Cave Diving Communications

by

Joe Prosser and H. V. Grey

Cave Diving Section of the National Speleological Society, Inc.

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ACKNOWLEDGMENTS

This book does not pretend to be a trailblazing epic of heretofore unheard-of methods of underwater-cave communication. It is, rather, a compilation, summary, and discussion of the techniques and knowledge that have been developed over more than three decades of cave diving in this country. As such, literally hundreds of people have contributed to this growing body of information—by adapting existing open-water signals for cave use, creating new and unique ones, and putting them all to the test in underwater-cave environments. In that sense it could probably even be said that there have been divers who have given their lives towards this end, by proving that certain forms of underwater-cave communication do not work.

Since its publication in 1977, the National Association for Cave Diving's (NACD) outstanding book, *Hand Signals for Diving,* authored by Claudette Finley, Jamie Stone and Carole Vilece of the "NACD Handsignals Standardization Committee" and with illustrations by Carol Vilece and Cathy Murray, has been the definitive work on cave-diving hand signals. It has been reprinted repeatedly and is so good that for a very long time no other text specifically on underwater-cave communications was deemed necessary. However, with the growing number of cave divers frequenting the caves, a need was seen for a more comprehensive text covering all forms of underwater-cave communication—including a discussion of reel, line, and line-marker protocols—to help standardize cave-diver education and use in the field.

The present work would not have been possible without the expert drafting skills of NSS Instructor Wayne McKinnon, who generously supplied all of the technical drawings for the chapters on light signals, touch contact, and lines and reels, and the illustration for the front cover. Once again we hit Wayne up for some professional-quality drawings, and once again he swiftly and graciously complied.

Acknowledgments would not be complete without a very special thanks to Steven Moore, John Wohlforth, and Rick Czar of PIP Printing in Venice, Florida for their invaluable efforts; and to Sergei Rachmaninoff, Sergei Prokofiev, and Daniel Elfman for their . . . moral support.

Joe Prosser, *NSS-CDS Training Chairman*
H. V. Grey

April 1, 1990

ABOUT THE AUTHORS

JOE PROSSER (NSS #24253) has been cave diving since 1966 and has explored underwater caves extensively throughout the United States and the Caribbean. He was certified as an instructor in 1971 and was one of the original recipients of the Abe Davis Safety Award for cave diving. He was also one of the first recipients of the ISCDA, the International Safe Cave Diver Award, which recognizes the completion of 1000 cave dives. From 1983 to 1986 he served as the NSS-CDS Training Coordinator, and was editor and principal author of the NSS Cave Diving Section's *Instructor's Training Manual,* which is now in its second edition. He has served on the NSS-CDS Board of Directors as Training Chairman since 1986, and in addition to making extensive reforms and advances to the program, has authored and edited the *Cavern Diver Course Instructor Guide, NSS Student Cave Diver Workbook,* and *NSS Cavern Diving Manual.* He has done extensive coordination of cavern- and cave-diving programs for other national scuba-certification agencies. He has also written numerous articles on cave diving and diver safety, and is a nationally published cave-diving photographer.

H. V. GREY (NSS #23062) began cave diving in 1982; is an Abe Davis Award Recipient; was elected for two terms to the NSS-CDS Board of Directors; served as NSS-CDS Publications Coordinator for six years; and was Editor of the Section's bimonthly newsletter, *Underwater Speleology,* for five years. Credits include coauthoring and -illustrating the *NSS Cavern Diving Manual;* chapters in the NACD's forthcoming cave-diving text, *The Art of Safe Cave Diving;* and numerous articles and cartoons on cave diving that have appeared in a variety of caving and diving periodicals.

NSS-CDS POLICY FOR CAVE CONSERVATION

As geological, hydrological, archaeological, and biological windows into the earth, caves have unique scientific, aesthetic, and recreational values which we believe should be preserved for future generations to study and enjoy. Although young geologically speaking, most caves have formed over the course of hundreds of thousands of years. Once defaced or destroyed, they cannot be repaired or replaced. A fragile cave formation, such as a stalactite or stalagmite, that may have taken thousands of years to develop, can be destroyed forever in an instant.

As members of the National Speleological Society (NSS) and the NSS Cave Diving Section, we pledge to do nothing that will deface, mar, or otherwise spoil the natural beauty and life forms in caves, wet or dry. The NSS-CDS motto is:

Take nothing but pictures,
Leave nothing but bubbles,
Kill nothing but time.

We urge you to do your utmost to dive "gently," to be considerate and protective of the caves. Pay special attention to "danglies" and stage bottles, so that they don't scar the floors, and use handholds sparingly and judiciously. We also ask you to respect the property rights of cave landowners by seeking permission to enter their property and abiding by their wishes. Some of the most beautiful underwater caverns in the world have been closed because of irresponsible behavior on the part of divers and other casual visitors. We urge you to do everything in your power to keep these natural sites beautiful and clean, and to continue the welcome that divers still enjoy. We hope that by setting a good example, we may stimulate others to good conservation habits and attitudes, and so preserve this wonderful underground heritage.

PREFACE

A cave-diving buddy of mine once confessed that secretly, deep down inside, he was actually kind of glad that voice communication systems were not yet a practical reality for sport diving; that that's what he went cave diving for in the first place: a little peace and quiet. No talkingl A laudable sentiment no doubt—unless you just happen to get separated from your buddy off the line in a total siltout, or get yourself so idiotically entangled that you can't even signal with your light, or blow a critical O-ring just as your buddy disappears beyond the next bend.

That effective underwater voice communication would be a tremendous boon to all facets of cave diving is undeniable. I'm sure that all of us, even that antisocial cave-diving buddy of mine, eagerly await the day when it might become a reliable and affordable reality. Think of the tremendous help it would be just on routine training and sightseeing dives, let alone, in advanced exploration, surveying, photography, and scientific study and documentation.

However, until such halcyon time, we are obviously forced to rely upon our current forms of visual and tactile communication. Even if underwater voice communication does become widespread, there will still be some aspects of underwater-cave communication, such as reels and line markers, that will remain visual and tactile. And a final, inevitable consideration will be that, in the event of the failure of any sophisticated voice system, we must have a comprehensive, practiced form of backup signals.

We need to say a few things about the limitations of this book. First of all, the techniques suggested in it are by no means the final word on the subject. We are presenting a way of communicating in underwater caves, not *the* way. We have tried to present signals and systems that are commonly being used and taught in the United States, and that are, at least in theory, basically logical and consistent. But you are certainly at liberty to use any sort of system that works well for you and your buddies. The only criteria that are really important are that 1) you *have* a comprehensive system of visual and tactile signals, 2) all team members are thoroughly familiar with it and agree upon it before the dive, and 3) all team members practice it regularly enough so that they will be able to perform and understand it even in an intensely stressful situation—because, unfortunately, that's the time when communication really becomes critical. Obviously, using a simple, logical, and widely standardized system of signals will facilitate

this, but it's not mandatory.

The second limitation is that this book is written not for the general public, or even for the general diving public, but for cave divers and student cave divers—or more precisely, for people who have had, or who are in the process of receiving, cave-diving training under the guidance of a certified cave-diving instructor. This book is intended to serve as an adjunct to that training and in no way as a substitute for it.

And that brings us to the third limitation, which is that this book is only a book. It cannot shout at you, hit you over the head, tie you up, or in any other way—other than the oh-so-flimsy method of rational discourse—dissuade you from attempting to use these techniques in a cave without the proper training.

We hope that if you are reading this from a perspective lacking cave-diving training, you will appreciate the gravity of our warning, if only from a sort of indirect inference from **the kinds of things that are being communicated about,** such as *total loss of visibility, line entanglements, disorientation, air failures,* and the ultimate nightmare—*being lost off the line in a complete siltout—a* thing that can (and unfortunately all too often *has)* happened very easily to people with no training, even just right inside the entrance of a nice, "innocent-looking" cave. (And if that doesn't convince you, hold this book ten inches directly above your head and let go.)

"Drowning" is believing. In a course under a certified instructor you will be allowed to "drown"—to realize that if that training drill had occurred under genuine cave conditions, you surely would have drowned. Our accident statistics and analyses point to a lack of training (or in a few cases, ignoring one's training) as the fundamental contributing cause of death in the overwhelming majority of underwater-cave fatalities. The real tragedy is that nearly all of these accidents could have been easily preventable, just with the proper training, proper equipment, and some self-control.

Our interest is in your diving safety, efficiency, and enjoyment. We have gladly volunteered our time and efforts in writing this book in the hope that the information presented will enhance your cave-diving learning process and overall cave-diving safety. But you have to do your part, too, and use good judgment in applying it.

Safe diving!

H. V. Grey

Chapter One
INTRODUCTION

Years ago while diving an ocean blue hole in the Bahamas, the authors of this book had a rather amusing "failure to communicate." Prosser was in the lead and spotted his first underwater-cave shark. He circled it with his light to draw Grey's attention to it. The viz wasn't so hot and, being off a few feet to one side, Grey didn't see the shark, only the circling light motion, which ordinarily means, "I'm okay." Grey thought, "Well, that's nice. I'm certainly glad you're okay—I mean, I can that see you're okay. But, since you asked, I'm okay, too"—and made an answering circular light signal. Prosser thought, "Well, gee, I guess if my buddy's not worried about the shark, then it's okay to keep on going . . ."

Fortunately, of course, it was a very courteous, gentlemanly shark, and the dive proceeded without incident. Most failures to communicate in a cave in fact do not have lethal consequences, and there probably isn't a cave diver alive who can't relate some ludicrous tale of comical misunderstandings underwater. But it should be more than clear that the potential for disaster certainly exists.

For example, despite all precautions to remain properly oriented, arguments underwater about which way to go to exit the cave are not as uncommon as one might hope. Occasionally they have tragically resulted in a team splitting up and only some of the buddies making it out alive. While this is certainly preferable to having all of the divers drown, it does point to the some of the limitations of nonverbal communication. It may be impossible to try to explain your reasons for favoring one direction over another using only one-handed signals, and there isn't always the time or visibility, or even the space, to hold an extended conversation with slates.

Underwater-cave communication begins on the surface, when

the first general plan for the dive trip is discussed. Having a well-formulated dive plan, contingency plans for options with which you can reasonably expect to be presented, and special customized, prearranged signals for any kind of safety drills, surveying, photography or scientific work you intend to do, can remove a lot of the guess work from underwater-cave communication. On a routine sightseeing dive with no complications whatsoever and no deviations from the plan, you may not have to communicate anything more exciting than an occasional "I'm okay, are you okay?" and "It's time to turn the dive around." But the name of the game in cave diving is "What if... ?"

Cave signals must be reviewed and practiced frequently, preferably with the people with whom you plan to dive. It's all too easy to simply forget specialized signals and even generalized policies that you rarely have occasion to use, especially when you're task loaded, tired, scared or otherwise stressed out.

This brings us to a second major category of underwater-cave communications. If you haven't agreed with your buddies in advance on the hand and light signals and methodology of reel and line-marker placement you are going to use, you have nobody to blame but yourself. However, it is not always possible to discuss the configuration and significance of lines, line markers, and even temporary reels that you may encounter in a cave, with the people who installed them. Philosophies differ as to the best way to lay and mark line, how to handle multiple teams in the cave, and whether or not to gap or "tee" side tunnels, etc. (As the immortal British cave-diving pioneer Will Shakespeare once wrote, "To tee, or not to tee,—that is the question"—and the controversy has been raging ever since.)

In the chapter on lines and reels we have proposed the basic protocols that have gradually emerged through years of experimentation and refinement, and are becoming the standards taught in NSS-CDS cave-diving courses. We believe these to be relatively straightforward and essentially logical and consistent, and, as the cave-diving population grows and greater numbers of divers visit popular sites, we recommend their general adoption where practical in order reduce the chances of misinterpretation. But we have also attempted to describe other differing systems and philosophies which you might encounter in your travels.

When in doubt, err on the conservative side. If you are not

sure of the meaning of a strange but tantalizing line marker, don't take any chances with it. Exit the cave by the known, guaranteed route—that is, the way you came in. If you should have reason to suspect that another team of cave divers (or worse—open-water divers!) might have rudely or stupidly taken advantage of your temporary line without prior arrangement, don't risk their deaths by removing the reel. Better to be put to the extra trouble of a reel-recovery dive than a body-recovery dive.

And a final word on the temptations of ego. It's always embarrassing to have to admit to ignorance or forgetfulness, but it won't kill you. It is much better to ask for a repetition of a message, or if that fails, to indicate non-understanding, than to feign comprehension. Some messages are not critical or particularly relevant to the safety aspects of the dive and it won't matter if you can't understand them; but some are (after all, not all sharks are well behaved). But you can't know which are which; only the person sending the message can know that. If it's only an incidental comment, he can decide whether to keep trying to explain it to you or just to forget about it. But if it *is* important, he'll know that he hasn't gotten through to you yet.

It's certainly possible that your buddies may decide never to dive with you again—or even speak to you again—because you hadn't reviewed your hand signals lately and forgot one. But it's much more likely that they will refuse (and with good reason) to dive with you if they find out that you have put your ego ahead of their safety.

Chapter Two
SOUND SIGNALS

There are some real problems with using sound for communication in underwater caves. In close quarters, the noise of reverberating exhaust bubbles can tend to overwhelm any other sound. The walls, floors and ceilings can alternately absorb or distort meaningful signals past recognition. And while water conducts sound waves more efficiently than air does, sound is still quickly lost in convoluted passageways. High flow will have the same effect as wind, and literally sweep the sounds away.

Even such a simple open-water attention-getting device as banging on a tank poses problems in a cave environment. For starters, cave divers don't ordinarily carry the big macho samurai dive swords favored by ocean ninja divers, which they use to hit the tanks. Our lightweight forearm knives, or even tiny plastic line cutters, may not be heavy enough to produce a good quality tone, and other typical cave-diving implements such as primary lightheads, backup lights, reels, dive computers, or video cameras, are not generally designed with that kind of deliberate abuse in mind.

But it's certainly possible that you might be able to let your buddy know that you want his attention by banging on your tank. (If you're really clever you might even be able to tap out Morse Code messages to each other.) The problem is that—assuming that you've managed to overcome all the obstacles with sound transmission listed above—distance and direction to a sound source are extremely difficult to determine underwater. Although you may be able to hear your buddy, you may not be able to find him unless you can see his light; and if you can see his light, then you can probably see his light signal. It has been generally conceded that the superiority of light signals for attracting a fellow cave diver's attention makes audio signals for the most part run a very poor second.

