

NYLON HIGHWAY NO. 31



...ESPECIALLY FOR THE VERTICAL CAVER

NYLON HIGHWAY

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THE NYLON HIGHWAY

The **Nylon Highway** is published on a Semi-annual basis pending sufficient material. It is the intent of this publication to provide a vehicle for papers on vertical work. All submitted articles containing unsafe practices will be returned to the author. With this issue the section is over 900 members strong with a mail out of over 100 copies. I hope to continue the fine tradition of the Section having one of the best publications of any NSS Internal Organization.

COVER: Olivia Whitwell in Tier Duct Cave, Bastille, British Columbia. Drawn by Linda Heslop

JANUARY 1990

NO. 30

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Opinions expressed herein are those of the Author and do not necessarily agree with those of the Vertical Section or its Executive Committee. Reprinted material must give credit to the author and source. Some material is designated as copy written. Letters to the editor are welcome.

FROM THE VERTICAL SECTION CHAIRMAN

REPORT ON THE SOVIET EXCHANGE PROGRAM

Dear Vertical Section Members,

Thanks to you, the Soviet exchange trip was a wonderful success. The Vertical Section sponsored the first 15 days of their six week visit. Donations from the section membership allowed them to see the sights in Washington D.C. and go caving in Virginia, West Virginia, TAG and Mammoth Cave, Kentucky. After Mammoth Cave, it was not easy to leave our new friends for the rest of their trip in the western U.S.

The Soviets, all from the Ukraine, left us with many memories and several special goodies. They presented the section with a medal, struck in the Soviet Union, to be presented to the discoverer of a 1,000 meter deep cave. They wished us to award it when this cave is discovered in the United States. In the mean time, the Section will establish a plaque, incorporating this medal, listing the current deepest cave in the United States and when the 1,000 meter barrier is broken, the award will be given. They also presented us with several innovative ascenders that will be described in a later issue of **Nylon Highway**.

Our unique country, its caves and cavers are a wonderful memory for our Soviet visitors. They returned home with many ideas, techniques and pieces of equipment. With the on going restructuring in the Soviet Union, we wish our caving friends the best and await their invitation to visit their caves with them. Thank you all.

Safe Cavin',

Allen Padgett, Vertical Section Chairman

P.S. The invitation for NSS/Vertical Section cavers to visit the Soviet Union has recently been received. The trip will occur around the end of May to the beginning of June of this year. The group will spend 2 week in the Soviet Union caving in the Western Ukraine and Crimean regions. If you are interested in being an ambassador for the Vertical Section, please contact Allen Padgett at the address below. You will need approximately three weeks leave from work and must cover your own airplane ticket (approximately \$1300) and personal expensed while in the Soviet Union. Our Soviet friends will cover all travel and living expenses while in the country. Three members of the Vertical Section will be eligible for this trip. If you are interested and can afford the time and trip, send your caving resume, occupation and why you think you would be a positive addition to the trip to Allen by the 20th of February. Send all information to Allen Padgett, Rt. 3 Box 3478, Cleveland, GA 30528. If you need more information, call Allen at 404-865-5390. If you are selected to go, you will need to give Allen your passport number by March 1. If you are even considering applying and do not already have a passport, you should apply for the passport now since they can take as long as 6 weeks to arrive.

You Shouldn't Shun the Shunt

Ron Miller

The Spelean Shunt got quite a bad rap in Allen Padgett's recent article (False Security; *Nylon Highway* #30). I suggest that his conclusion--that the shunt offers a false, and potentially dangerous, sense of security--appears to rest on incorrect use of the shunt.

According to Padgett, "proper" use of a Spelean Shunt requires pulling on an accessory cord loop to keep the shunt's cam disengaged from the rope during normal rappelling, then letting go to stop an out-of-control rappel. This differs critically from the technique described in the *Manual of Cave Rescue Techniques*¹ and in *On Rope*², which I paraphrase and embellish upon below.

The Spelean Shunt requires only a Gibbs ascender (preferably free-running), a long oval steel carabiner and

Although this is a "positive response," it is also instinctive--you're falling, so you grab the tether to your shunt and pull like hell. Either way, you stop the fall.

The purpose of the accessory loop is simply to make release of a loaded shunt easier. As a release sling, it works fine. In fact, the loop is not essential, as a sharp blow with a palm to the free end of the carabiner is often sufficient. The accessory loop just gives you something to grab onto while pulling.

To solve the potentially lethal problem described by Padgett, **DO NOT HOLD ONTO THE RELEASE SLING** while rappelling! If the shunt doesn't slide freely, add more weight to the free end of the carabiner, lengthen your tether or get a free-running Gibbs. If it catches once in a while, tug on the cord to release the cam, then **LET GO**. If you still find yourself habitually pulling on the loop while rappelling, leave it on your harness, where it will be accessible if you really need it. Personally, I'd prefer occasionally working for a minute or two to release a jammed shunt as an alternative to cratering at the bottom of a pit.

Padgett considers the Spelean Shunt to be a "crutch"--unnecessary and offering little more than psychological protection. I couldn't disagree more. Any number of scenarios (e.g. rockfall, mental lapse or sudden medical emergency) could cause an out-of-control rappel or rappel device failure, even to an experienced vertical caver. Without a backup safety system such as a shunt, that caver might die. While we can't take all of the risk away from vertical caving, and while training for proper response to rappel emergencies is certainly important, we can use safety systems to lessen those risks. One of the unwritten rules of caving is that a belay should be requested whenever the caver feels that he or she need it and that belay should be provided without question. For those cavers who desire a self-belay while rappelling, and particularly for beginning vertical cavers, who are more likely to make mistakes (remember, it only takes one...!), a properly used Spelean Shunt makes a very effective self-belay device. As for those vertical cavers who don't make mistakes or who have trained for every conceivable rappel emergency, I would suggest that you consider using a shunt whenever there is a possibility of having to change over to ascent while on rope. I have found that the Spelean Shunt makes change-overs considerably easier and safer, as it is already on the rope, in the right place for a safety cam, and can be released while under load.

REFERENCES

¹Hudson, Steve (ed.), 1988, *Manual of U.S. Cave Rescue Techniques*, 2nd ed., National Speleological Society: Huntsville, AL.

²Padgett, Allen, and Bruce Smith, 1988, *On Rope*, National Speleological Society: Huntsville, AL.

