hole occurs in the separator, a short will eventually develop there, and the cell will "die." Slow charging is recommended.

Sealed Cells ("Dry NiCd's")

Sealed NiCd cells are perhaps the best cells currently available for use in cave-diving lights. Also, since they are sealed, they do not vent upon charging, and one never needs to add water (no hassle here). Since they are sealed, they must not be overcharged at high currents. Sealed cells are equipped with relief vents which should open when there is excessive internal pressure. If a cell is excessively overcharged and the vent does not open, the cell may explode. If the vent does open, some of the electrolyte will be lost, and there is no way to replace it. If the vent does not reseal, the cell will eventually dry out and "die." It is best to charge sealed cells only at low currents, and put the battery on charge after the dive rather than immediately before.

High-current sealed cells have recently become available, with about half the rated internal resistance of normal sealed NiCd cells. These cells also require a high charge rate (5.5 amps for 1 hour). Such a charger is expensive to build due to the high current alone. It must also be equipped with temperature-sensing cutoff circuitry to turn the charge off (or cut it back) when the cells become fully charged. It is also said that these cells do not charge well at low currents.

Sealed cells may be used in any position (install & forget), unlike the vented cells which should be charged and discharged only in an upright position (at least with the plates covered with electrolyte).

A primary advantage to the sealed NiCd cells is that their size and shape makes it possible to build batteries of 24, 36, and even 48 volts, without requiring an enormous canister. This both opens up a wider selection of high-power lamps, and also allows less current through individual cells when 12- or 24-volt batteries are run in parallel. This results in less internal losses and less electrical wear on the cells.

LAMPS ("BULBS")

When selecting a lamp for a light, one should consider many factors. One desires as much light as possible up to some point of diminishing returns. Candlepower and watts alone are sometimes misleading, for the brightness may all be concentrated in a small bright spot. Such "pencil beams" may be good for lobstering, or signaling long distances through air, but frequently are

Equipment - Werner (cont'd)

not as satisfactory as other systems for cave diving. Frequently the light output from a lamp is directly related to its rated power (watts). However, again, this may be a lot of light concentrated in a narrow spot or a wide and dim flood. Sometimes the beam pattern will be different underwater than in air.

The ideal beam will vary with the cave application. It is nice to have powerful floods or wide spots (250 watts) for BIG CLEAR rooms, however most batteries won't drive these lamps very long. Also, such lamps would be blinding in a small room or tunnel -- especially if used to read slates or tables! For poor visibility, a spot will be more appropriate than a flood, since there will be less backscatter. Spots are also more appropriate for tunnels than are wide floods. Even in a big room, a bright spot may be required to see across the room.

If a lamp is driven at higher voltages, it will burn brighter and whiter. Almost all lamps are overdriven in cave-diving lights (6V lamps at 7-8V; 12V lamps at 15V; 19,20,21V lamps at 25-26V). Overdriving a lamp also tends to shorten its life. This is not a great problem with many low-wattage lamps which have very long rated lifetimes at their rated voltages. Many high-power lamps, though, have short lives to begin with at their rated voltages. Beware of he who boasts of a light which will drive a 100-watt lamp for 3 hours or a 250-watt lamp for 1 hour. Will you be able to afford the lamps to fully utilize that battery capacity? If you can, where will you use it? If you use lower-power lamps, will you ever need all that battery's capacity? The battery is certain to be very heavy!

"Quartz-halogen" lamps are more efficient than conventional tungsten lamps, i.e., more of the energy is actually converted into light, and less into heat. The quartz light also tends to be whiter (less yellow) than the tungsten light.

LIGHT HEADS

Lamp styles commonly used in cave diving include "test-tube," sealed-beam, and more recently, projector lamps.

TEST TUBE HEADS

Of the light heads commonly available, test tube lights are the easiest to make, the least expensive (initial purchase), and are currently the only focusable head. They also have the least variety in lamps, and will occasionally require new test tubes and reflectors. Available lamps include: 6V/55W, 12V/55W, 12V/100W, 24V/70W. The test tube must be very uniformly blown, and good test tubes are of a thicker stock than the ordinary test tubes used in chemistry labs. Stainless steel reflectors will last longer than aluminum reflectors. Different reflectors also yield different beam patterns. Larger reflectors will reflect more light, but will also be more difficult to push through the water. Try to avoid a reflector which only gives a bright ring of light.