Courtesy of Brent Potts ©1987 HV Grey

However, while you may not choose to try to communicate messages to your buddies with audible signals, sounds can definitely convey important, useful information. For example, the countdown alarm on a digital dive watch may be the sump diver's only method of keeping track of his bottom time in a particularly nasty, no-visibility sump. Under certain conditions it may be possible to pause occasionally as you swim and, ceiling conditions permitting, listen for air leaks from your equipment. The percolation of your buddy's exhaust bubbles or whine of his scooter will advise you that they are both operational. And a "singing" regulator will assure you of its user's proximity (although not necessarily of the state of its repair). The audible warning signals of "sonic regulators," on the other hand, which are activated at low tank pressures, are obviously of dubious value in most cave-diving scenarios.

It's not true that you can't ever understand talking through a regulator underwater. Profanity comes across astonishingly well. And there are a few cave-diving buddy teams around who seem to be so completely attuned to each other that they are able to comprehend some clearly enunciated commands that are shouted—or perhaps it's hissed—at each other.

But for the most part, with our current technology talking is simply not a viable form of communication underwater. And it's an even less viable form in "air" pockets. We have a suspected instance of a couple of open-water divers succumbing to the foul air in a cavern air pocket: it is thought that they might have drowned as a result of having lost consciousness while in the air pocket with their regulators out of their mouths. If an air pocket is large enough, you can certainly "surface" for a quick conference, but you are very strongly urged to breathe only from your own air supply. You you are cautioned to treat all standing air pockets and abandoned decompression troughs as potentially poisonous.

Courtesy of Dennis Williams ©1984 HV Grey

Chapter Three
LIGHT SIGNALS

A photographer we know has a sign outside his darkroom that reads, "Caution: Keep door shut or all of the dark will leak out." He claims that occasionally somebody'll fall for it. Well, be that as it may, it *is* true that occasionally people who know nothing about caves will ask, seemingly seriously, "You mean it's possible to cave dive at night? But doesn't it get awfully dark inside the cave?" (Uh, right. . . *What* college did you say you graduated from?)

But it's probably not fair to be too hard on them. After all, a lot of fairly intelligent people seem to have difficulty with the concept that what qualifies as a "cavern" dive* during the daytime, becomes a full-blown "cave" dive** at night. A lot of people also seem to have difficulty grasping the idea that small lights, which are adequate for night diving and cavern diving, are only good enough to be used as emergency backup lights for cave diving.

Cave-diving generally requires at least one very bright light, which we refer to as the "primary light." With a good primary, a cave with white or light-colored rock will be astonishingly well illuminated. A bright, powerful light also makes it easier to keep track of the line without having to be right on top of it at all times, to reference the cave passageways in both directions, to plan your swimming and buoyancy strategies well in advance, to keep tabs on your buddies, to have your buddies keep tabs on you, and to attract your buddies' attention should you need to.

But because primary lights *are* so bright, it is especially important to avoid temporarily blinding and destroying your buddies' night vision. Care must always be taken not to shine your light

*** which we define as a dive *within* the natural daylight zone of the cave**

**** a dive which is *beyond* the reach of daylight**

directly at your buddy's face. If you see your buddy looking in your direction, you can point your light down or off to the side to spare him the full force of the glare. This can be hard to remember to do sometimes when you are focused in on some other engaging task. But with frequent mental review it can become practically an instinctive habit.*

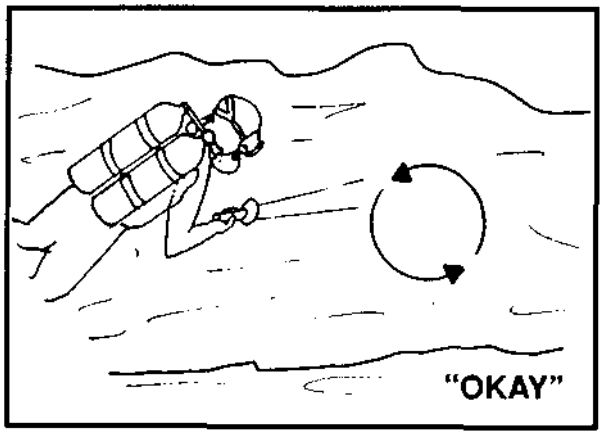
Courtesy of Jeffrey Bozanic © 1984 HV Grey

Care should also be taken not to make too many unnecessary, random, jerky movements with your light. These can be mistaken for light signals. If your light is constantly flashing around carelessly, your buddy will learn to ignore it, and when you really do need to get his attention, you may find yourself in the unfortunate position of the boy who cried, "Wolf!" Good cave divers try to keep their normal light movements smooth, slow, and controlled.

With this in mind, suppose you notice that your buddy behind you seems to be making light movements which, while they are clearly not a direct signal, are definitely more erratic than normal. As an alert partner, you will want to observe him more closely to determine if he is just making some minor adjustment or if this might be the prelude to a more difficult situation. Typically, the diver isn't concerned enough to formally signal you and halt the dive. But if you're alert, you can slow down and let him see that you're watching him and willing to pause for a moment if he so desires.

An important part of communicating underwater in a cave is being receptive to the communication in the first place. You can't just swim along in a coma and forget that your buddies exist. Being a good buddy is a lot like being a good friend: you have to meet your friends half way; you have to listen, not just hear. You have to care about the other divers—the other *people*—you're with,

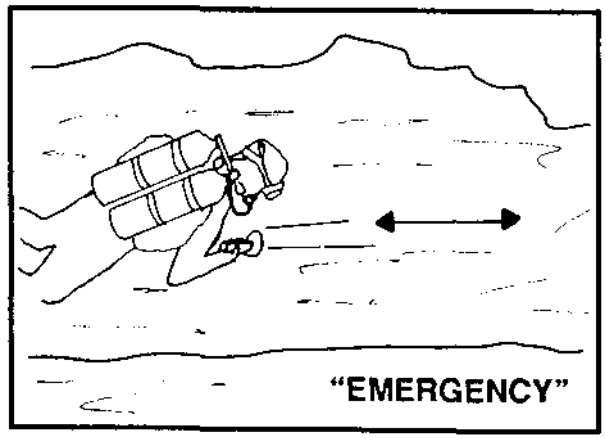
*** Divers who wear their lights attached to their helmets may have a more difficult time of this, because of the horse-blinder effect of masks, which makes it hard to see things without turning your head, and thus your helmet and light, directly towardsthem.**



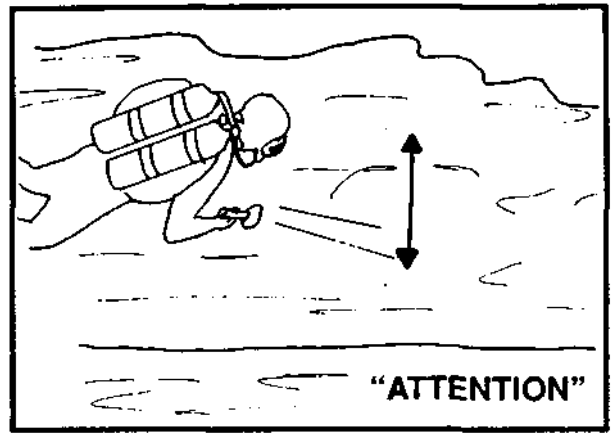
devoting some part of your conscious, and even subconscious, awareness to their presence and well-being throughout the course of the dive.

There are really only a few basic light signals. There is the slow movement of the light inscribing a moderate-sized circle (in either direction) on the wall, which indicates either, "I'm okay, are you okay?" when it's the initial signal, or "Yes, I'm okay, too, thanks for asking," when it's the reply. If you circle and do not get a response, it behooves you to find out why. Failure to respond may mean anything from your buddy not having seen you because he was looking elsewhere, to him not having seen you because he's unconscious. Ordinarily, however, this circular "Okay" is something that you do in the smooth course of the dive. One does not ordinarily vigorously signal for his buddy's attention only to perform this routine "Okay" signal.

The signals for "Emergency" and "Attention" are performed by vigorous flashing movements of your light beam. In the *NSS Cavern Diving Manual* we specified a horizontal flashing as meaning "Emergency!" versus a vertical flashing meaning merely "I want/need your Attention." The problem is that an emergency situation is, after all, an emergency situation—of potentially both imminent and eminent pro-



portions. The diver doing the signaling may be in a such a state of anxiety that he has completely forgotten the existence of any such distinction between vertical and horizontal movements. In addition, the cave configuration may not always allow for visible flashing in the desired direction, and in practice, even for non-emergency situations, it seems that there is frequently little or no attempt to make the distinction in meaning by the direction of the flashing. You just flash however you have to to get the guy's attention. It would seem that, considering that in the worst-possible case your buddy could conceivably be only seconds away from inhaling his first breath water, it is probably the best to assume that all flashings are emergency signals until proven otherwise.

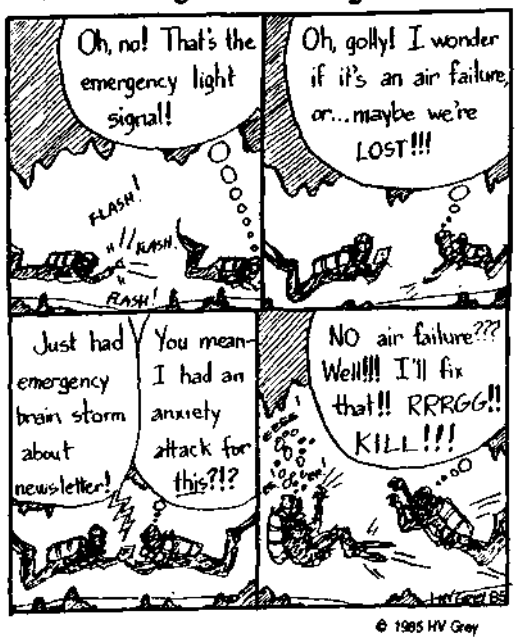


If, as your buddy starts swimming towards you, he sees that you now appear calm and are attempting to hand sign or point at something with your light, he will probably conclude that the message is not life-threateningly urgent. You may even want to give him the "Okay" signal just to reassure him that it is not a real emergency. Generally, several quick flashes followed by a steadily held light signal "Attention."

On the other hand, continued, intense—if not massive and frantic—flashings (or thrashings around, or huge quantities of air gushing from your tanks) after you have his attention will probably clue him into the fact that whatever it is, it's really important and you would be eternally grateful if he would beat it to you double time prepared for the worst. Consider also the possibility that your buddy may be trying to draw your attention to some danger affecting you. You may leaking large quantities of air unawares, or be silting up a storm behind you without realizing it, or even have taken a wrong turn into a nasty little side tunnel.

If you're in the lead and your message is not particularly

The Authors go cave diving . . .



urgent, you may not even need to perform the attention or emergency signals. You may only have to stop and turn side ways, and wait until you are sure your buddy is looking at you. Then you either begin hand signing, or use your light to direct your buddy's attention to some feature of the cave you want him to examine. If, on the other hand, your message is very urgent or you're immobilized (e.g., entangled in the line), the attention or emergency flash should start him on his way towards you posthaste.

If you're behind the diver you want to signal and his light is shining ahead on a wall, a good bet is to flash your light across his beam, since chances are that's where he's looking. If, on the other hand, you are in a system with dark walls which reflect very little light, or where there are no visible walls at all, it may be more difficult to flash him down. If he is experienced and has his wits about him, the lead diver will be aware of the greater difficulty of seeing your attention-getting light signals. He will know that he must take it upon himself to turn around and look at you more often.

Swimming through what appears to be a black void with no visible walls, floor, or ceiling, can be even more disorienting for the lead diver handling a reel. He is encountering it first and doesn't even have the object orientation of dim rock shapes or another diver to view. If it's a relatively deep void, he won't have his ears to clue him onto subtle depth changes, so he will have the added distraction of having to check his depth gauge fairly frequently, if not almost continuously. (Of course, if it's *that* big a void, there probably isn't too much reason why you can't swim along side by side.)

Limited visibility—and by that we mean anything from 30 feet, to 30 inches, to 30 microns—poses its own problems for visual communications. The poorer the visibility, the closer you must be to the line and, within reason, to your buddy. Even with visibility measured in feet, at close quarters your buddy's light will help guide you to him, where you can communicate with hand signals, or failing that, with touch contact.

Later in the dive . . .

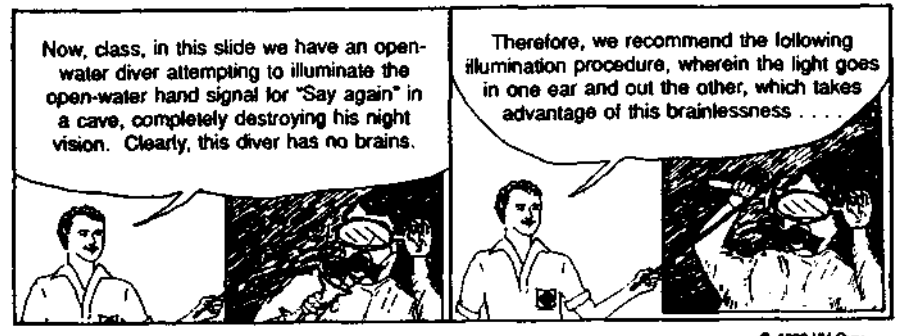
Assuming that you are not completely silted out and still have sufficient visibility to be able to see your buddy's fingers, the next step in communicating more complicated messages is usually hand signals.

Chapter Four
HAND SIGNALS

When one goes cave diving there is an implicit, or sometimes even an explicit, agreement that each team member is allowed to make certain demands upon the other members. The most important of these is the call for immediate assistance. The "Emergency" or "Attention" signal is usually performed with the light, although physically grabbing your buddy or anything else necessary to attract his immediate attention is also acceptable.

Other information may be just as vital, but less urgent, and perhaps more complex. To exchange information, cave divers have adapted and devised a number of hand signs. To be effective, these hand signs must be illuminated and care must be taken to avoid temporarily blinding a buddy while trying to sign to him. Furthermore, all members of the team must be included in the signing. When the team consists of only two people, exchanging information can be as easy as simply facing each other and signaling. Should the team involve three or more people and these people be traveling in single-file formation, the information must be passed from one diver to the next. Naturally, this exchange process is slow, and the more complex the message, the greater the likelihood that the message will be confused. This is why, typically, hand signs are used to convey only one or two ideas at a time. Even if the message is extremely complex, break it down into simple portions to be digested by the team before offering the next morsel.