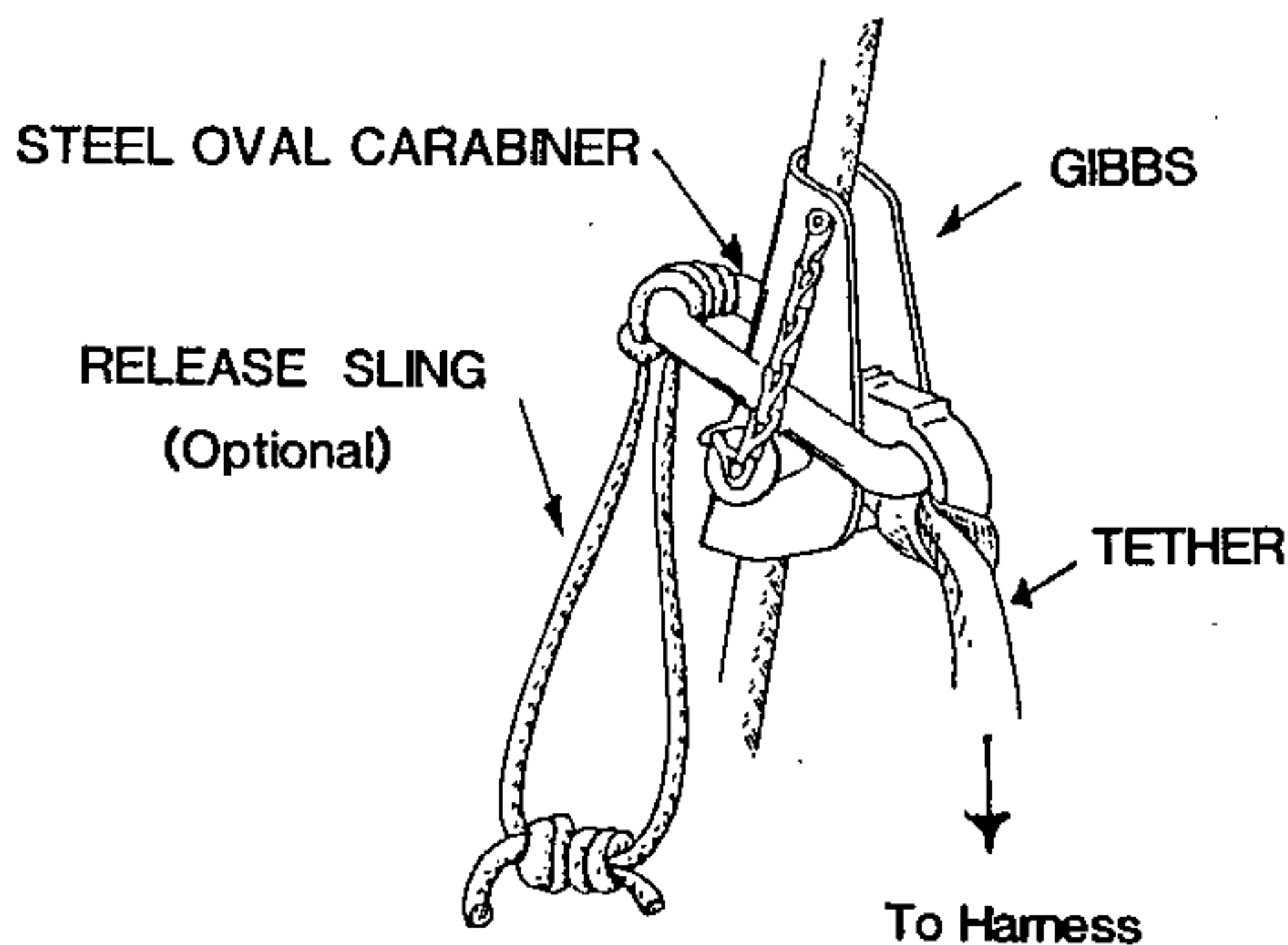


FIGURE 1. Spelean Shunt (modified from ON ROPE)

a tether to the harness (see figure 1). During normal rappelling, the weight of the steel carabiner is usually sufficient to prevent accidental engaging of the cam. If necessary, you can clip another steel carabiner to the first to add weight. In any event, this should be a **PASSIVE** system--in other words, no effort from the rappeller is needed. The tether to the climber's harness should be rigged with enough slack to prevent loading the shunt during a normal rappel.

If an emergency situation develops, a tug on the tether will overcome the weight of the carabiner and engage the cam.

FROM THE EDITOR

by Maureen Handler

Well my first solo issue of the **NYLON HIGHWAY** is nearly done. It has been a lot of work but I think you will be pleased with the results. I apologize for the late arrival of this issue but there have been some technical problems. We are working with some new software for desk top publishing and there were hardware problems in getting a good printout. The last issues of the **NYLON HIGHWAY** were professionally typeset. While this makes for a good looking publication, it also cost the section over \$900 per year. In trying to save the section that money in hopes of producing 3 issues of the **NYLON HIGHWAY** next year, there was a certain amount of learning time and coaxing the desired result from the computer hardware. Now that most of these problems have been corrected, hopefully the future issues will be out on time and you can look forward to three issues in the 1991-92 fiscal year.

I would like to use the remaining space to voice some concerns about vertical caving safety. In the last 13 months there have been three tragic accidents in the TAG area. All three of these seem to have been caused by a lack of experience and good judgment on the part of those involved. The first two involved out of control rappels. Both victims lost control on long drops and were badly injured requiring extensive man power to extricate them from the cave. Fortunately both cavers are expected to make a full recovery. The third accident victim was not so lucky. He was killed on impact after his rope broke. All of the conditions present must be carefully evaluated prior to beginning a rappel. What is the condition of the rope? Is it used and stiff or new and slick. Is the pit and rope wet, making conditions for a potentially fast rappel? Should I ask for a bottom belay?

The out of control rappels occurred under different conditions. During the first rescue, the pit and rope were both quite wet. Wet rope, especially when it gets wet, can be very fast. Even with older rope that hasn't been hanging and soaking in the waterfall can be fast. Conditions like these may require more friction than would normally be used on dry rope. In the second case, the rappeller had done a deep pit the day before on 4 bars with no problems. He assumed 4 bars would be sufficient for his next rappel. However, he was using newer, faster rope and ended up in a speed rappel. When trying to slow himself down by locking off the rack, the rope came out of his hand and he lost control. The fatal accident occurred on an Eastern European rope. These ropes, while usually plenty strong, do not have the abrasion resistance we are used to with American ropes. If you are going to use European or smaller diameter (than 7/16"), you may want to consider rigging the pit with a rebelay. European rigging techniques developed partly due to the lack of good abrasion resistant ropes.

All cavers need to learn somewhere. If you are not experienced in all of the problems that may occur in vertical work, ask someone for help. Do not be shy about asking for a bottom belay or consider using a braking device such as the Spelean Shunt or Petzl Stop Bobbin. Rappelling is a fairly safe sport. If everything goes all right, extensive experience is not needed to safely drop a pit. However, it is easy to getin over your head very quickly. How will you react if something goes wrong? This is where experience comes in. Please get proper training before attempting to engage in vertical caving. Let's all cave safely and enjoy.

Maureen Handler,
Editor.

Friction felling energy absorber by Serifimov.

fig 1 "FRAMS"-R



fig 2 "FRAMS"

The New Falling Energy Absorber "FRAMS"

by Konstantin Serafimov

National Association of Soviet Speleologists

The new friction falling energy absorber "FRAMS" was invented by the author of this report and recommended to use by the group of Security of the East-Kazakhstan Regional Club of Speleology - "Sumgan - SRT". This device has the best set of characteristics among falling energy absorbers that we know.

The "FRAMS" consists of a U-type frame, three non-opening brake bars and 2 regulator knobs on the ends of the frame. The amount of friction caused by the bars on the rope is controlled by the knobs. The knobs are tightened hard so the device will not slip along the rope under the load of 300-600 Kg - then the "FRAMS" is ready to use.

The "FRAMS" has 2 sizes. The rope type - "FRAMS-R", (figure 1) and the ribbon (sling)-type, (figure 2). The examination of the construction of falling energy absorbers allowed us to select some basic classes of devices.

- A. The absorbers with destruction elements or "textile type".
- B. The absorbers by "friction destruction" type.
- C. The friction absorbers

So, criteria of appraisal of fitness of falling energy absorbers was formulated. Let us look at the criteria in the succession of reduction of their significance.

1. Strength

If the maximum value of the load of slipping absorber along the rope is 400 Kg., the absorbers strength need be no more than 800 kg.

2. Threshold of the Working

The amount of force which leads the absorber to slipping is called the Threshold of the Working. The threshold of the working can vary as much as 250 - 500 Kg. If the force of the threshold of the working is more, we can not guarantee that the top anchor will be able to withhold the dynamic shock load. (We don't suppose the top anchor will "live".) So the maximum load on the anchor, in

conformity with the demands of the UIAA, must be no more than 500 - 800 Kg.

3. Regulation

The construction of the absorber must make possible the regulation of the threshold of the working. So, the means of the coefficient of over-loading: $K = P/G$ where P = the mean threshold of working and G = weight of the caver = 80 Kg, will be no more than 3.5 - 4.5. In the opposite case, the caver can suffer a traumatic blow as a result of the sharp dynamic blow.

4. The Minimum Braking Way

The absorber must have the minimum braking way. If 2 absorbers of different construction have the same threshold of working, the absorber with the shorter braking way is best.

5. Security

The absorber have sufficient security in the different, most unfavorable underground conditions.

6. The Influence on Wear

The absorber must not wear the rope or sling in the process of braking. But the absorber must have sufficient resistant to arrest the fall.

7. The Smooth Braking

The absorber must have a smooth nature of braking, without vibration. We felt the working of the destruction type absorbers vibrated too much.

8. Comfort During Use

The absorber must have good versatility characteristics, working on different size ropes, different conditions and repeated use.

9. Small and Lightweight

10. Simplicity in Technology and Manufacture

The analysis shows that the best set of characteristics are exhibited by the falling energy absorbers of the "friction" type. These devices have good prospects in vertical caving.

Not Only Knots

by Konstantin Serafimov

To the very last time, a fundamental feature of vertical caving technique, it was always necessary to knot a rope to be able to use it. In the first case, in the process of rigging.