If you purchase a test-tube light, You will probably have to obtain both test tubes and reflectors where you got your light or from someone who makes one very similar to it. (Although lights of the same general style may look alike from a distance, they all are different from one manufacturer to another.) Contrary to what one who has not been through the light-building phase might expect, these reflectors are not readily available in your neighborhood camera shop.

Having never owned a test-tube light, it is entirely possible that the author has not come to realize their full potential.

SEALED-BEAM HEADS

The sealed-beam head is more complex than the test-tube head. Although it is easy to remember the general concepts of the design, it is also easy for the originally simple concept to evolve into a monstrosity. Much care, planning, and experience is required in order to develop a small sealed-beam head design (minimize forward cross section).

Sealed-beam heads come with handles on the back (to be held like test-tube heads, with standard reels), and with handles below, which one puts his fingers through (like a handbag), leaving the finger tips free for pulling. Some manufacturers provide both types of handles. If you are considering the latter type, see that your hand fits. Foam neoprene may be added for padding. This will make the handle tighter at shallower depths and looser at greater depths, due to compression of the foam. If handles are adjustable, the light head will fit a wider variety of hands.

Sealed-beam lamps offer a wider selection than the test-tube lamps. In the PAR 36 size, good lamps include a 30W/12V spot (4416--"hand-held spot"). This lamp produces a linear spot in air (if you shine it on a wall, its spot forms a line rather than a circle), but it gives a round spot under water. The rated life on the 4416 is 300 hours. It seems to last forever when driven by 12 NiCd cells (14-16volts). Other good sealed beam lamps include the 37.5W/12.8V (H7616 - quartz), 50W/12.8V (H7604 - quartz), and 100W/13V (4509 - aircraft landing). The 4509 has a rated life of only 25 hours, and burns out often. It is not significantly better than the H7604 (and draws more current). Sometimes even an H7616 will match or outshine a 4509. All beam patterns of the above mentioned sealed beam lamps are very similar. Some 6V lamps are also available.

One advantage to the sealed-beam light head, not found in others, is the instrument light. A second low-power (5-10 watts) lamp may be mounted in the back of the light head for use in reading tables, gauges, reading at decompression, or even extending burn time of the light when the battery gets low (one can turn off the main lamp and follow line using the instrument lamp).

One disadvantage of sealed-beam lamps is their large exposed surface area. When exposed to the water, they have been known to implode at depths of 180 ft and more. They have also been to over 250 ft without imploding (watch your fingers!). Completely exposed sealed-beam bulbs (with wet contacts) have been known to implode at the electrode nipples at 145 ft. Test-tube lights, on the other hand, have no problem going to 300 ft.

PROJECTOR-BULB (LAMP) HEADS

Projector lamps offer the widest selection of lamps. Good lamps include: 20W/12V narrow spot, 20W/12V narrow flood, 42W/10.8V wide spot, 50W/12V narrow spot, 50W/12V narrow flood, 75W/12V narrow spot, 75W/12V narrow flood, 80W/19V flood (this is very white, driven at 25V), 80W/21V wide spot (good for Manatee), 150W/20V flood, several 200W/24V and 250W/24V, and a 340W/36V wide spot. With such a selection there is a perfect lamp for every dive. There are also three or four very good general purpose lamps. With the exception of the 12V lamps, these lamps should not be driven at more than 12-13 volts or 25-26 volts. This being the vast majority of lamps with attractive specifications, 12/24 volt batteries (20 cells) are recommended rather than 15/30 volts (12 or 24 cells). (The 12V "Precise" series lamps look very good when driven by 12 cells, e.g. the 12V/20W (ESX), when driven by 12 cells outshines a sealed beam 4416 (12V/30W) driven by 12 cells.)

Projector lamps, offer a very white light which is very evenly distributed over their main beam (as one might expect since they were designed for use in projectors). Projector lamps also get very hot. In order to maximize cooling, projector heads should have walls of minimum thickness (and maximum thermal conductivity).

After years of using a sealed beam system, the author has changed to a projector system for his personal use.

CORDS

Cords may be exposed (naked to the water) or sleeved. A sleeve protects the cord from abrasion and also offers mechanical strength (of course, we know light cords never get pulled on!). An unsleeved cord exposes a light to potential leakage in the event that the cord jacket is pierced. Such leakage will not flood the

Equipment - Werner (cont'd)

light, but will be enough to get things wet (will probably cause test-tube or projector lamps to break). Water-blocked cable can be obtained, at greater expense, but is not as flexible.