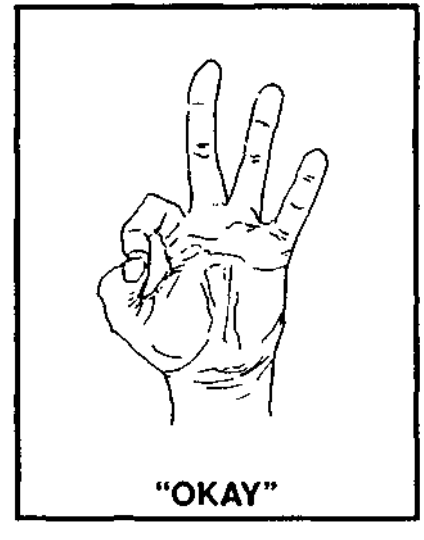
The basic vocabulary of commonly used signals is fairly simple and straightforward. It consists of what we call "command" or "demand" signals, which require a response and frequently an action; "response" signals, which are mandatory replies to command signals, and sometimes command responses of their own; and "information signals," which can communicate an impressive



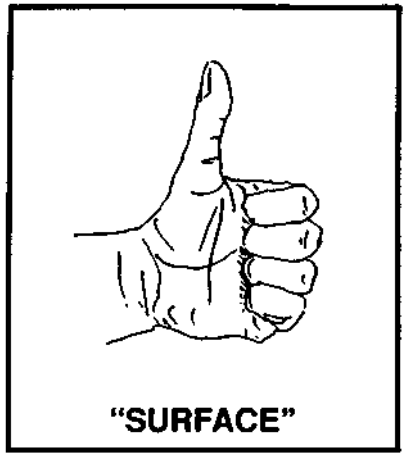
amount of both quantitative and qualitative information, and also sometimes have the force of a command.

The most common signal, and one which qualifies at various times under all three categories, is the "Okay" signal. Vital Alsar once wrote that during the six-month *La Balsa ran* crossing of the Pacific, one of the international team members was able to communicate almost any nuance of expression with the two simple words, "Oh, boy"—joy. sadness, concern, satisfaction, anger, skepticism—even hunger. Not to be outdone, cave divers attempt to communicate an almost equally impressive array of information and emotion with the ubiquitous "Okay" sign.

The technical meanings are generally defined as "I'm okay, are you okay?" "Yes, I'm okay, too," just plain old "Yes" or "All right, I agree," and "I understand." In actual practice, though, it may also be used to express anything from "Wow! This place is really neat!" to "Are you really sure you're okay??" to "Oh, yes, by all means let's go there!" to 'That's good" to "Yeah, yeah, yeah, yeah, I've heard it all before, so tell me something I don't know." The variance in meaning is differentiated partiallly by the context and partially by the manner of delivery.



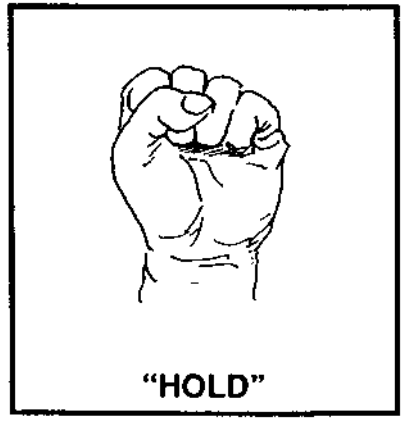
When your buddy initiates a conversation that starts with an



"Okay" sign, he is signifying that he is okay and asking if you are all right. In this instance, the "Okay" sign functions as a command sign and you must answer. If you are, in fact, perfectly all right, with no objections to proceeding with the dive, then the appropriate response is a return "Okay" signal. In these instances it makes no difference whether that "Okay" is delivered by light or hand.

Your buddy's failure to respond to your "Okay" is an indication either that he has not seen your signal or that he. is experiencing some sort of difficulty. Assume that a problem exists unless you have some reason to believe otherwise. A team of highly experienced cave divers who are negotiating a tight, silty restriction are obviously not going to expect to be able to see and hand signal each other at all times. But in large cave with good visibility, the failure of a buddy who is close by to acknowledge your hand signals and queries (or who acknowledges them improperly, with a nod of the head, for example) is cause for immediate concern. The dive should be stopped, the source of the problem investigated, and appropriate measures taken.

Other absolute, undisputed command signs are "Surface" and "Hold." "Surface" indicates that the diver is calling the dive and requesting that the team return to the surface. "Hold" asks for a temporary stop. Both of these can be initial signals, or responses to an "Okay" query. The diver receiving either the "Surface" or "Hold" signal should repeat it back to the diver initiating it to signify comprehension and compliance. If there are other buddies in the team, they should



be contacted and the process repeated, until all the team members understand that the dive is either being turned around or temporarily stopped. Both signals have the force of royal command and are not open to debate.

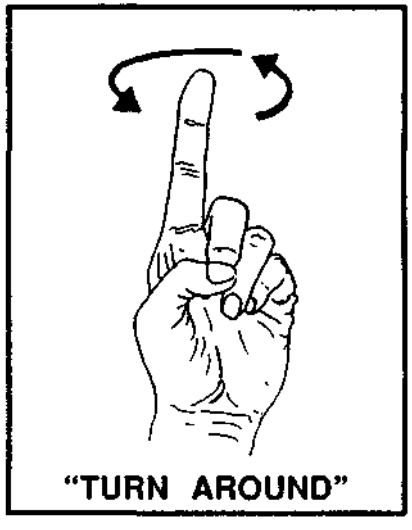
The Changing of the Guard at Neptune's Palace . . .

Both signals can indicate serious problems, however. If the dive is being called because one of the divers has reached his pre-established turn pressure, this is a completely normal event. After all, *somebody* has to turn the dive. But supposing the diver signals "Surface" because of the failure of a critical item of gear, such as a primary light, or because he is feeling scared or is physically exhausted. This additional level of stress places the team slightly more at risk. If the stressed diver's buddies are aware not only that a problem exists, but what it is, they will be that much more prepared to handle any additional problem that might arise as a consequence or to give moral support (e.g., by staying closer to the stressed diver, letting him see that they are watching him closely and are ready to lend assistance, etc.).

The calmness or violence of the "Surface" signal is also a pretty good indication that either all is well or something is wrong. With new cave divers, sudden attacks of the heebie jeebies are not uncommon. If such a diver signals fairly emphatically to turn the dive way before prearranged air or time turns, you may want to be alert for subtle signs of distress or difficulty.

There is one additional consideration, however. If a diver turns the dive, not because of air, but because he is feeling uneasy, due, say, to the penetration distance, that diver may, later on in the dive, indicate that he is now feeliing better about things and that it's all right with him if the team turns around and heads back into the cave. This may seem a little peculiar, but it has been known to happen, even two or three times on a single dive, especially with cave divers who are trying to be careful not to dive beyond their psychological limits.

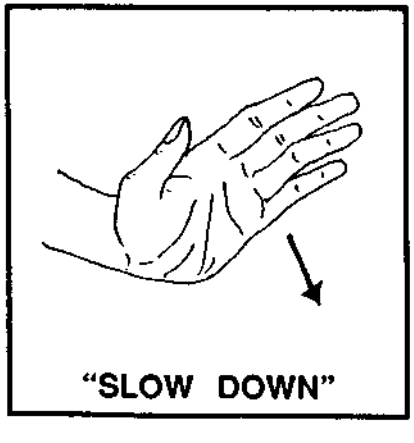
As long as the team is well within its air turnaround parameters (and the other divers are comfortable with the idea and


"TURN AROUND"

understand the reason for the original turn), this is perfectly acceptable. But *only* the diver who called the dive can make this suggestion, and only if the dive was not called for air or equipment-failure reasons. None of his buddies should ever pressure him into heading back into the cave. Nor should they allow the team to repenetrate the cave if they have any doubts regarding the mental fitness of any team member. No attempt to estimate new air-turnaround pressures should be made, however; the divers should adhere to their original turnaround pressures.

Note also that there is a distinct difference between the "Surface" command and the signal which indicates turning around in a particular passageway, but not necessarily proceeding directly to the entrance. The team may be investigating a side tunnel which becomes too silty or tight to suit the tastes of all the team members, and exploration can be redirected elsewhere.

People use the "Hold" signal to call for temporary halts during the course of dives fairly frequently. They may just need a few moments to adjust some bothersome piece of gear or to catch their breaths, or want to take a look down some intriguing side passage.


"SLOW DOWN"

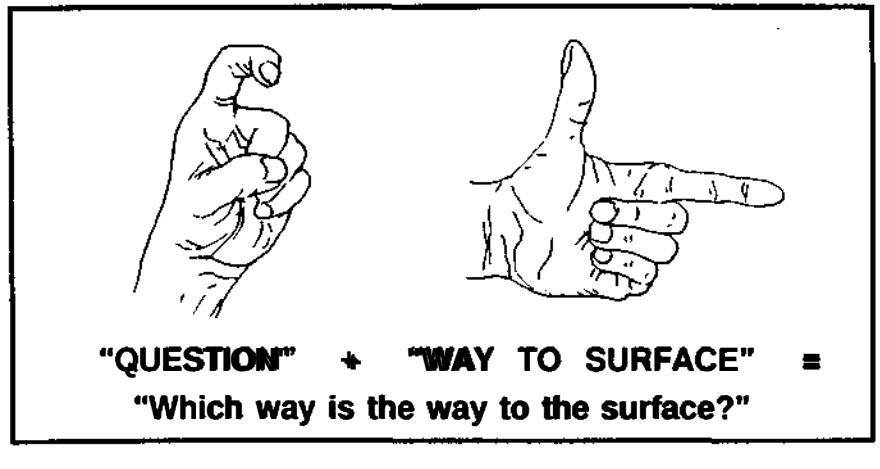
If your partner looks like he's trying to fix something, you may want to come over and see if you can lend a hand or shine a light, even if he hasn't specifically signalled for your assistance. If he does motion for you to come over, you should, of course, attempt to do so immediately. "Hold" halts the dive until the initiating diver either indicates that it's all right to proceed or turns the dive.

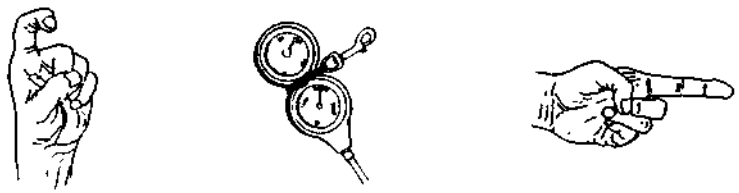
If a diver has called a temporary halt in order to catch his breath, the "Hold" sign may very well be followed by a secondary signal such as "Slow Down." While a "request" such as this does not have quite the absolute authority of "Surface" or "Hold," it is certainly polite to comply with it if at all possible. Remember, a diver out of breath is under considerable stress, as well as physiological insult, and this places the entire team at greater risk.

Another possibility, after the initial attention-getting signal, is that the diver may signal some kind of problem, question, warning, request, suggestion, or observation. Problems such as a line entanglement, air failure, physical injury, or difficulty with equipment which the diver cannot solve on his own, command the assistance of the buddy. Though the problem may not be immediately life-threatening, it may quickly upgrade to an urgency, or bona-fide emergency situation.

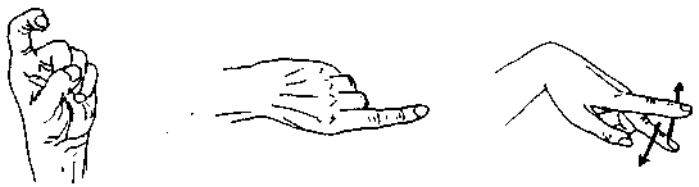
Warnings may be urgent or casual and concern anything from treacherous silt; poor silt technique; air leaks, large or small; strong flow; loose line; dangling equipment posing entanglement hazards or causing destruction to the cave; or going the wrong way. Warnings require proper acknowledgment, usually either with an "Okay" sign or repetition of the signal followed by an emphatic "Okay" sign indicating understanding of the serious nature of the warning, and, of course, appropriate behavior.

Questions such as "Which way is out?" "How much air do you have?" "Do you want to go that way?" "What is that?" "What is your decompression schedule?" or "What is your max depth/bottom time?" all require some kind of response. If you do not attempt to

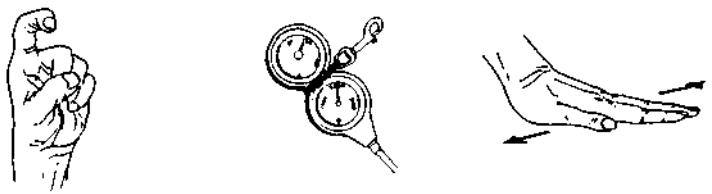

"QUESTION" + "WAY TO SURFACE" =
"Which way is the way to the surface?"



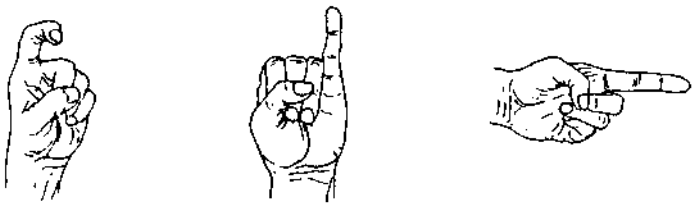
"QUESTION" + (point to pressure gauge) + (point to buddy) = "What is your pressure?" or "How Is your pressure with regards to turnaround?" [Precise meaning usually determined by context]



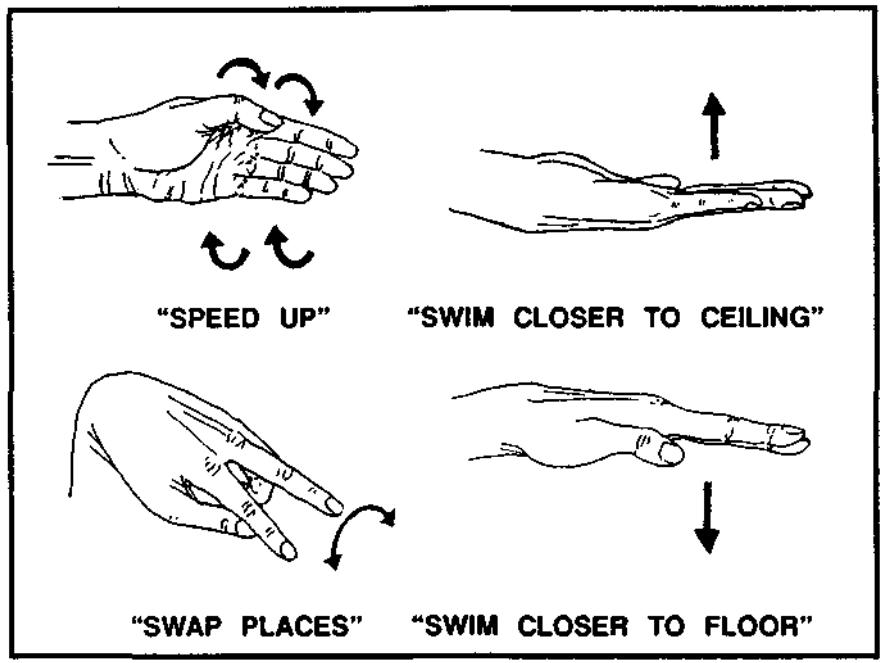
"QUESTION" + (point In a direction) + "SWIM" = "Do you want to go that way?"