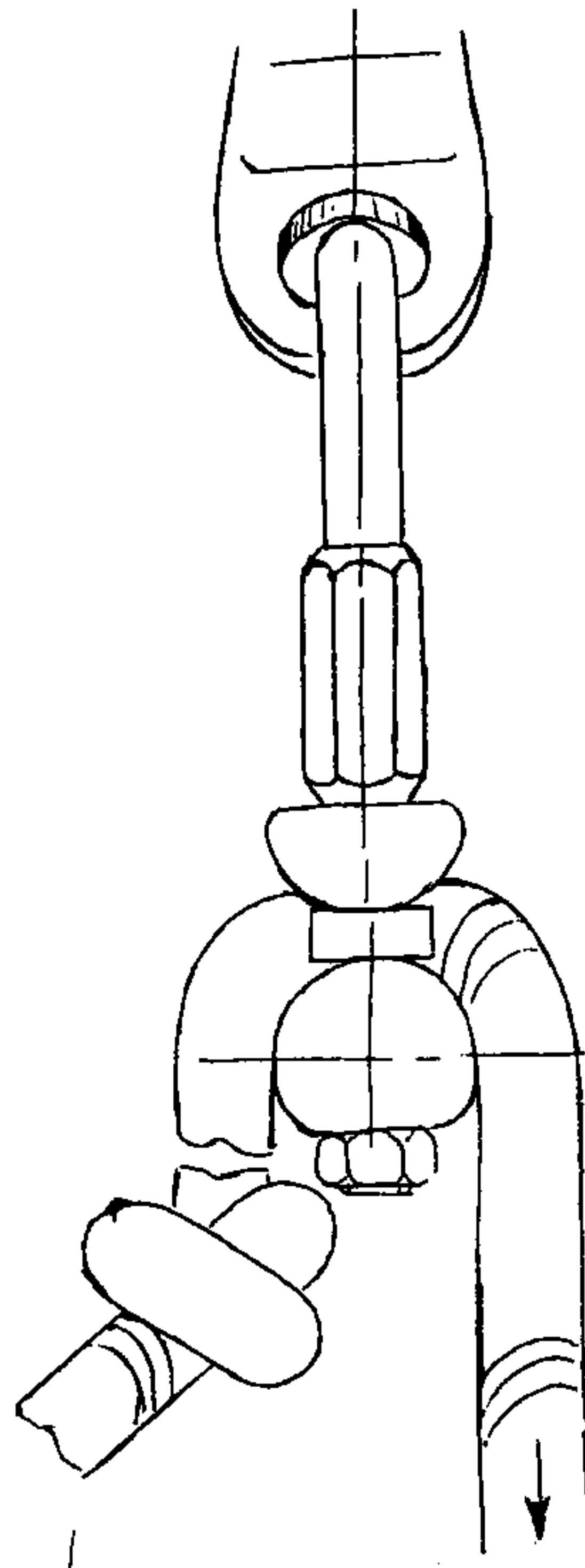
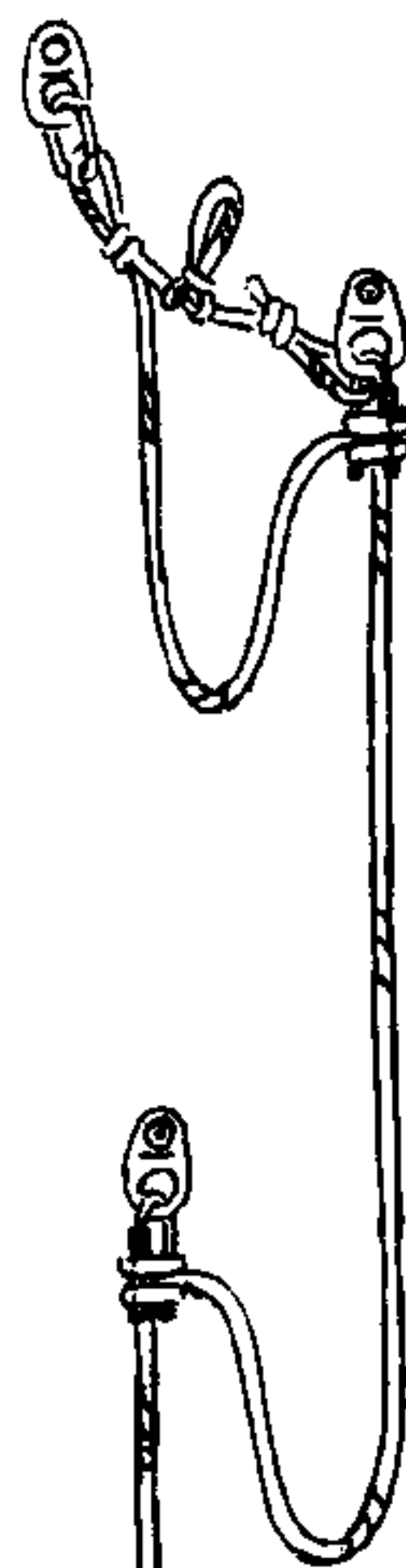
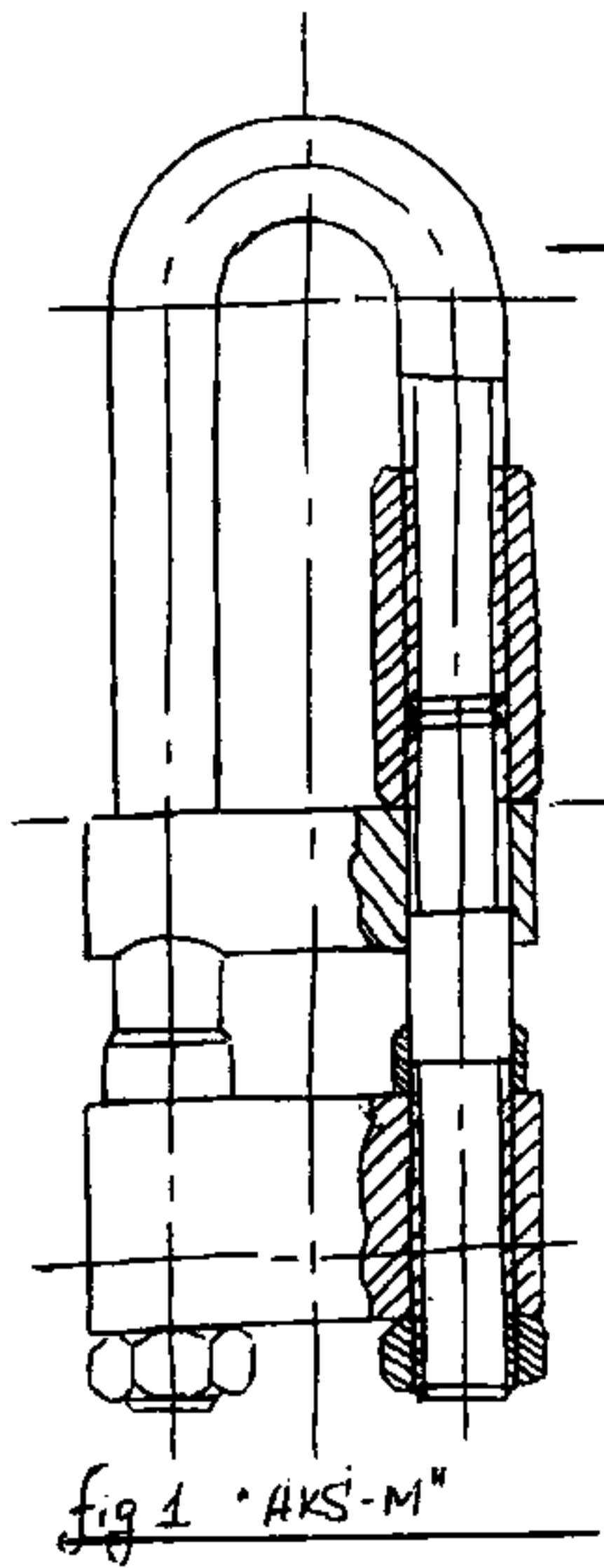
The group of "Techniques of Equipment" of the NASS looked into a new device: "Absorber Carabiner by Serafimov" ("AKS", "Sumgan - SRT" Club), which may substitute partly the knots in caving practice.

The device - the AKS - comes in some different sizes.

See figure 1. The testing shows sufficient characteristics of the "AKS" for application in Single Rope Techniques.

"AKS" can regulate the load of slippage of the rope, as a result of the dynamic blow. In the anchor point, for the purpose of holding the load within the admissible limits, this should be no more than 300 - 400 Kg. The application of the "AKS" in SRT gives a good prospect in improving the security of cave exploration.