Both straight and curly cords (like telephone cords) are available. Those who have the curly cords seem to prefer to them to straight cords. The author regards them as a tangle nuisance, but has never had one.

Underwater connectors are available for both cord systems, but are rather expensive. Test-tube and projector lamps (and maybe even sealed-beams) are fully capable of starting fires. When a light is not in use, it should be unplugged. If one does not have a connector on the cord, this requires opening the battery canister. This little bit of inconvenience has caused more than one diver to delay in unplugging his light. In one case such a delay resulted in holes burned in a BC and a wetsuit. When one considers what else it might have cost, the underwater connector (convenience, slickness) looks less expensive when regarded as fire insurance.

Underwater connectors also offer one the option of using different light heads and battery packs on the same dive.

Cord ports, or the fittings through which the cord goes from the water environment through a wall to the dry inside, should hold the cord tightly. The cord should not slip out if pulled. If the cord should pull out, the compartment it pulled out of will be flooded, with the full ambient water pressure. Such will probably ruin most batteries (except some sealed lead-acid batteries, when exposed to low pressures (less than 100 ft) of fresh water).

The wire and switch employed should be capable of handling the highest current expected (see lamp current calculations above). Wire sizes of 16 or 18 gauge will usually be adequate. Higher wire gauge numbers imply smaller wire and therefore more resistance, or less current-carrying capacity. A wire should have a maximum number of strands for maximum flexibility and minimum work fatiguing. This is most important near the terminations, where a wire gets most of its exercise.

CANISTERS

Double "O" ring seals have been common on canisters since the early '80's. This not only gives backup sealing of the canister lid to the light, but one of the "O" rings is fully captured. This is a precision fit. Due to the variability in diameters of acrylic tubing, one cannot expect any canister lid for a 4" tube to fit any other 4" tube. They are custom fit. One should be able to visually inspect the "O" ring seals to ascertain that the canister is sealed.

Not all clasps are alike. One may desire one type over another. Mounting of clasps is another way in which the experienced craftsman earns his pay. They must neither be too tight nor too loose when the lid is clamped down with the "O" ring(s) in place. Screw holes for mounting the clasps may also be drilled and tapped without going all the way through the canister wall (extra leak reliability).

Canister lids should be fitted with a cord-entry chamber. Such chambers were originally incorporated to separate switches from the explosive hydrogen atmosphere vented from NiCd cells. Such a chamber is still a good idea, even with sealed cells. It protects the batteries from water in the event that the cord leaks, and protects the cord from from the electrolyte in the event that the cells leak. Cord entry chambers are an example of a feature which is often omitted in mass-produced lights. They impose considerably more labor at assembly time--especially when used in conjunction with a sleeved cord.

NEUTRALITY and BALANCE

Next to stage bottles, a light is perhaps the most negative item commonly carried by cave divers. This does not have to be. A battery and canister system may be made neutral by lengthening the canister. This adds no more frontal drag and eliminates the need to add more air to one's BC (which does add more frontal drag) to compensate for a light's negativity. It would also be good for a light (or any other piece of equipment) to be well balanced, so that it may be worn in any position without placing a torque on the diver.

CHARGING

A hidden expense in the purchase of any piece of rechargeable electrical equipment (lights and scooters) is the cost of charging. Chargers ideally should be equipped with polarized connectors, such that it is impossible to plug the light in backwards. Ideally one should be able to plug in one's light in the dark. An ideal system will also prevent shorting out of either the battery or charger, but will still have fuses to prevent major damage if either is shorted out.

If you frequently require charging away from 110VAC power, it is possible to charge many lights off of automotive systems. It is a good idea, though, to include a deep-cycle battery (marine or RV) in any automotive charging system. Charging off an automotive battery will often lead to its premature failure (it is not a deep-cycle battery). 12V batteries cannot be charged off a 12V automotive system without the car running.

If you do not carefully consider the various charging configurations which you will need, it is also easy to end up with a great investment in different chargers and adapters. A few universal adapters (cord with your polarized connector on one end and color-coded alligator clips on the other) are handy to have anyway. If you have a charging system, you will probably find your buddies who do not have their own charging systems wanting to charge their lights off it as well. You may expect that they will not have the same connector standard which you have set up for yourself. Also, be careful not to run down the source battery(s) if you need it to start your car.