"QUESTION" + (point to depth gauge) + "LEVEL OFF" = "What Is your max depth?" or **"Do you want to level off at this depth?"** [Precise meaning usually determined by context]



"QUESTION" + "DECOMPRESSION" + (point to buddy) = "What Is your decompression?"



answer these questions one way or another, the other diver is going to conclude that you are experiencing difficulties.

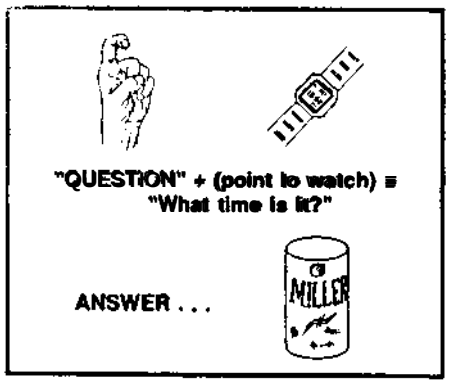
The distinction between requests and suggestions can be somewhat vague. Requests that you slow down or speed up, swim closer to the ceiling or closer to the floor, etc., do not quite have the force of command, but should certainly be given serious consideration, as safety issues (e.g., silting or hyperventilation) may be involved. "Let's swap places" may be either a request or a suggestion, which you may or may not wish to decline. If your buddy is not suggesting it merely so that you might better enjoy the cave (in a polite fashion, coupled with the query sign, that conveys, "Would you care to swap places?"), but has a safety reason in mind, he may become more insistent. This will usually be indicated by more emphatic gesturing implying a distinct reluctance to take no for answer. Compliance with such requests and suggestions should be indicated with a repetition of the signal or the "Okay" sign, followed by appropriate action. If you wish to decline a suggestion, such as swapping places, you should so indicate, so that your buddy at least knows that you got his message.

Observations require acknowledgment, usually in the form of

an "Okay" signal. Your buddy may be pointing out some interesting feature of the cave, such as animal or plant life, an unusual formation, a side tunnel, the strength of flow, a special location discussed on the surface, or organic debris indicating a nearby access or strong flushing of the cave. Or he may be calling your attention to some technical item such as a line marking or configuration, or reel placement. Or he may regretfully be pointing out some form of vandalism or accidental damage to the cave. The observation may either be made with a hand signal, pointed light beam, or some combination of both.

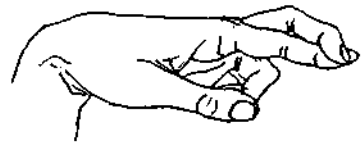
The communication of some of these problems, questions, warnings, etc., may be fairly complex, involving a lengthy series of signals. A question, for example, may begin with the "Question" sign, be followed by pointing to some item of gear, such as a pressure or depth gauge, then be further qualified by pointing to the other diver to indicate whose gear. The answer may involve a series of numbers, indications of being close to turn or being at maximum desired depth, desiring to go no deeper, etc.

Nouns such as "tunnel," "current," "bubble," or "problem," may be qualified by adjectives such as "big," "little," "bad," or "silty." Verbs such as "swimming" or "tying off the reel" may be modified with adverbs such a "slowly" or "quickly." The movement of items or divers from place to place can be expressed by describing a progression of objects and events in the approximate order that they would occur in the simplest, most straightforward of spoken sentences. For example, "You - hold here - I - operate reel - over there - tunnel - point to watch - small - hold here" equals "You wait here tor just a minute while I take a quick look-see with one of my jump reels in that tunnel; I'll be right back so just wait right here for me," with the further probable implication that if it looks good, he'll then motion you to follow. Although, with an experienced exploration team making a dive, the specific purpose of which is to check out side leads, it may be necessary to do no more than signal "Hold," if even that.



Courtesy of Joe Prosser © 1990 HV Grey

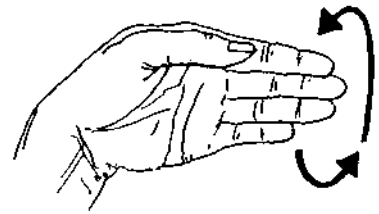
DICTIONARY — NOUNS



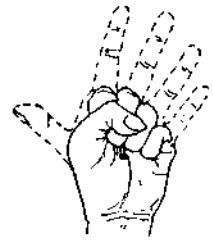
"LINE"

"GAP LINE"
May be used to refer to either a gap or jump line.

"KNIFE"
Make a sawing or slashing motion.

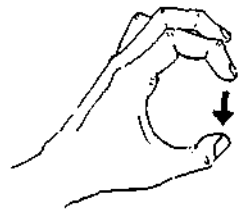


"REEL"



"LIGHT"

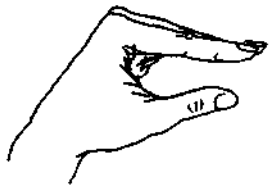
"TANK"
Make a motion at least a foot high, simulating a cylinder.



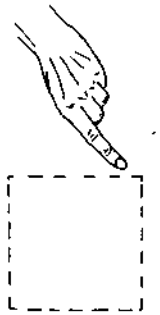
"CAMERA"

DICTIONARY — NOUNS

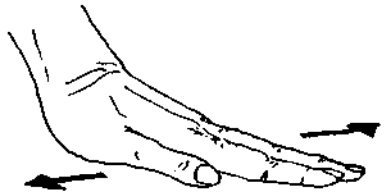
"TUNNEL"



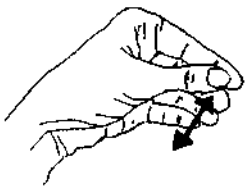
"RESTRICTION"



"ROOM"



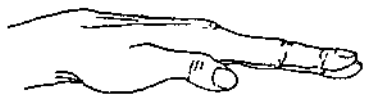
"BOTTOM"



"SILT"

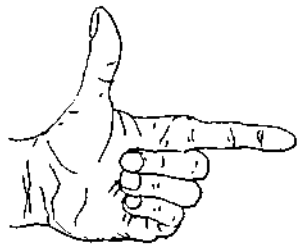
"CURRENT"

"WALL"
Move hand up and down to suggest a wall.



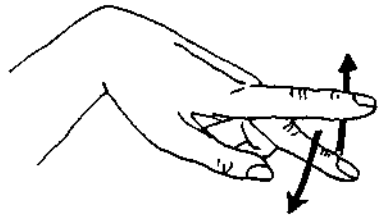
"CEILING"
Hold hand high and move it back and forth to suggest a ceiling.

DICTIONARY — NOUNS

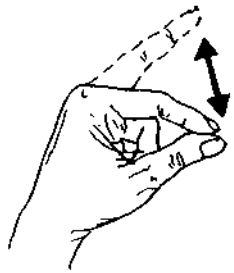


"DIRECTION TO SURFACE"

"BUDDY"

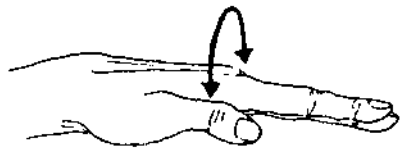


"DIVER / SWIMMER"



"BUBBLES"

"MUSCLE CRAMP"
Point to afflicted muscle and squeeze fist several times.



"PROBLEM"

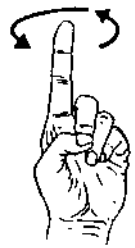
"DECOMPRESSION"

DICTIONARY — VERBS

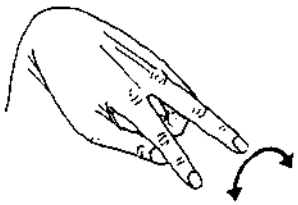
"OKAY"
Asks buddy if he is okay. Requires a response.

"SURFACE"
Commands dive be terminated. Requires acknowledgment and compliance.

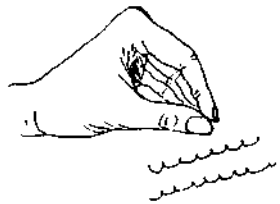
"HOLD"
Commands dive to be halted temporarily. Requires acknowledgment and compliance.



"TURN AROUND"
Commands dive be turned around in this particular passageway. Does not mean termination of dive. Requires acknowledgment and compliance.

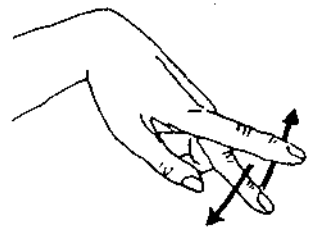


"SWAP PLACES"
Asks that divers change places or reverse order. Requires a response.

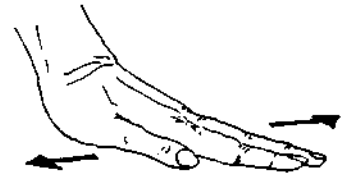


"WRITE DOWN MESSAGE"
Requests communication by slate.

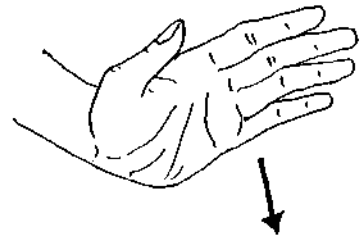
DICTIONARY — VERBS



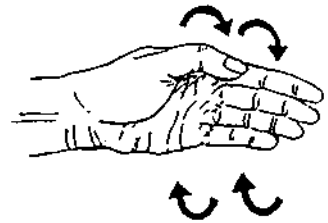
"SWIM"
May be used with directional references or questions.



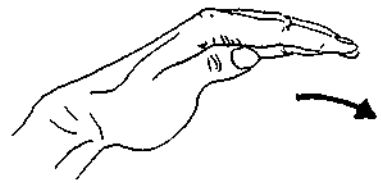
"LEVEL OFF"
May be used to ask that dive depth be limited to current level. May also be used to modity questions or statements concerning maximum depth.



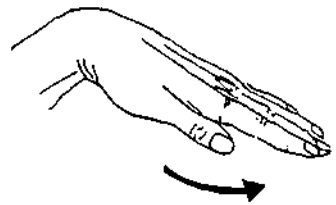
"SLOW DOWN"
Asks that pace be reduced.



"SPEED UP"
Asks that pace be increased.

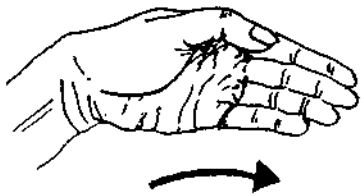


"GO OVER"
Directs diver to swim over some feature of cave such as a projection or line.

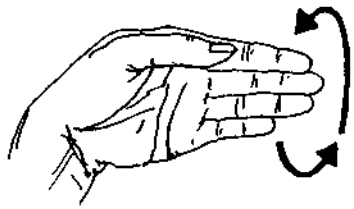


"GO UNDER"
Directs diver to swim under some feature of cave such as a projection or line.

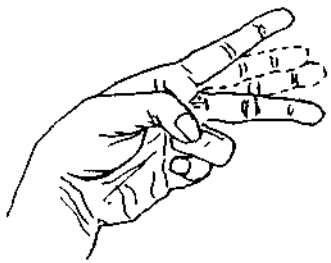
DICTIONARY — VERBS



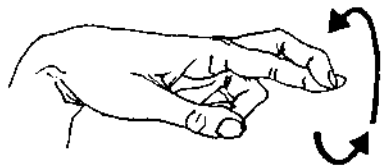
"GO AROUND"
Directs diver to swim around some feature of cave such as a projection or column.



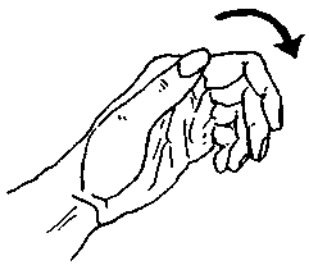
"REEL"
May be used to ask that diver operate the reel, either for deployment or retrieval.



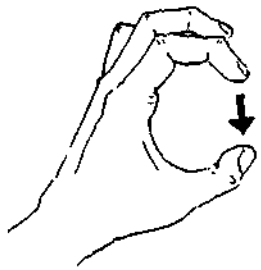
"CUT"
Directs that line be cut.



"TIE OFF"
Directs that line be tied off.



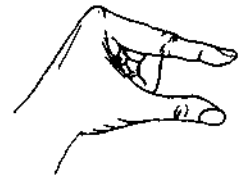
"TURN ON"
Directs that diver turn on some piece of equipment, usually a tank valve.



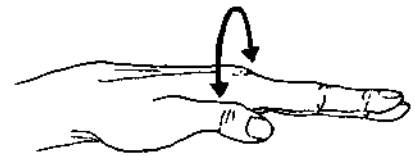
"TAKE PICTURE"
Refers to the taking of photographs, movies or videos.

DICTIONARY — ADJECTIVES

"BIG"



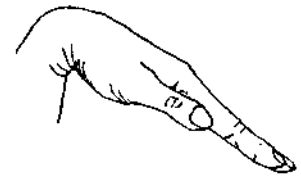
"SMALL"



"BAD"
Also used to indicate that a problem exists.