Absorber carabiner by Serafimov



СССР. ВКОКС "Цумган" К.Б.Серафимов 1988г

TREASURER'S REPORT

NSS VERTICAL SECTION

FOR THE PERIOD FROM JULY 21, 1898 TO JUNE 25, 1990

INCOME:

Memberships.....	\$3309.00
Subscriptions.....	148.00
Back Issue Sales.....	742.60
Symbolic Item Sales.....	1351.75
Vertical Techniques Workshop (89).....	239.84
Bank Interest.....	332.36
Interest on CD's to date.....	124.40
Total Income.....	6,247.95

EXPENSES

Editor:

Printing Nylon Highway #29.....	1150.00
Typesetting Nylon Highway #29.....	450.00
Mailing Nylon Highway #29 International.....	114.45
Domestic.....	95.61
Resends.....	5.50
	215.56
Printing Nylon Highway #30.....	1200.00
Typesetting Nylon Highway #30.....	495.00
Mailing Nylon Highway #30 International.....	96.15
Domestic.....	102.33
Resends.....	8.33

	206.81
Printing Membership Questionnaire.....	293.00
Mailing Membership Questionnaire.....	78.26
Resend Questionnaire.....	25.87
Bulk Permit.....	60.00
Mailing Envelopes.....	185.89
Supplies.....	17.00
Total Editor Expenses.....	4,377.39

Secretary/Treasurer:

Postage.....	\$445.17
Supplies Dues Renewal Notice.....	\$41.21
Envelopes.....	35.63
Cash Box.....	23.57
Membership Forms.....	26.78
Other.....	40.15

	167.34
Vertical Techniques 89 Workshop Expenses.....	75.84
Advance for Vertical Techniques Workshop 90.....	200.00
Advertisements.....	112.87
Symbolic Items Cost.....	1143.81
Cave Register Project Donation.....	25.00
Gift to Czechs.....	19.00
Reimbursement to VAR for Patches sold at 89 Conv.....	18.00
Returned Checks & Service Charge.....	38.00
Total Secretary-Treasurer Expenses.....	\$2,245.03

TOTAL EXPENSES.....	6,622.42
NET LOSS.....	(374.47)
BALANCE AS OF JULY 21, 1989.....	5303.92
Net Loss.....	(374.47)
Balance as of June 25, 1990.....	\$4929.45

Soviet Exchange Program Contributions to date.....	2442.50
Cash Position as of June 25, 1990.....	\$7371.95

Close to the Edge

1989 Expedition

by Dale Chase

Personnel:

Alberta contingent: Rick Blak, Ron Lacelle, Gille Roy

Prince George: Dave Matthews, Gordon Meakin, John Kleininger

Costal contingent: Dale Chase, Merv Mitchell, Kevin Roberts

Quebec: Jean Pierre Boivin

For those unfamiliar with Close-to-the-Edge, it is an 800' shaft with a rebelay at 400'. Below the main shaft, a 90' drop leads to a short horizontal passage which ended in a tight crevice with a howling draft and a drop of undetermined depth on the other side. Depth to Twin Falls Resurgence is at least twice the known depth of the cave.

From the parking lot to the cave is several miles and a steep 3000' climb. It was discovered by Ian MacKenzie and not bottomed for several trips due to insufficient rope lengths. The intent of our trip was to go over, under, around or through the crevice.

Months of dreams, schemes, preparation and practice started coming together with the possibility of a free helicopter gear lift with Brian Pratt, a paleontologist who is studying the fossils of the Dezaiko Range. After days of waiting, Brian arrived in Jasper late one night to announce the Prince George departure the following morning. Rick Blak of Jasper accompanied the chopper up the mountain and stashed 2400' of rope, a very heavy rock drill, assorted paraphernalia and food for the coastal and Prince George contingents. The Albertan somehow got nothing on the lift but with typical Albertan guts and iron Neanderthal determination, they made 2 trips up the mountain instead.

Day 1, Saturday, August 26

The Alberta crew carry up their first load of gear.

Day 2, Sunday

Prince George and coastal crews arrive at the Horse Corral and join the Albertans for a 'pleasant stroll' up the hill. Also along for the hike and to sherpa for us was Steve Cutts from Prince George. The Albertans left us all choking on their dust, arriving at the top hours ahead. Carrying heavy loads up the hill for 2 days running had left them so full of vim and vigor that they elected to camp another half mile and 200+ meters higher up the mountain, at the 'Penthouse'. At the pit everyone hangs over the 'Cookie Tosser', a large flat boulder with a dizzying view of the drop.

Day 3, Monday

The first task is to rig the top half of the drop and un-clip the (nuisance) American rope from the rebelay (400' down) so that all the rigging can come out of the cave and major gardening begin. The rope was left in place by the previous bottoming trip. The author's feelings about this rope in no way reflects on his regard for our American

comrades. Dale waffles the least and is sent over wondering "how did this happen to me?". The rebelay is unhooked and we put our backs into hauling out the (cursed) American rope which has stubbornly wrapped itself around large boulders on the bottom. Gord rigs a block purchase but to no avail. Gord's blocks are left rigged for a possible rescue situation. We decide to go with the will of fate and leave the (misbegotten) American rope in place. Minor gardening takes place up slope. Dave clears and flattens the trail from the handline to the entrance. Rat traps are set with an absolutely fool-proof bait - peanut butter.

Day 4, Monday

The rat traps are checked. The little rotters have cleaned the bait without springing the traps and have defecated all over them. Ron Lacelle and Gille Roy descend the 800', the blasting/communication wire is lowered and with the usual obstinate nature of physical reality wraps itself around everything. Our first communication with the bottom is Ron's immortal phrase "the turkey has landed". The search begins for the famous flying garbage can. It's hard to find, partly because Ron is standing on it. Speculation as to its future usefulness is ended when Ron announces he has found it and that we might be able to cram in a soda cracker.

The rope for the go is inspected and rigged around a VBFR. Gille and Ron start a dig in the clay and rubble below the crevice while Merv descends. The dig starts at about the old floor level and slopes downward at about 30 degrees for 1.5 meters, still drafting well through the floor. The dig continues until it becomes impractical to pull rubble out from any further in. The ascent begins. Each of the climbers tries to untangle and climb through or over the wire. Merv almost solves the problem, but is defeated by the lateness of the hour and the cold. Gille observes that coming out on the frog system is like doing 800 push-ups on a water bed. Gordon and the others spend time grading and paving the entrance path to the rope, so that the surface crew created no danger of sending down rocks. The rat traps are reset, this time with sure fire shrewdness and irresistible gait, peanut butter, raisins and old rope. "If you want to catch a rat, first you have to be smarter than the rat."

Day 5, Wednesday

No rats again. Gord heads down the mountain for an unbreakable commitment. Dale and Rick descend, sort out the wire and assess the dig. First thing, plan B is put into effect. Smoke bombs are placed in the furiously drafting crevice and everyone on the surface scans the topography below. No smoke is sighted so the consensus is that it must be coming out near Twin Falls Resurgence. The bottom of the go is solid clay under rubble so we set the charges at the end of the dig and the entire dig is repacked with clay. Rick and Dale emerge. Kevin Roberts (from Richmond) arrives just in time to derig. The cave is derigged, the blast set off and not a pebble falls.

We decide to give up on catching rats. Everyone is secretly pleased that we didn't catch any. They're so cute with big brown eyes, that if they didn't eat rope and gear, smell like skunks and carry bubonic plague, we'd love them dearly.

Day 6, Thursday

Steve Cutts arrives with coffee, fresh cream, toilet paper and liquid refreshment. He also brings us a surprise visitor from the S.Q.S., Jean Pierre Boivin. After a brief lunch, Dave Matthews and Jean Pierre re-rig and descend the pit, with only minor problems caused by our line wrapping round the (G.D.) American rope, which we haven't yet pulled because it is located in such a way as to surely wrap and thrash our communication line. This wire serves a dual purpose. One is to function as a telephone line for the low power C.B. radios, extending their range and allowing them to transmit round corners. It also carried a current from the top to the dig to set off the charge. While previous tests had shown that our radios didn't put out enough power to set off the caps, we decided that discretion was the better part, observe radio silence and went to whistle communications when the caps were on line. The pit is so large that numerous lines could have been put down without tangles, had we but the infinite benefits of hindsight. Dave and Jean Pierre find that the blast has opened the back of the dig to a point 2 meters deep over top of a 3.5 second drop. Some hours of digging opens the 2 meter tube to 60 cm in diameter, with a very short constriction over the next drop.

Gille (formerly a hard rock miner) descends to place the charge, leading ultimately and almost surely to success. While he is descending, giant cumulonimbus clouds build up on the horizon. At about the time he is ready to put the electric caps on line, lightning approaches the mountain, so the blast is aborted. All the gear is tied on in preparation for derigging and all ascend. The lightning storm passes us by, by a wide margin, but too late. Ron has headed down the mountain with the unneeded rock drill and made it back to camp by dark. Four hauling trips for Ron. Rats scurry underfoot looking for yummy cave gear.