One system which seems to work well is a rheostat box (with ammeter) which can plug into an auto DC source or a DC source of the same voltage, transformed and rectified from 110VAC. With such a system the current monitoring and control unit can be used in both configurations, and one only needs the 110VAC-25VDC or 110VAC-12VDC adapter.

FAST VS. SLOW CHARGING

If you want your battery to last a long time, do not fast-charge it. Almost all manufacturers recommend a "C/10" rate for charging. This is a charge rate which, if 100% efficient, would fully charge a fully discharged battery in 10 hours. For example, a 6 amp-hour battery should be charged at 0.6 amps; a 10 amp-hour battery should be charged at 1.0 amp; a 100 amp-hour battery may be charged at 10 amps. Since the charging is not 100% efficient, it will often take longer than the calculated time to restore a full charge.

Lead-acid batteries may be charged in parallel and should be charged at a constant voltage of about 2.2 to 2.5 volts per cell (14.4V for a 12-volt battery). The charge rate will usually be greater than C/10 at the beginning of charge, but will taper off as the battery approaches full charge.

Nickel-Cadmium batteries should be constant-current charged at the C/10 rate. Faster charging is permissible up until the end of charge, when the charge rate must not exceed C/10. Since one is easily distracted and may be involved in something else (other than battery monitoring) when the battery reaches its end-of-charge state, it is best to simply do the full charge at the C/10 rate. Fast chargers should have voltage- or temperature-sensing circuitry to cut the charge rate back at the end of charge. Even with fast charging, some topping off at the C/10 rate is necessary in order to achieve a full charge. NiCd batteries should never be charged in parallel unless there is some current control on each parallel branch. Without the current control there is no way of knowing how the current will split. NiCd batteries should also not be stored in parallel, as they will discharge each other.

Equipment - Werner (cont'd)

IF POSSIBLE, SEE THE LIGHT PERFORM IN THE WATER

It is not always convenient to get a personal demonstration of a particular light in the cave-diving environment, but seeing how a light performs in an underwater cave is a far better indication of how well it lights things up than any amount of talk and demonstration in air.

OUTSTANDING SERVICE AWARD

Nominations are now being solicited for the Section's "Outstanding Service Award."

I. PURPOSE OF THE AWARD - to recognize long-term contributions on the part of individuals to the improvement of cave diving.

II. CRITERIA - Contributions to be recognized by this award should be those which improve the sport of cave diving, but which do not primarily or directly benefit the contributor. They must be long term in nature, rather than a single action, and should represent a sincere dedication to contributing to the enjoyment of cave diving by others.

III. ELIGIBILITY - Any person shall be eligible, regardless of whether a trained cave diver or a member of the Cave Diving Section. However, no one may receive the award more than once.

IV. PROCEDURE -

A. Each year nominations of potential recipients of this award shall be solicited from the membership through Underwater Speleology. [CDS members (only) may make nominations by sending a written statement to Chairman Steve Ormeroid, NSS-CDS, POB 950, Branford, FL 32008-0950 before October 15, 1985.]

B. The Executive Committee shall act as the selection committee and shall annually review the list of individuals who have been nominated in that year or previous years. Each year the Committee shall decide if, and to whom, the award should be given. The award shall be presented only when there is a truly outstanding contribution to be recognized.

C. The Executive Committee shall adopt a formal resolution incorporating the award. Said resolution shall include a description of the contributions being recognized, and shall be suitably framed for presentation.

D. The award-resolution shall be presented at the Winter Workshop.

BRANFORD DIVE CENTER NAMES MURPHEY DIRECTOR OF UNDERWATER EDUCATION

Gene Broome, Mayor of Branford and owner of Branford Dive Center, recently announced the appointment of Dr. Milledge Murphey as Director of Underwater Education and Cave Diving Instructor. Broome stated that Murphey brings more than 30 years of cave-diving experience and instructor ratings from CMAS, NAUI, PADI, NSS-CDS, and NACD to the position. In addition, he is a faculty member of the University of Florida and teaches scuba diving in that outstanding underwater education program. He is author of numerous articles on scuba and cave diving, is primary investigator in the study of diver personality types, and will speak on the topic "Cavern and Cave Diving Certification Standards in the United States" at I.Q. '85: The International Conference on Underwater Education in San Diego, CA, Nov. 21-23, 1985. Murphey is the General Manager for the National Association for Cave Diving at present and is an active recreational cave diver in his spare time.

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