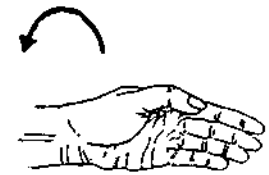
"STUCK"

"ENTANGLED"



"BENT"

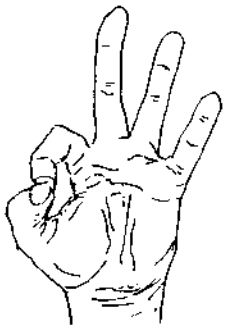
"OUT OF AIR"
Slashed across throat. Alternatives include chest thumping, regulator grabbing, etc.



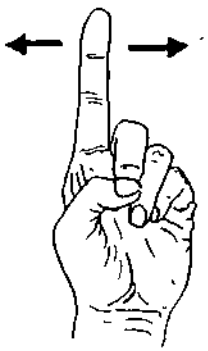
"BACKUP"

DICTIONARY — GENERAL AND NUMBERS

"QUESTION"



"YES"



"NO"

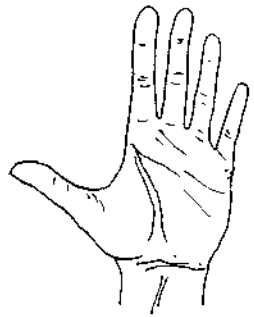
"ONE"

"TWO"

"THREE"

DICTIONARY — NUMBERS

"FOUR"



"FIVE"

"SIX"

"SEVEN"

"EIGHT"

"NINE"

"ZERO"

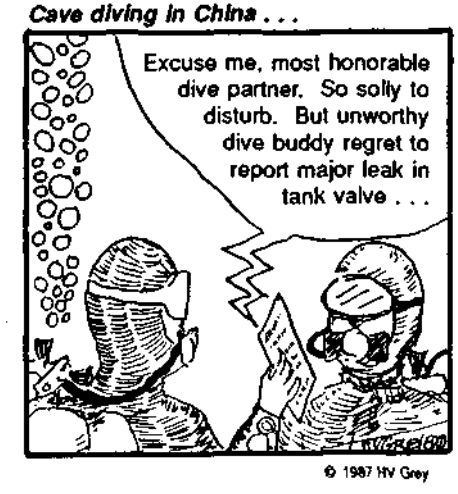
Chapter Five
SLATES

Why, you may ask, should there be any question about the advisability of using your slate to communicate in an underwater cave? After all, it's a fairly straightforward proposition of whipping out your slate and writing down your message.

The problem is that in cave diving one must always weigh advantages against disadvantages. It is certainly true that communication by slate has a tremendous number of advantages over light and hand signals. It uses the written word and can therefore convey extremely complex messages that cannot be expressed with sign language. The message is also semi-permanent, and can thus be consulted later on during or after the dive. And usually the message is fairly unequivocal, although this is not necessarily so. For example, one of the authors was once guarding vehicles and otherwise tending the surface at a tiny sinkhole while other divers were performing some cross-sectional flow measurements in the cave. Seeing exhaust bubbles appear in the sinkhole shaft at the appointed time, the author lowered down a weighted slate to the ten-foot stop, asking if anything was needed, jocularly suggesting a bottle of bubbly. The slate was sent back up with the message that everything was okay, but could the author send down a small bottle. The author interpreted this to be a jocular response, meaning a small bottle of bubbly, and only found out later that, in fact, a genuine bottle was being requested for biological collecting purposes.

The disadvantages of communicating by slate may be legion. First of all, it takes time. If the message is really urgent, there may simply not be enough time to write it out, and the emergency may well be over before the message is. Even if the message is not so urgent, precious minutes may still be lost in the process. The deeper and farther in you are, the more critical this is.

The use of slates also requires that the divers be stabilized while engaging in reading, writing, and if it's a science dive, even arithmetic. In high flow this may be extremely difficult, although the flow will tend to have the advantage of sweeping away any silt that is inadvertently kicked up. Even in a cave with a moderately comfortable floor-to-ceiling height, it is not uncommon for divers who are absorbed in their writing or reading—especially novice divers—to revert to a vertical trim and fin unconsciously in order to remain stable, kicking up the bottom severely. The divers may look up from their message, only to find that during the course of it, visibility has been reduced from 100 feet to 10 feet.



Because writing takes two hands—one to hold the slate, the other to operate the pencil—a hand is not readily available for holding onto a wall or projection of the cave. Sometimes the buddy can actually physically hold onto the writer and help keep him stabilized, but in many instances, unless the diver has excellent trim and buoyancy control, it will be necessary either to become positive and brace against the ceiling, or negative and rest on the floor. The ceiling may not be a practical alternative in a domed area, and one may have to choose between the lesser of two evils by resting as carefully as possible on the bottom and trying to minimize silting as best he can.

Because of the distraction of the reading and writing, it can be easy to get turned around on the line, or even to drift away from it altogether. The divers may look up from their slates only to find that they suddenly aren't sure which way is out, or even where the line is, particularly if they have managed to stir up some silt. So obviously, if you feel you must communicate by slate, it is very important to take all of these factors into consideration, and to make sure that you are both stable and oriented on the line.

Another problem with the slate is that, because of the require-

ments of streamlining and dangly avoidance, it must be stored somewhere, usually either in a BC pocket or zippered dive pouch. This means that before use, it must be located and removed, which is not always as easy as it sounds, especially while trying to maintain proper trim. The slate will either be attached to the pocket with some kind of cord, or be free standing. If it is attached by a cord, rest assured that you can get tangled in the cord; if it is free standing, you can drop it. If the bottom is very deep or silty, and the slate also happens to be attached to your decompression tables, you could be in serious trouble. (Murphy's Law dictates that the likelihood of your dropping it is directly proportional to the difficulty of retrieving it.) Tiny arm slates are now commercially available, and while they have the triple advantage of being quickly and easily accessible, and attached to the diver, they are very limited in writing surface, and it may be somewhat difficult to pass your arm back and forth.

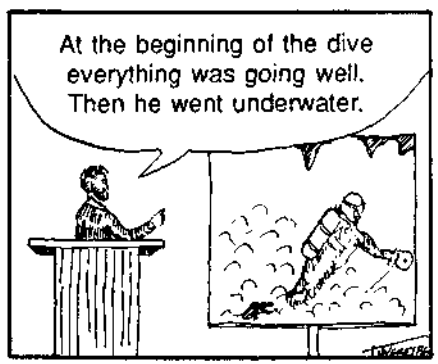
There are times, of course, when it will be entirely appropriate to spend the necessary time getting oriented and stabilized in order to write a clear message. But the importance of the message should be weighed against the disadvantages of communicating it by slate. For example, if you do not feel comfortable in the cave, it is not necessary to write a long essay of apology explaining this to your buddy. All you have to do is signal "Surface." He may want to know why, and even ask to see your pressure gauge (or even surreptitiously look at him himself), because if it's something other than a routine air turn, it may mean that you are experiencing some difficulty he should be alerted to. But he has no right to dispute the matter with you. If he does, then … as Confucius say: "Most honorable dive partner truly have most unworthy buddy." The NSS-CDS motto is that "Any diver may call any dive at any time for any reason." And the decision to terminate the dive for one team member, terminates the dive for all.

Chapter Six
TOUCH CONTACT

Many people wonder why we go cave diving. "What is there to see?" they ask. And you answer, "Water. Rock. The occasional troglobyte or fish." "Is that *all?"* they ask. You smile and shrug your shoulders. "But when the visibility drops to only a few feet, and you can't see a blessed thing, then why do you do it?" That's when you tell 'em about the "treasure."

We advise cavern divers to turn their dives when the visibility deteriorates below forty feet. In contrast, many a cave doesn't *begin* with as much as four feet of visibility, let alone forty. Cave dives involving scientific data collection, exploration, mapping, and the search for dry cave beyond a sump do not always afford the luxury of crystal clear water. They may require precision techniques in very poor or even nonexistent visibility. Obviously, these conditions are going to place serious limitations on the use of light and hand signals, and even strain the effectiveness of the buddy system itself.

Where cavern divers and beginning cave-diving students are encouraged to remain within arm's reach of the line at all times, seasoned cave divers will routinely swim farther away from the line under conditions of good visibility. Frequently, this will afford protection from current, a better view of the cave, etc. However, as visibility drops, the cave divers will get correspondingly closer to the line and to each other.



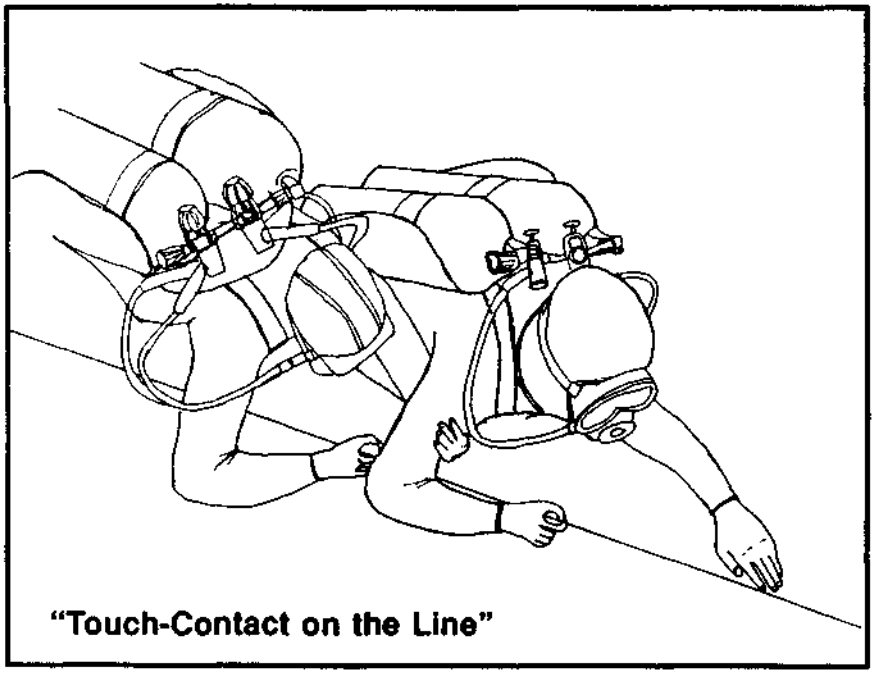
Courtesy of Steve Hudson © 1986 HV Grey

Good visibility can deteriorate during the course of a dive

due to a multiplicity of reasons, and it can deteriorate gradually or instantaneously. In large cave, it is usually easy to swim without stirring up any silt at all. If silt is accidentally disturbed, the damage will not usually be as extensive, and the divers will have a lot more time to react—to get to the line and tighten up formation.

In small cave passages, however, silting can be a much greater problem. In these close quarters, even a single careless fin stroke may completely destroy the local visibility. In very low, clayey areas, it may be impossible, despite the most careful technique, not to completely blitz out the passageway. But while very tight areas do pose many significant problems—for silting, turning, attempting to signal and hand sign, etc.—the divers will usually be swimming much closer to the line. Of course, this poses its own hazards, in terms of line entanglements. The divers will also usually be moving much more slowly, and therefore, be closer together.

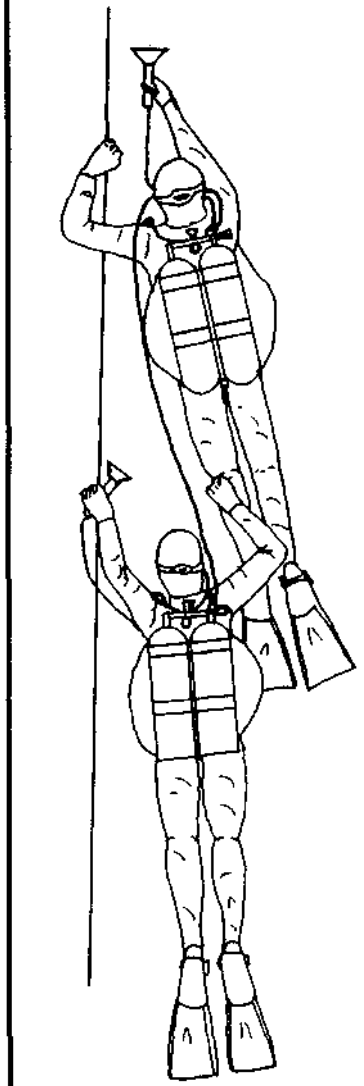
Where silting can easily and quickly become a problem, it makes sense to swim within arm's reach of the line. At the first sign of significant, rapid silting, it may be prudent to immediately make an encircling "Okay" sign around the line, even though you still have several feet of visibility.



"Touch-Contact on the Line"

If the visibility does decrease to zero or near zero, the team members should get into physical contact with each other. The lead diver should pause while the trailing divers close up the ranks, each diver firmly gripping the arm or leg of the diver in front of him, while maintaining an "Okay" around the line. Although it may be necessary occasionally to release one's grip on the diver ahead in order to adjust buoyancy or to feel for obstacles in tight quarters, you should otherwise try to maintain constant contact. Whether or not the dive is turned depends upon the experience level of the team, the conditions they were anticipating, and many other factors. Whereas cavern divers and cave-diving students are required to turn dives when visibility drops below acceptable minimums, fully trained, experienced cave divers may choose to proceed with exploration despite temporary drops in visibility. This method of keeping in touch your dive partner while maintaining contact with the line is referred to as "touch-contact." With it some basic communication is also possible.

The basic touch-contact signals are "Stop," "Go," and "Back up." If the rear diver pushes on the lead diver's arm or leg, it means, "Go" (and also, implicitly, is signalling that he's okay). If he pulls, it means, "Stop." Successive pulling movements mean, "Back up." If



"Sharing Air with Touch-Contact on the Line"

the "Back up" movements are repeated and intense, the rear diver may be signaling for assistance.

If the rear diver pushes on the lead diver, but the lead diver doesn't move, it means either that the lead diver has a problem, the passage has pinched down so as not to be passable, or the lead diver could not feel the other diver's grip through his wetsuit or drysuit. If the rear diver keeps signaling "Stop" every time an attempt is made to move forward, he may be entangled or have some other problem. If the lead diver wants to back up, it will usually be apparent.

Space permitting, the divers may be able to get close enough to make limited hand signs. The sign for "Hold" may be performed by squeezing the other diver's hand tightly on the line. Other signs such as "Surface" may be performed if necessary so that the recipient diver can feel them with his free hand. But it is very important that each diver stay in direct contact with the line at all times.