That night, all around the fire, all the liquid refreshment is consumed. Arms entwined we bemoan the fact that never again will such giants as we walk the earth. Merv discovers a clean pair of underpants and offers them around for \$5 a sniff or \$10 to wear them. A small voice in the dark cursed rats and American ropes. Slurred promises are made to return same time next year to finish the job with helicopter assist.

Day 7, Friday

Schedules and weariness catch up with us. We derig

everything. The (Devil-begotten) American rope comes up reluctantly, dragging along great tangles of wire. The cave is once again free of human artifacts except for bolts. All is finally sorted, inspected and coiled. We succumb to that common caver's malady - phyllaholup syndrome. Most of the crew depart, deciding to carry everything down in one grueling grunt instead of 2 trips. Kevin, Joan, Dale & Merv stay another day to sort out, stash, burn and clean up around the entrance and camp areas. We also decide to do the one trip grunt.

Day 8, Saturday

After considerable haggling over relative volumes and weights, we cram 4 peoples gear and 600' of rope into 4 packs. We head down the mountain looking like a Gypsies' caravan without a caravan. On the way down we find that our guardian angel, Gord had been up with a chain saw and turned some of the worst of the trail into the best. We arrive in Prince George mid afternoon and after some stops for refreshment, head to Joan's bathroom scales for the weigh-in. The weigh-in soon becomes a befuddled farce as various shapes and sizes of rocks are found lurking in people's packs. Undaunted, we continue;e celebrating till the wee hours.

Afterward

This pit is awesome and beautiful but treacherous in the extreme. Melting ice formations break loose, spontaneous rock falls occur with alarming frequency and wet weather creates major waterfalls. Pack rats really do crawl out of the walls and chew up ropes and gear for nesting materials. Our toilet was dug by a grizzly bear. Groups attempting this drop should have some system for self rescue. Shoulder pads, if not too restrictive, would be a good idea. Communication to the lodge is very difficult and to the bottom, impossible without technical aid. Anyone considering this adventure should discuss it with someone who has been down. GOOD LUCK.

CTTE '89 would like to thank the following people:

The Devil's Club of Prince George: Gord Meakin, Ed Griffiths, Steve Dubas, Ian MacKenzie and Dave Meakin for the work on the trail and cable crossing.

Steve Cutts of Prince George for 2 sherpa trips.

Ian MacKenzie and others for their good advice and help in organizing.

Brian Pratt and Liz Turner, paleontologists for the helicopter lift of gear up the mountain.

Phil Whitfield for the loan of 600' of PMI

John Kirk of Denman Island for technical advice.

And all participants for a great time.

GRAVITY!
IT'S NOT ONLY REASONABLE
IT'S THE LAW

Improvised Braking with the Ball Hitch

by Heinz Prohaska

The basis for these considerations was a nautical knot named the Munter hitch or Italian hitch among climbers and cavers. It is known for lowering persons instead of rappelling, especially in difficult situations and rescue work (Figure 1). Unfortunately, the braking force of this knot can be insufficient, e.g. with a rope of smaller diameter or with two persons on it. Two Munter hitches in a tandem arrangement, like shown in publications (Figure 2) can cause inner forces between the Munter hitches and unequal load of the anchor points. This author saw the possibility of superimposing Munter hitches in the same carabiner in a simple way and gave the result the name "ball hitch" (Figure 3).

The ball hitch shows how even high braking forces can be realized quickly with a few wraps. The friction grows with every wrap by nearly a factor of 5. Moreover, similar to the Munter hitch, the friction grows with the speed of the rope and can increase many fold. As the load below a limit depends on the rope and the number of wraps, the friction in the ball hitch locks off the rope. Lowering is possible above the limit and below. Above, which is the traditional way, controls speed by additional braking. Working below needs a reduction of friction, which can be obtained like shown in Figure 4, and has the advantage of excluding human failure. It is impossible for the rope to get out of control. Similarly, rappelling is shown in Figure 5. The use of these techniques depends on the circumstances. In

Caving, rappelling with descenders is the standard and other methods are restricted to emergencies. In mountaineering, where conditions are different and special devices are not always carried along, descenderless work is usual. In both applications, the ball hitch technique can contribute to more safety by simple means.

Another application is the shock absorber. Figure 6 shows an improvised autobelay for climbers reducing impact forces on intermediate belays. Ball hitch release knots are simple and efficient and can be finished, for instance, like shown in Figure 7 and need no wraps.

The ball hitch is not needed every day, but it is a supplement to the Munter hitch, making a complete system. It has been tested with webbing, kernmantle rope and kernmantle cord. In every application, the needed number of wraps depends on, besides the load, the material used, especially on the thickness of the rope or sling, but as a rule, 2 to 4 wraps will do.

Historically seen, the superpositions of Munter hitches has been known for fastening ships on bollards for a long time. But conditional to the requirements of this use, the nautical way of making the superposition is different from the method shown above and accordingly, the result is another one too. It looks more asymmetrical and every odd wrap has an additional coil.