If it becomes necessary to share air under conditions of zero visibility, the diver in need of air may have no choice but to take a regulator. The dive should, of course, be turned immediately. It makes no difference to communication whether the recipient or donor leads out. Cave divers have successfully managed to share air in zero visibility in this manner for thousands of feet.

Chapter Seven

REELS & LINE MARKERS

In the early days of cave diving, nearly everyone was forced either to make his own reels or employ a cave-diving buddy to make them for him. Both the reels and their applications were as physically varied as the divers using them. But by the mid 1980's, the designs of most reels used in the American cave-diving community shared certain features. These included uniform capacities within similar physical dimensions, reliable locking devices for the spools, attachment clips, handles, and more. With this move towards more consistent design, regardless of the manufacturer, the ability to relay standardized information with reels and guidelines also improved dramatically.

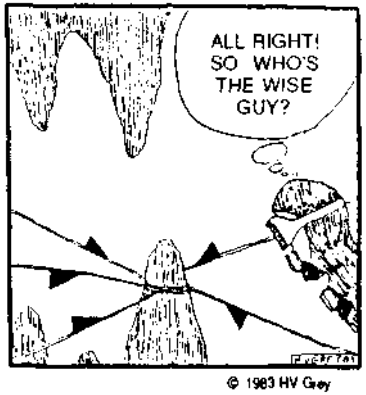
By standardizing the use and deployment of reels and line markers, a basic communication system can be established. Such a system is presented in the balance of this book. But a word of warning is also required. As the following presentation on reel and line-marker use is the most in-depth attempt to date, there likely will exist a substantial number of cave divers who will find the following descriptions different from those which they may have learned during their initial training. We do not mean to suggest that other deployment practices are necessarily either incorrect or inappropriate for any given situation; however, we consider that what we have presented here is the most consistent of deployment systems.

In the early '60's, it was common practice to lay and retrieve the guideline on every single cave dive. No lines were left in the caves, and thus "jumps," "gaps," and "circuits" were unheard of. In addition, as very few people were involved in cave diving, the likelihood of encountering another team at a site was almost nil. But the drawback to laying out the line on each dive was that a great deal of time and energy were expended doing it. As penetra-

tions increased and passageways were found to be more complex, this procedure was abandoned in favor of installing permanent guidelines.

Once guidelines became permanent, the need for determining direction and estimated distances to nearby exits became paramount. At that time cave maps were little more than imaginative scratches on a note pad and each cave dive became a project unto itself. One of the first attempts to resolve this difficulty was a series of colored rings painted on the guideline at various intervals. But this idea was quickly abandoned as the combination of colored marks was difficult to remember. Tanic acid also had a deleterious effect on the colors, and, as the marking system was strictly visual, localized silting could Fender the information useless. Lastly, this identification process was semipermanent and new discoveries often invalidated the information available.

In the 1970's, Lewis Holtzendorff began to advocate the use of triangle-cut wedges of duct tape, hence the name Dorff Markers. These Dorff Markers could be easily attached to the diver's tanks and, with reasonable care, be installed on the line, pointing in the direction of the nearest exit. With some markers the date of placement and a specific distance were also included. Some of these Dorff Markers are still in place on lines in use today, but they began to fall out of favor as the preferred marking system for several reasons. Chiefly, during a siltout, directional information was not clear. Furthermore, should the discovery of a new entrance warrant a change in the direction of a Dorff marker, the old marker could not be easily removed without damaging the guideline.



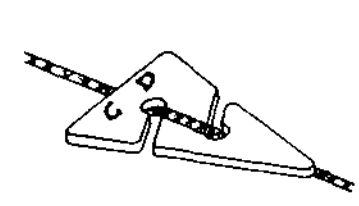
Enterprising cave divers overcame these shortcomings by cutting remnants of plastic and plexi-glass into triangular shapes for use as line arrows. Forrest Wilson, who was at that time Training Chairman of the NSS-CDS, developed a method to mass produce these plastic line arrows. Currently, arrows such as these are an integral part of every cave diver's basic equipment, and are available in a variety of colors.

Line Markers

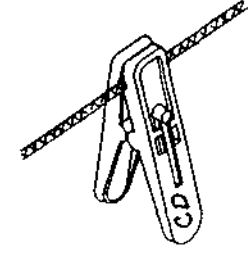
PLASTIC LINE ARROWS

Plastic line arrows are generally used to permanently mark a guideline. The "arrow" points toward the nearest exit. In many systems these arrows point towards the nearest "practical," most easily accessible exit and not necessarily the geographically closest exit. For example, the nearest practical exit for a hypothetical cave may be some 500 feet away from the placement of a line arrow through a spacious passageway. The true, or physically closest exit may be only 100 feet away from the line marker and lie in the opposite direction, but it may involve passing through a series of extreme, equipment-removal restrictions. During an emergency, the fastest way out of the cave is likely to be the longer of the two routes.

What constitutes an "extreme" restriction, or other reasons for pointing away from a nearby exit, is likely to be a subject of some debate among cave explorers. The point to remember is that plastic line arrows are used to permanently indicate the most direct, or fastest, route out of a cave. But one must exercise some common sense when reading installed line arrows. In most all cases the arrows do point toward an exit, but in a very few instances the arrows were installed incorrectly and point toward additional penetration. When entering a cave system, confirm that each line arrow

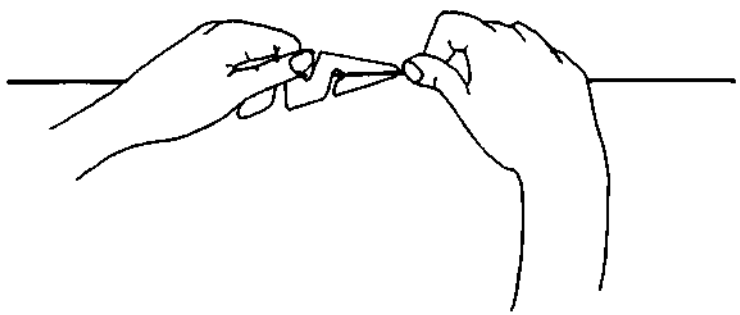


Plastic Line Arrow
Arrow or "point" always points toward exit. Always identify your arrows with your name or initials.

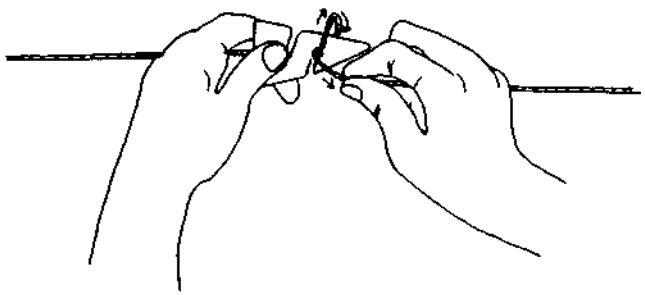


Clothespin
Clothesline clips should include, at least, the installer's initials as extra identification.

SECURING A PLASTIC LINE ARROW



Arrow being "clipped" into line
Clipping will attach it to line temporarily.



Arrow being "looped" into line for further security
If in doubt about the security of the arrow, make the extra wrap.

End product of "clipping" versus "looping"

you pass is pointing in the correct direction. If you encounter a line arrow which seems amiss, confirm your location and direction of travel. Backtrack your known direction of travel and check arrows along that route. If in doubt, call the dive. You do know from which direction you entered the cave, don't you? It is far better to return another day, after consulting with others more familiar with the cave system, than to press on and invite trouble.

In more popular systems, plastic line arrows are placed every 100 to 150 feet apart. Arrows are also generally placed at potential "jump" points to secondary passageways, the beginning and end of permanent lines, or anywhere else directional decisions need to be reinforced.

In order to be confident that the plastic line arrow is properly secured and not likely to be moved about by current or a careless diver, the arrow should be looped into the guideline. If the line arrow is intended to be temporary (i.e., you are planning to remove it on your way out), it is completely acceptable to simply clip the arrow onto the guideline. If in doubt about the arrow being moved about, then by all means, install it with a loop. It is as easy to install the arrow one way as it is the other.

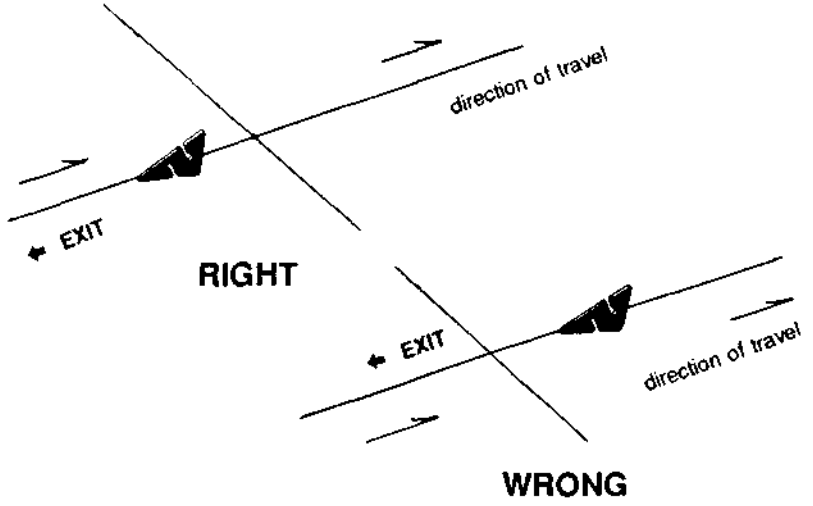
Any device installed on a guideline, permanent or temporary, should be identified as belonging to the installer, although it is true that some relining projects at major sites do not take the time to identify each arrow. The marking of the arrows is as simple as writing your initials on the arrow with indelible ink. The purpose of this identification process is to provide a secondary confirmation of a marker. Seeing your own markers, or those of a known individual or group, pointing toward a known exit can be very comforting in an otherwise uneasy situation.

CLOTHESPINS

Clothespins are generally considered temporary line markers and can be used in a variety of ways. For example, dive teams will often use clothespins to indicate the maximum penetration into a cave passage during initial exploration by that team. Others use clothespins to identify prior penetration points when setting up a traverse (entering at one location and exiting at another). Clothespins are also used to confirm an original exit direction when jumping from one line to another, or they can be used to indicate that more

Back-to-back arrows indicating midpoint on line

Arrows placed back to back mark the spot as the midway distance between two entrances. Although the travel distance between the entrances may be equal, other factors, such as current strength or potential restrictions, may not be reflected by the line arrows. It may be easier, if not wiser, to plan to return along a known passageway rather than continue on should an emergency develop.



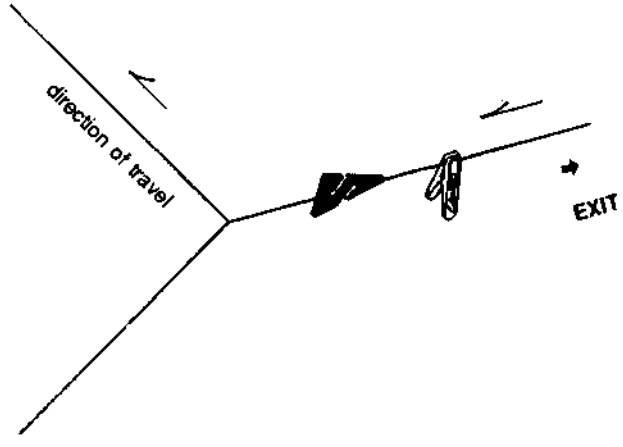
The RIGHT way versus the WRONG way of identifying the exit route at a "T" in lines

Arrows are always used to mark the intersection of lines and should be placed on the **OUTBOUND** side of the intersection to avoid confusion. Arrows should be within a few inches of the intersection, always within easy reach of it.

than one dive team is using the same primary reel from the entrance of the cave to the start of the permanent line (we will return to this specific practice later). As with any other device installed on a guideline, clothespins should be identified as belonging to the installer. Since these clothespins are intended to be temporary, they should be removed from the cave system upon conclusion of the dive or project. Needlessly abandoned clothespins are a source of visual litter within the cave system.

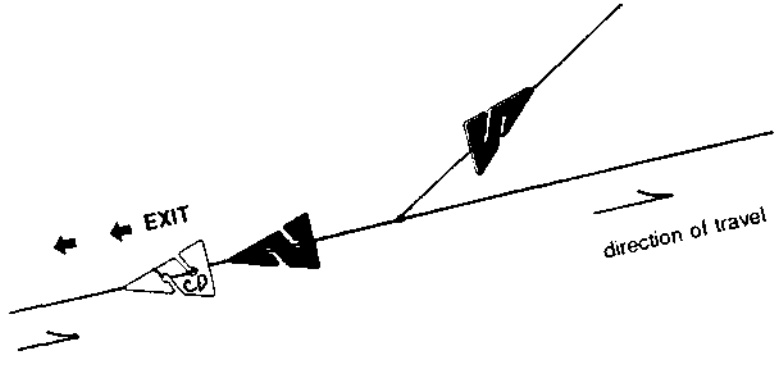
Every cave diver needs to incorporate plastic line arrows and clothespins into his equipment. Stowing of these devices can be as easy as threading some spare guideline through a piece of surgical tubing and then tying the tubing into a pouch or pocket. When required, markers can be removed without dumping the contents of the pouch onto the floor of the cave. The exact number of line markers required is dependent on the intricacy of the particular dive plan. Current NSS cave-diving course requirements cite three line markers, either plastic line arrows or clothespins, as a minimum. At least one spare plastic line arrow should be carried by each diver to be used to replace missing or broken arrows. It is the responsibility of all members of the cave-diving community to keep guidelines in sound order. Just as we have the responsibility to repair damaged guideline, we also have the responsibility to replace missing line markers.

A final word on line markers. The above examples represent generally accepted methods of marking guidelines. The general policies discussed are recommended by the NSS-CDS. In everyday real life some exceptions are necessary and also generally accepted. At certain sites, such as those frequented by open-water divers, line markers are not utilized until well within the cave system. This is done to avoid potential confusion among the untrained and to avoid encouraging them to travel farther into a system. We do not wish to be guilty of enticing these untrained individuals into reliance on any system of which they have no knowledge. They may well accept practices at one location as gospel for another, more complex site. Also, as one ventures deeper into any cave system, one is apt to find fewer and fewer directional indicators. The initial dives into most cave systems are done to set up and gather surveying information. Directional reminders are installed only for the safety of the survey team. Additional identification is left to future teams.