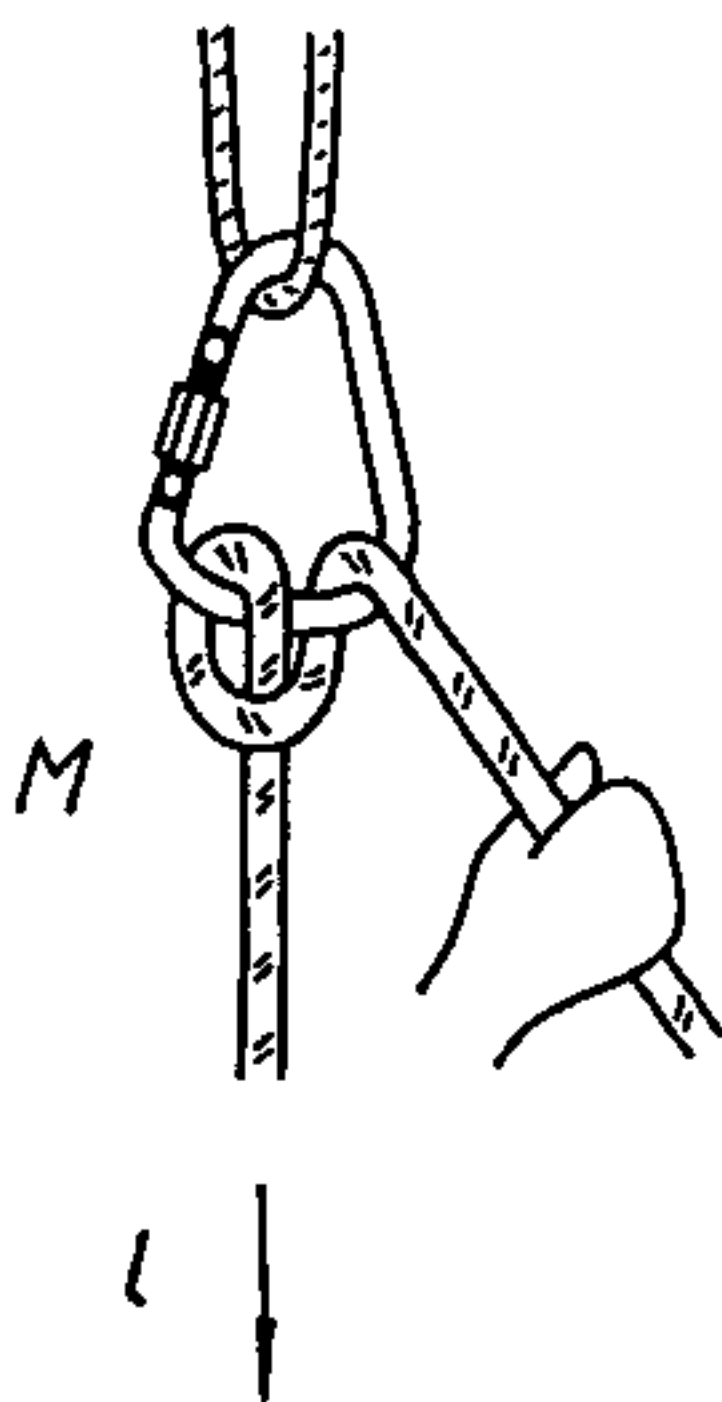


Fig.1 Use of the Munter hitch (M) for lowering (l) load

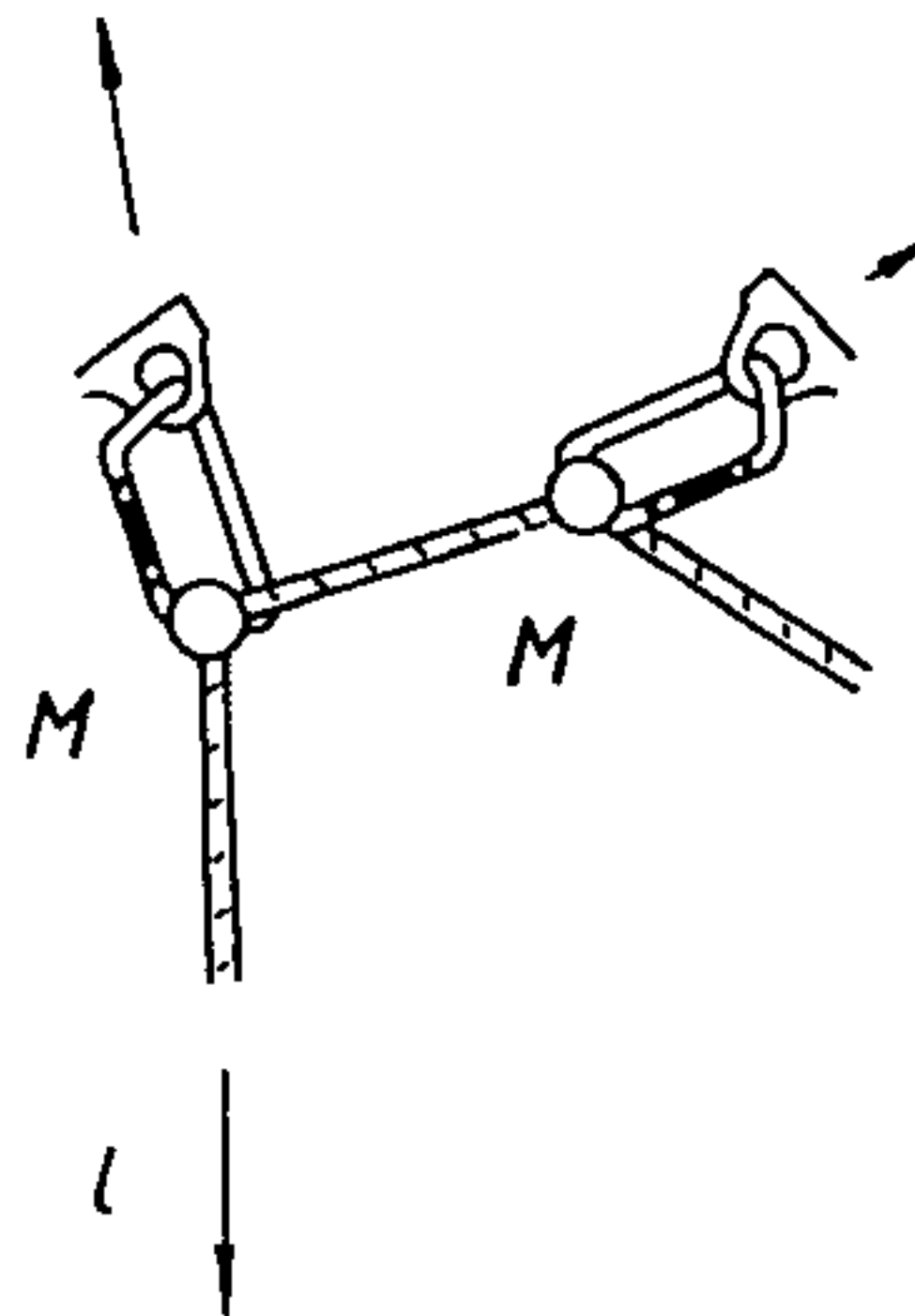


Fig.2 Unequal load of anchor points by Munter hitches (M) in tandem arrangement

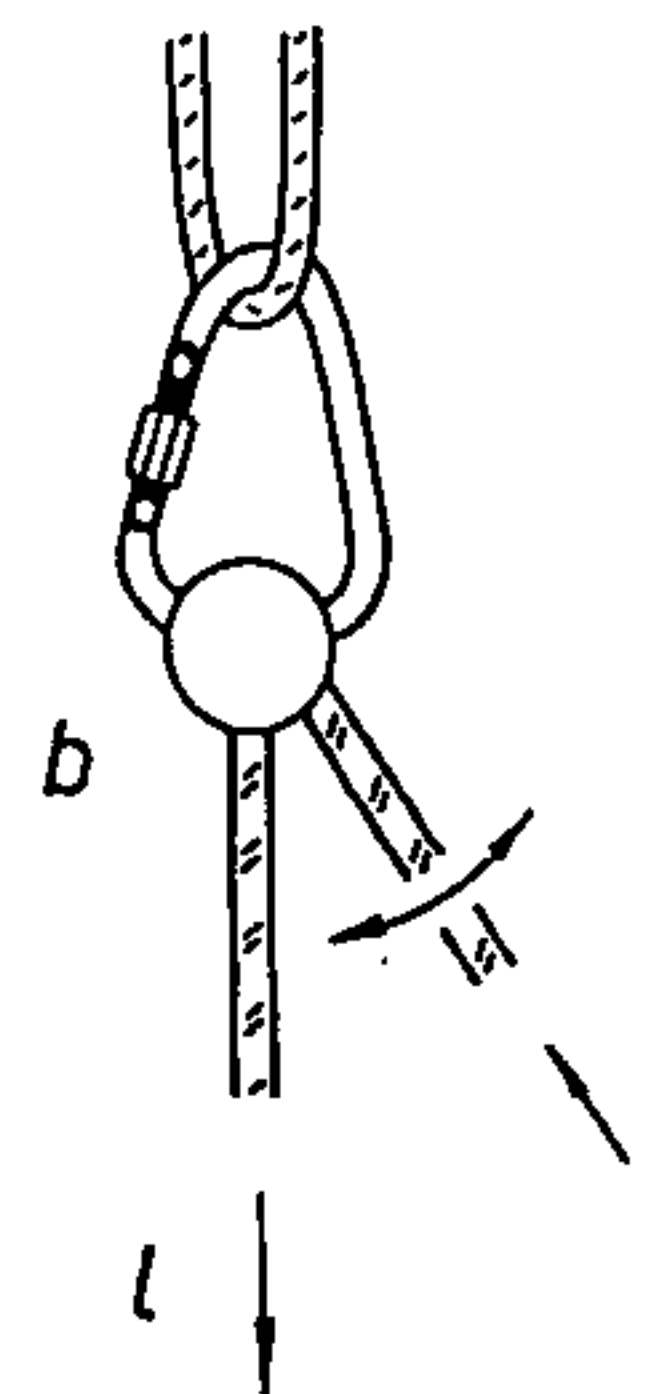


Fig.4 Self-locking lowering with the ball hitch (b) by reduction of the friction of the outermost layer

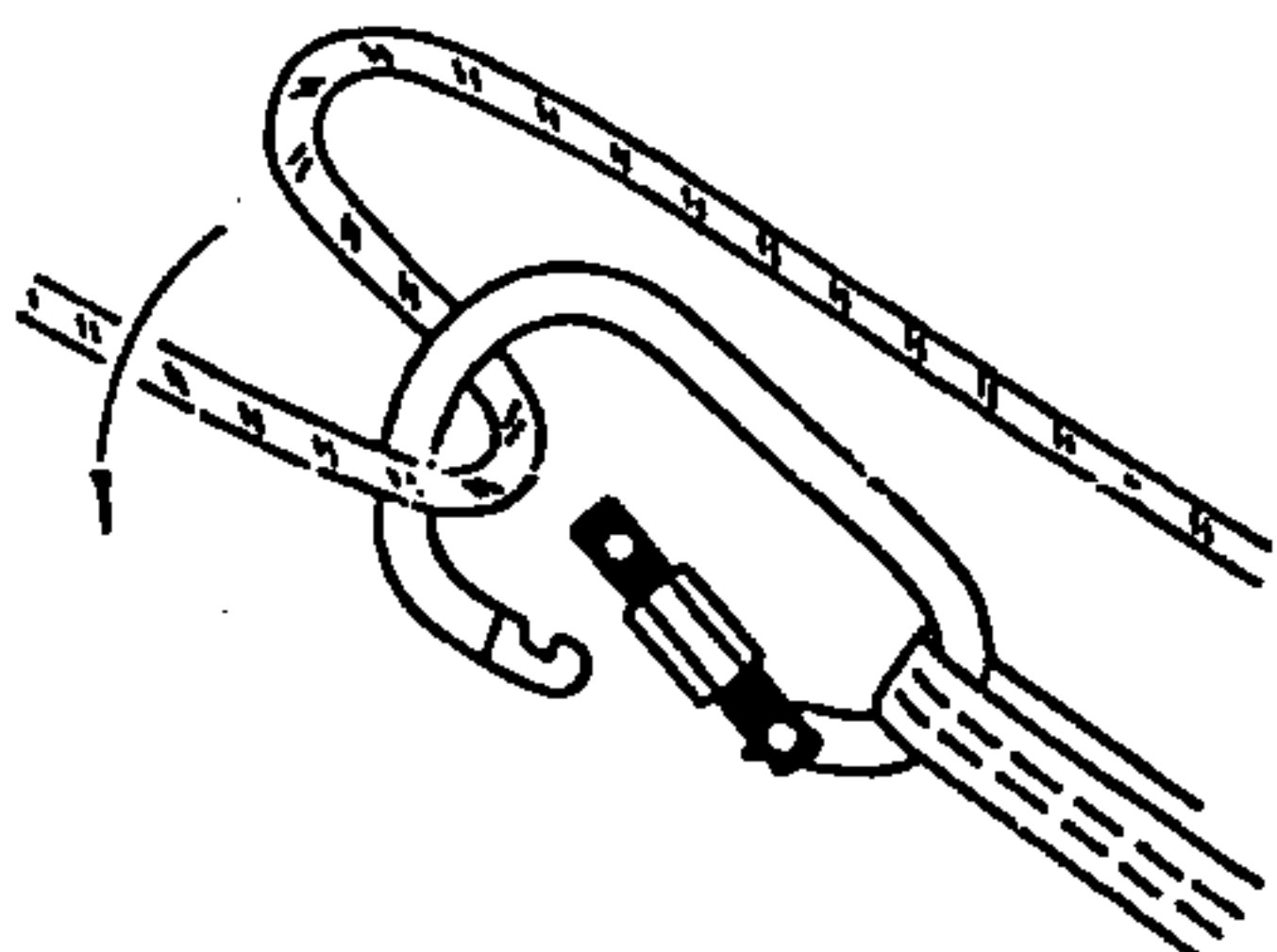


Fig.3 Spiral superposition of Munter hitches to a ball hitch

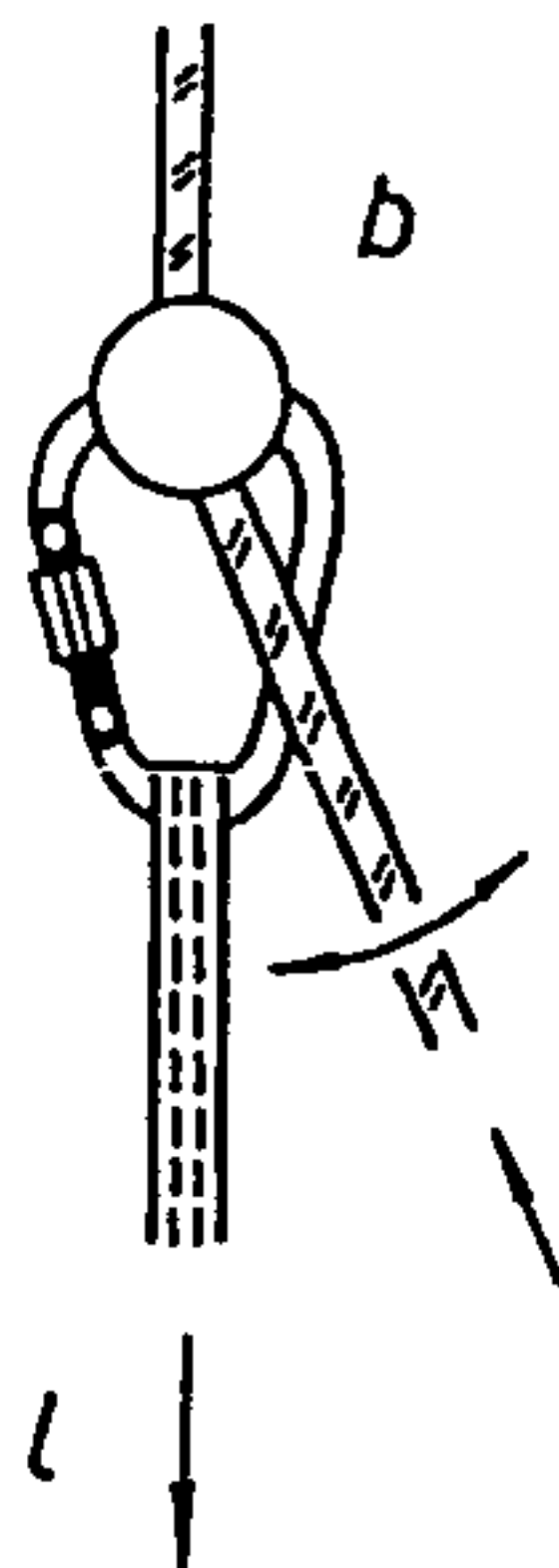
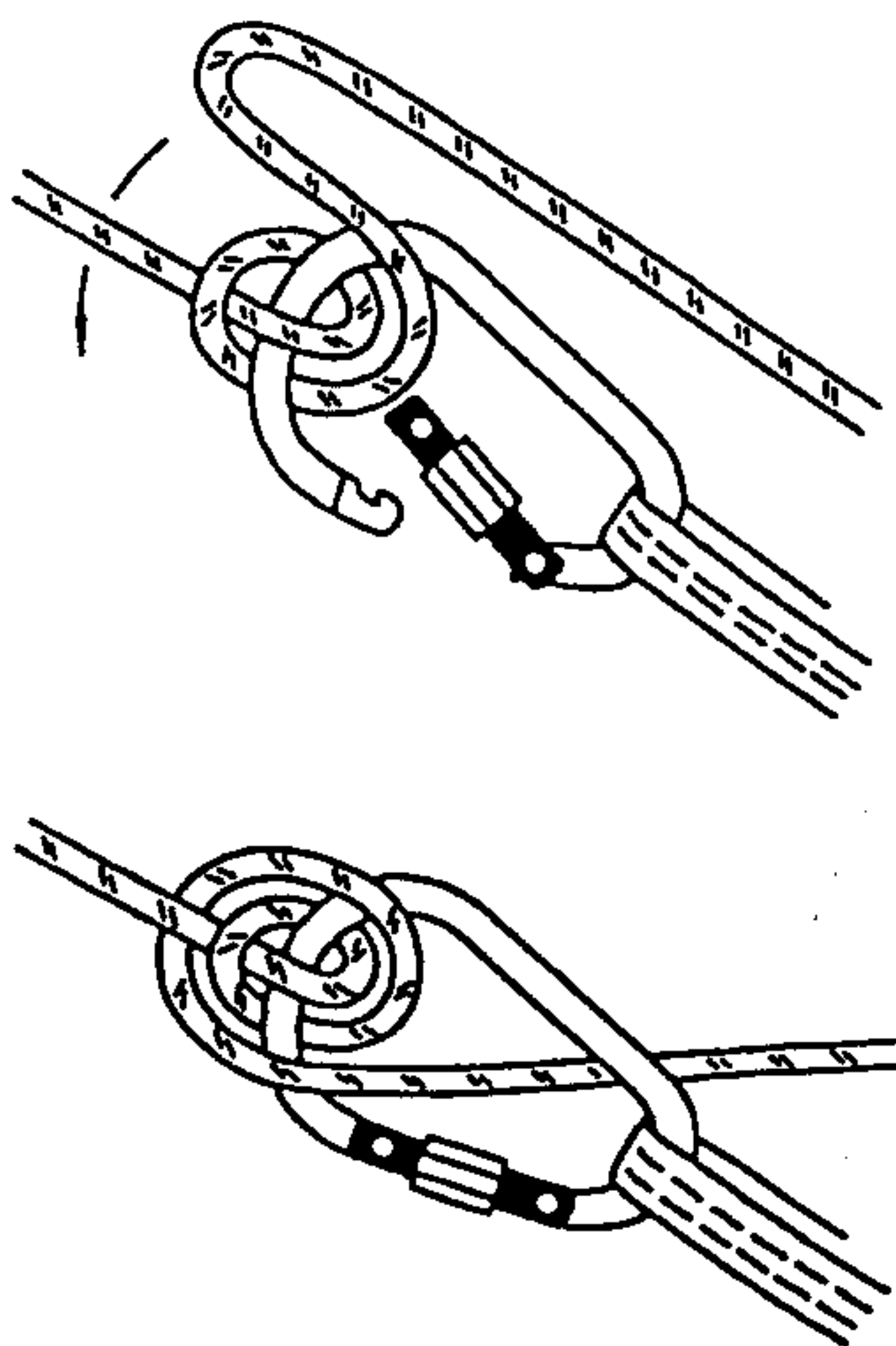