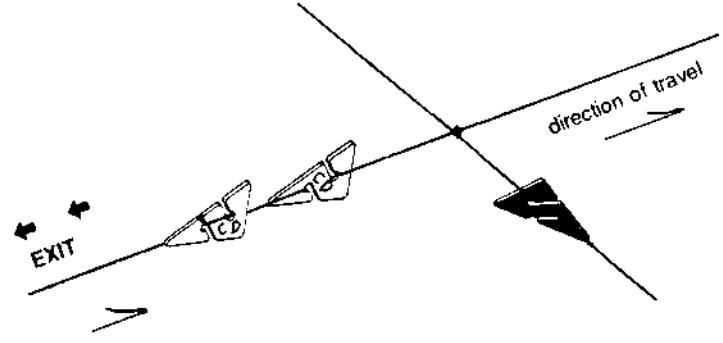
Plastic arrow and clothespin marking exit at "T"

Many divers prefer to add their own clothespin to an existing arrow for added confirmation on the way out. Clothespins make excellent visual aids and can withstand some banging around on the line. For consistency, the NSS-CDS recommends that the clothespin be placed on the **OUTBOUND** side of the arrow.



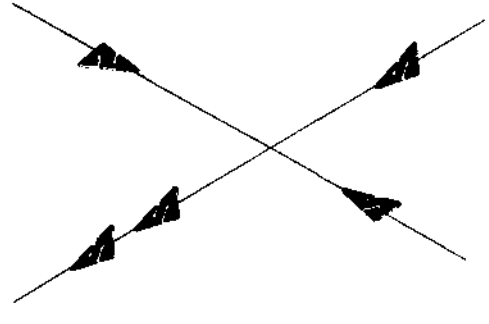
Plastic arrows identifying two exits at "T"

You are unlikely to see an intersection marked this way in a North Florida cave. But such intersections are common in the Caribbean. Any time a suspect intersection is encountered, it is best to add your own arrow (don't rely on a clothespin) to confirm your exit route.



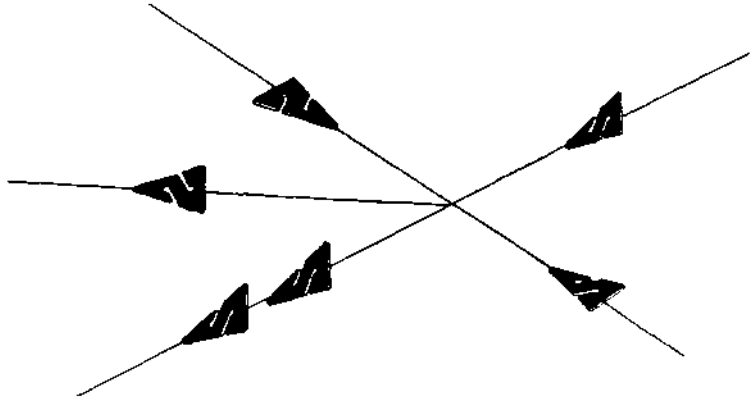
Plastic arrows identifying a preferred exit at an intersection

It is possible that you will encounter an intersection where you are unsure of an existing marker or you plan to travel in a direction away from an existing line marker. In any case, until you are familiar with the cave system, you can only be confident of one direction, and that's the one you came in from. To avoid confusion during your recrossing of this intersection, use two line arrows to identify the route you must follow to return to your original entry point. Line arrows are always preferred at intersections. Even as temporary markers, many prefer the simple, but effective information conveyed by a line arrow.



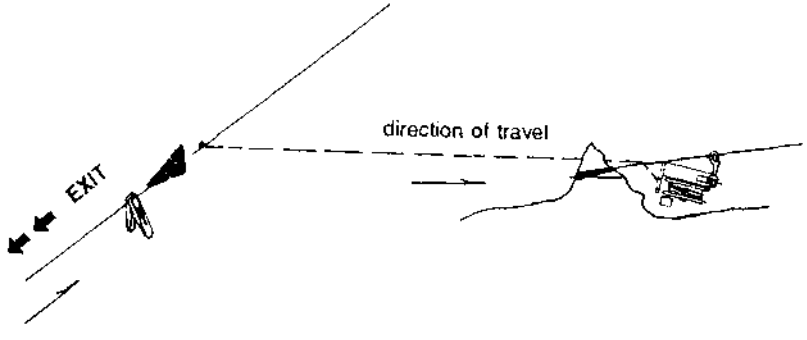
Four-line intersection - too much of a good thing

This drawing shows the line situation depicted on Page 42 with a whole bunch of additional arrows. Initially, one might believe that additional arrows will be a help when negotiating the intersection, but in actual fact they may cause the team to waste precious moments decoding the information presented.



Five-line intersection

This drawing depicts a line intersection similar to ones seen by the authors in some of the maze-like caves in the Bahamas. The information presented by the arrows suggests that the double-arrowed line is the recommended route out of the cave. There may be locations which require that the guideline be so completely identified, but this added indentification may also create more confusion in low visibility than it cures.



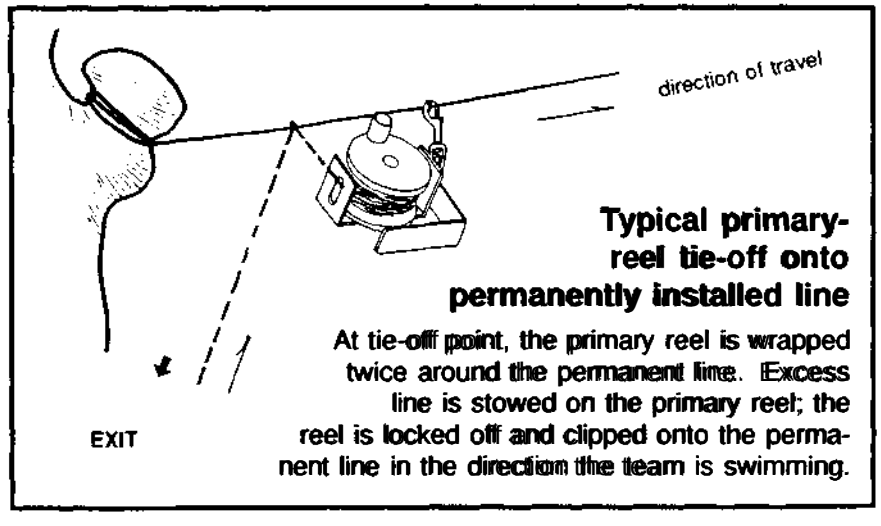
Clothespin added to OUTBOUND side of line to reconfirm directional information at a line jump

Reels

THE PRIMARY REEL

For cave divers who are visiting a cave where they do not expect to lay new survey line of their own, the primary reel serves to establish a continuous guideline from the entrance to the permanently installed line in the cave. In most locations, particularly North Florida, the permanent line begins in far enough so that you must lay line to it. The method of tying onto this guideline with the primary reel, beyond certain mandatory requirements, is a matter of personal choice.

However, for consistency, we are recommending the following procedure: ***Wrap the primary reel line twice around the permanent guideline, then clip the reel onto the permanent line in the direction of travel.*** Clipping the reel onto the guideline in the direction of travel is arbitrary, but it does establish a practice which will be consistent with those that follow. Mounting the reel in this manner also places the reel in a very convenient position for retrieval during the exit. Everything is in the right place for easy pick up at the right moment. There is a minimum of fumbling to disengage the lines. For the same reason it is also wise to avoid connecting temporary and permanent lines together at the same tie-off point. Moving the primary reel away from this spot a few inches will greatly ease disengagement.



Typical primary-reel tie-off onto permanently installed line

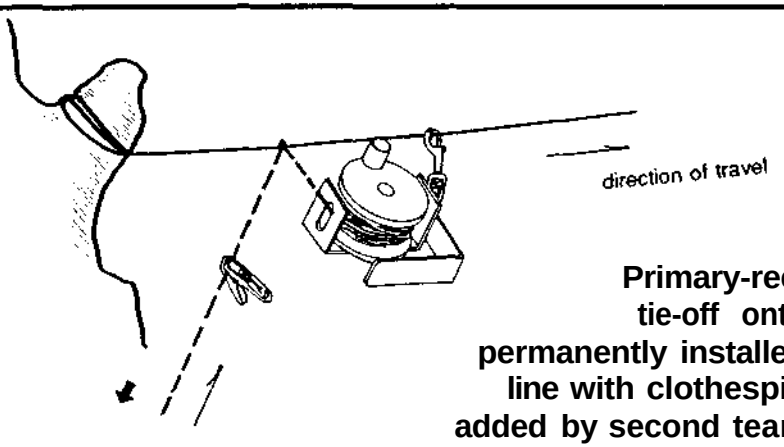
At tie-off point, the primary reel is wrapped twice around the permanent line. Excess line is stowed on the primary reel; the reel is locked off and clipped onto the permanent line in the direction the team is swimming.

Two or More Teams and a Single Primary Reel

On occasion, two or more dive teams will desire to use the same primary reel to tie onto the permanent guideline. This practice can eliminate potential entanglements, but it can also create a mass of confusion between dive teams. ***Never use another team's primary reel to obtain your continuous guideline to the cave entrance unless you have first obtained the permission of that team to do so.***

Over many years of cave diving, one of the authors has witnessed several incidents and near accidents involving dive teams that have attempted to share another team's primary reel without first advising the original team about the decision ahead of time. There is just no excuse for such a practice. Why jeopardize anyone's safety for want of a few moment's inconvenience? If two teams do agree to use the same primary reel, then a method of communicating during the dive must be established in order to avoid confusion during the exit. The method proposed utilizes a clothespin and is summarized in the following:

1) Prior to entering the water, all members of both teams will mutually agree that more than one team will be using the same primary reel. The specific identification process to be used will be reviewed.
2) A specific member of each dive team will be assigned the responsibility of both installing and/or confirming the existence, or lack thereof, of the clothespin. This is typically the second man of the team.
3) The first team to enter the cave lays the primary reel in the usual method.
4) The second team to enter adds a clothespin (one that everybody has seen and agreed to beforehand) to the exit side of the primary-reel tie-off on top the permanent guideline.
5) Whichever team exits the cave first will remove the clip during the exit. This responsibility is usually assigned to the second man of the dive team. When the second man sees the clip he notifies the reel man to leave the primary reel, then picks up the clip. If no clip is observed, the second man notifies the reel man that no clip exists and that the reel man should remove the primary reel.



Primary-reel tie-off onto permanently installed line with clothespin added by second team

Should two teams agree to use the same primary reel at the same time, the second team must announce its presence to the first team. This is done by the second team (and each additional team) adding a pre-agreed-to clothespin to the outbound side of the primary-reel tie-in point. As each team exits, a clothespin is removed. The final returning team, finding no clothespins, will remove the reel in the usual manner. Before undertaking this identification system, each team must agree to the procedures, type of clip to be installed, and the specific diver (typically the second man) from each team to add or remove clips from the guideline.

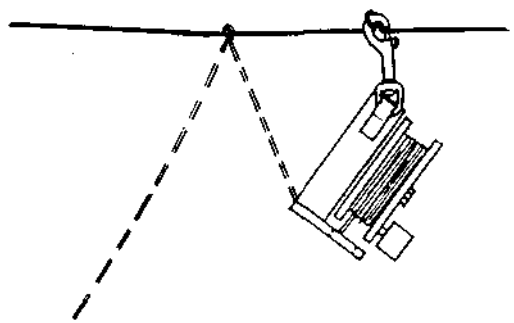
6) The last team to exit the cave, seeing that there are no clothespins, will remove the primary reel in the usual manner.
7) Should any doubt remain concerning the whereabouts of *any* other team, then leave the primary reel for later retrieval. Take no chances with anyone's safety.

GAP REELS

Gap reels are used to connect two permanent guidelines together. Generally this implies joining the end of one permanent guideline to the beginning of another, and there are no directional decisions to be made. Typically, one begins by looping the line from the gap reel over the end of the permanent line, then over the

reel so that, when pulled tight, there is a direct line-to-line connection. Cave divers prefer to begin the tie-in a few inches away from the final tie-off of the permanent guideline. This is the same reasoning used in tying in the primary reel. Simply stated, it just avoids potential confusion from a mass of guideline and some work in recovering the temporary line. Some teams also prefer to add a clothespin to the outbound side of the tie-in point. While this is not a universal practice, the addition of a clip does provide confirmation of the original exit direction.

When tying onto the new permanent line, wrap the gap reel around the new line twice and clip the gap reel onto the new line in the direction in which the team is traveling. This makes retrieval of the gap reel easier and serves as notice to other teams that your team is not only using a particular line, but traveling on that line in a particular direction.

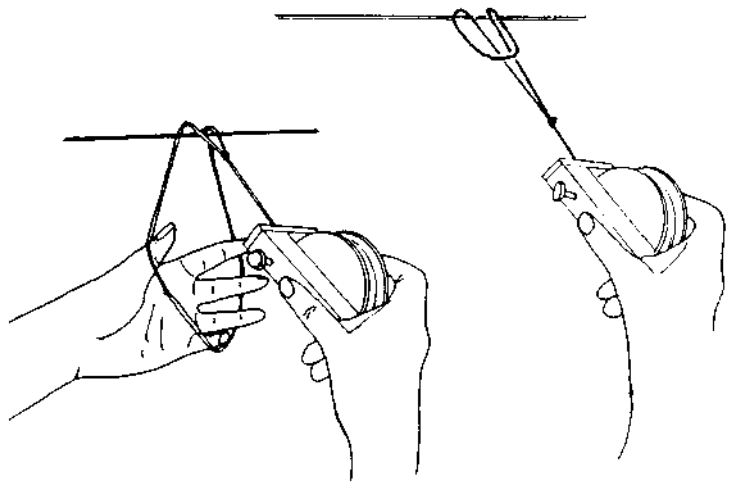


The GAP REEL versus the JUMP REEL

Gap reels and jump reels are typically interchangeable, being differentiated primarily by function rather than appearance or design. Both are typically smaller physically than the primary reel and are usually designed to hold only about 50 feet of line. A "gap" is defined as the distance spanned by a temporary reel between the end of one permanently installed guideline and the beginning of another. Thus with gap reels there are no directional decisions to be made. A "jump," by contrast, involves spanning the distance between the middle of one line and the beginning or middle of another line, or vice versa. Thus, the use of jump reels will involve planning for one or more directional decisions.

JUMP REELS

A jump reel is used to connect the middle of one permanent line to the end or middle of another line. Jump reels and gap reels may be exactly the same type of reel, differing only in application. If you are going to be leaving or entering the middle of another line, then directional decisions are going to be encountered during the exit. Minimize these decisions during the entry; don't rely on visual indicators alone. At the very least, a team will install a clip to the outbound side of the jump-off point. This task is typically assigned to the second man. Others prefer to install an arrow for additional directional confidence. Still others prefer the security of using both an arrow and a clip, while still others prefer that each member of the team mark the jump-off point using either an arrow or a clip.



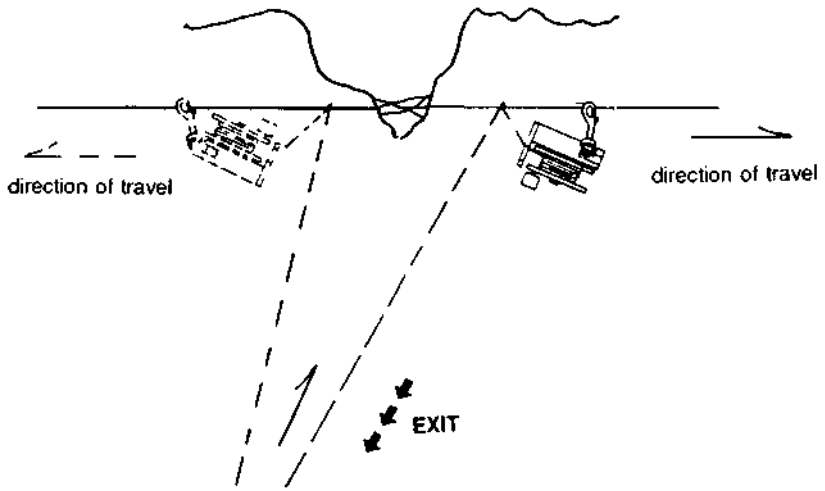
Installing a gap or jump reel

Place the end loop of the reel line over the permanent line, then feed the reel through this loop and pull tight. When properly joined to the beginning or middle of the other permanent line, a direct, line-to-line connection is the result. Some cave divers prefer to have a small brass or stainless-steel snap attached to the loop, but while this snap may be useful in maintaining control of the reel line, it should not be trusted to provide the line-to-line connection.

When tying onto the new line, wrap the jump reel twice around the new line, then clip the reel onto the new line in the direction of travel. Again, this makes it easier to retrieve the temporary line and will let other teams know your plan.

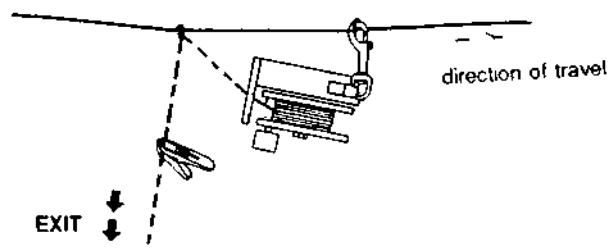
Conclusion

The preceding presentation on the use of reels and line markers will, we believe, help to establish a consistent method of deploying this apparatus and make available to the cave-diving community a consistent means of communication. With these standardizations established, variations can be more readily identified and interpreted by cave divers in the field.



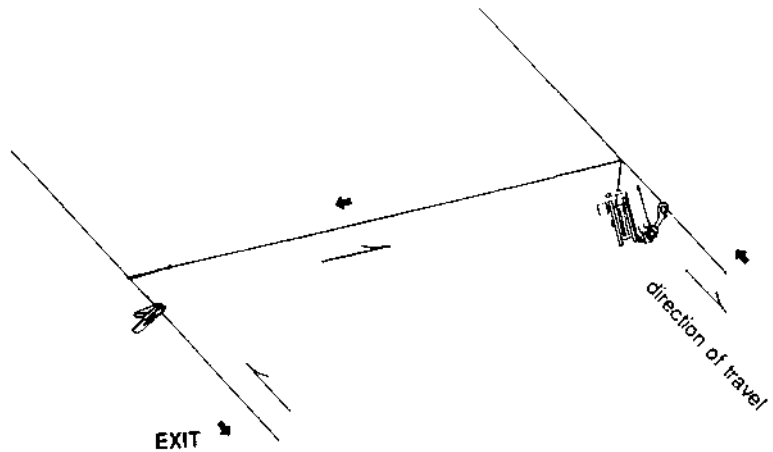
Tying into the middle of a permanent line with a temporary line

When tying into a permanent line with any kind of temporary line, it is recommended that the tie-in point avoid nearby placements, wraps, or tie-offs of the permanent line. Tying in a few inches to the right or left of placements, wraps, or tie-offs—depending on the intended direction of travel—provides for clean line-to-line contact. Having one or more lines use the same tie-off fixture could cause unnecessary delay during a low-visibility exit.



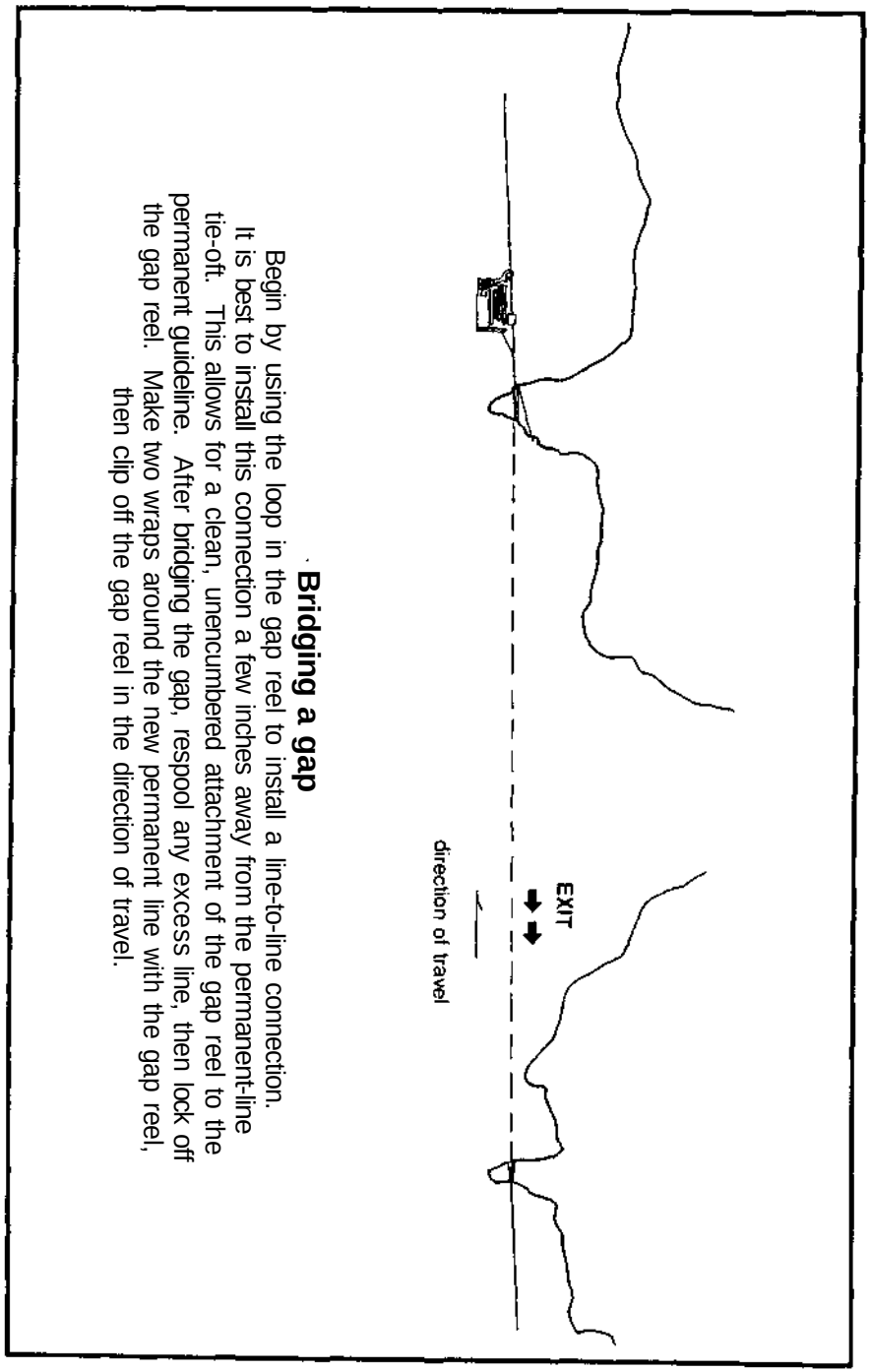
Clothespin added to a temporary-line connection

Many cave divers like to add a clothespin to the outbound side of any temporary line connection. This added clip provides an additional directional confirmation to the tie-off point. Should the divers be forced to return through this connection in low visibility and abandon the temporary reel for later pick up, no second guessing will be required at the intersection. Other teams prefer that each team member mark the intersection with his own clip.



Jumping from the middle of one line to another

The procedure here is the same as with the gap reel except that a directional decision must be reinforced before the jump. A clothespin or arrow should be installed on the outbound side of the jump. When the jump is made in a reasonably large, clean tunnel, a clothespin is sufficient. If low visibility is expected on the return trip, an arrow is preferable. If in doubt, install an arrow.



Bridging a gap

Begin by using the loop in the gap reel to install a line-to-line connection. It is best to install this connection a few inches away from the permanent-line tie-off. This allows for a clean, unencumbered attachment of the gap reel to the permanent guideline. After bridging the gap, respool any excess line, then lock off the gap reel. Make two wraps around the new permanent line with the gap reel, then clip off the gap reel in the direction of travel.

CAVE DIVING AND THE NSS

Founded in 1941, the National Speleological Society (NSS) joins together thousands of individuals dedicated to the safe study, exploration, and conservation of caves. As a nonprofit organization affiliated with the American Association for the Advancement of Science, the NSS promotes a variety of scientific, educational, and conservation projects—including grants and scholarships to professional and student biologists, geologists, hydrologists, and archaeologists for cave-related research; purchase of cave properties for the public trust; conservation studies, clean-ups, and restorations; a nationwide rescue-and-recovery network; and a multitude of publications concerning all aspects of cave science, exploration, survey, cartography, photography, and physical techniques.

The first cave-diving information ever published in the United States was in a 1947 *NSS Bulletin.* In 1948, NSS divers were responsible for the first cave dives in the United States using scuba. In 1953, the Florida Speleological Society (a local NSS subsection or "grotto") conducted the first cave-diver training course, complete with written standards. In 1968 an NSS member authored the first American manual on cave diving. By 1973, in response to a growing need to address the particular needs of cave divers, the NSS formed the Cave Diving Section (NSS-CDS). In 1983 the Cave Diving Section was independently incorporated and in 1987 was granted official IRS nonprofit tax-exempt status as a scientific and educational organization.

The NSS-CDS has the largest cavern- and cave-diving training program in the world, and is a leader in setting cave-diving standards for the rest of the diving community. The NSS-CDS was the first to institute the concept of cavern-diving training, and has certified more than 7000 Cavern and Cave Divers. In addition, the NSS-CDS has a comprehensive instructor training program.

The NSS Cave Diving Section has also trained more than 500 Cave Diving Rescue/Recovery Specialists. In cooperation with the National Association for Search and Recovery (NASAR), the National Cave Rescue Commission (NCRC), and the National Crime Information Center (NCIC), these Cave Diving Rescue/Recovery Specialists are made available to law-enforcement agencies that are affected by underwater-cave-related rescues and recoveries. The team of cave divers is available 24 hours a day. NSS-CDS members have performed numerous rescues and recoveries throughout the United States and at the request of several

foreign governments. If assistance is required by a local law-enforcement agency, it should contact the NCIC or Jacksonville, Florida Sheriff's Office at (904) 633-4159.

The NSS-CDS has installed numerous safety/warning signs at some of the more popular underwater caves in the United States, Mexico, and the Caribbean islands. These signs are available for installation in underwater caverns where a risk is perceived. Interested persons are invited to contact the NSS-CDS for more information. The Cave Diving Section, in voluntary cooperation with national, state, county, and private parks, has also developed a "No-Light" rule for open-water divers. This policy, aimed at locations which contain a cavern or cave, discourages open-water divers from carrying a dive light while diving these waters. The plan has proven very successful, as divers without lights are naturally limited by lack of daylight in their penetration of underwater caverns.

Within the caving community, NSS-CDS members are most renowned for their biological documentation, exploration, surveying, cartography, photography, and cinematography of underwater caves. Some of the surveyed systems.are more than seven miles in overall length. The Cave Diving Section has also funded scientific studies to examine life forms unique to underwater caves.

While the center of activity remains in Florida, CDS members also dive sumps and mines in the northern states; conduct high-altitude sump dives in the West and Mexico; perform motorized and multiple stage dives in the South; dive sea caves along the Pacific, Atlantic, and Great Lake coastal regions; dive lava tubes in the western United States, Hawaii, Mexico, and Canary Islands; and dive blue holes and cenotes in Mexico, Bermuda, the Caribbean, and the Pacific.

The Cave Diving Section has an active publications program, including a bimonthly magazine, *Underwater Speleology,* and conducts semiannual Safety Workshops for the exchange of current information on exploration, scientific discoveries, conservation, equipment innovation, and safety techniques. These are traditionally held in Florida over the Memorial Day and New Year's weekends. The Section has members in almost every state in the Union, and in many foreign countries. Membership is open to any interested individual. For more information, write to us at the address on the next page.

NSS-CDS PUBLICATIONS

Publications available from the

NSS Cave Diving Section
P. O. Box 950
Branford, Florida 32008-0950

Basic Cave Diving - a Blueprint for Survival, Sheck Exley

Basic Underwater Cave Surveying, John Burge

Cave Diving Communications, Joe Prosser and H. V. Grey

Deep Into Blue Holes, Rob Palmer

NSS Cave Diving Manual, Sheck Exley and India F. Young, eds.

NSS Cavern Diving Manual, John L. Zumrick, M.D., Joe Prosser, and H. V. Grey

NSS Instructor's Manual, Joe Prosser

NSS Student Cave Diver Workbook, Joe Prosser, ed.

The Wakulla Springs Project, William C. Stone, Ph.D., ed.

Free Brochures on cavern- and cave-diving courses and safety.

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