Fig.5 Rappeling with the ball hitch (b) as both a braking knot and a rappel belay

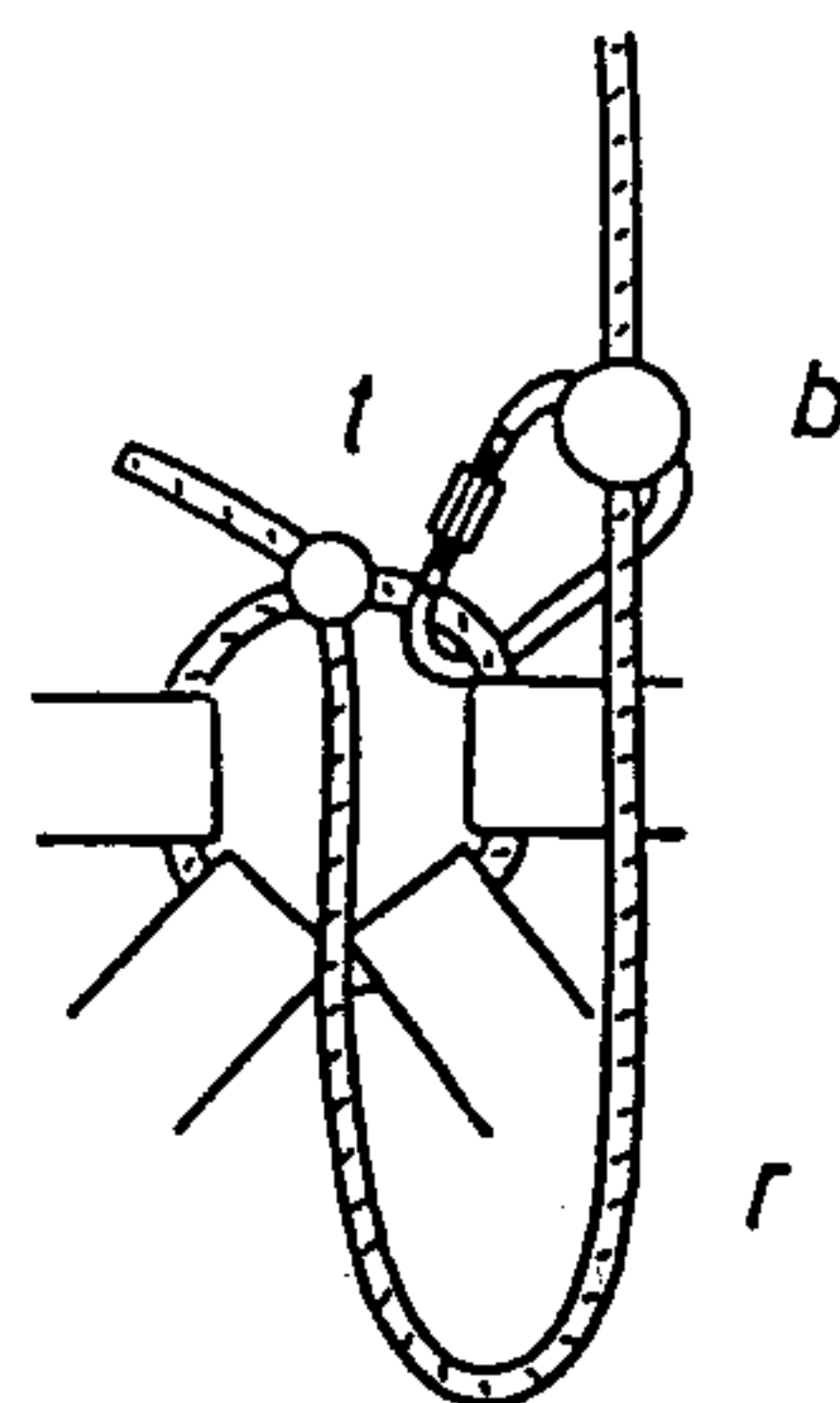


Fig.6 Use of the ball hitch (b) as an auto-belay (r rope reserve, t tying-on knot)

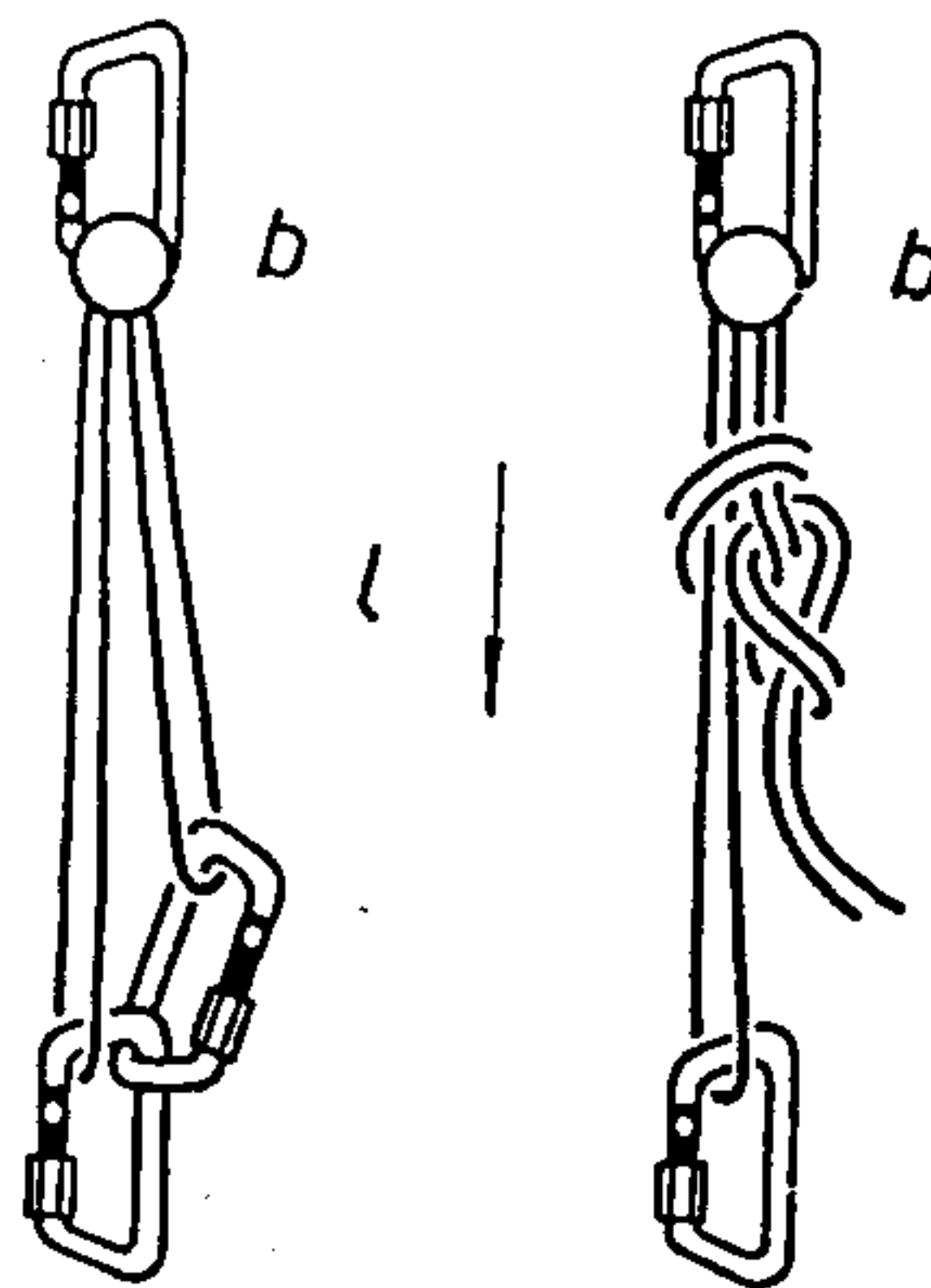


Fig.7 Ball hitch release knots, finished with a karabiner (left) and like a halter hitch (right)

Strength of Climbing Systems

Bill Klimack

In *Nylon Highway 26*, Gary Storrick discusses several topics about strength of vertical equipment and raises some questions. He sought to stimulate discussion. I read through his article and had a few thoughts of my own. My musings follow.

1 Weld Strength

1.1 Distribution of Weld Strengths

One of his topics is the strength of welded rappel racks. He hypothesizes that the strength of the welded eye on the rack may be bimodally distributed. Examples of unimodal and bimodal probability density functions are shown at Figure 1. The term modal refers to how many “humps”

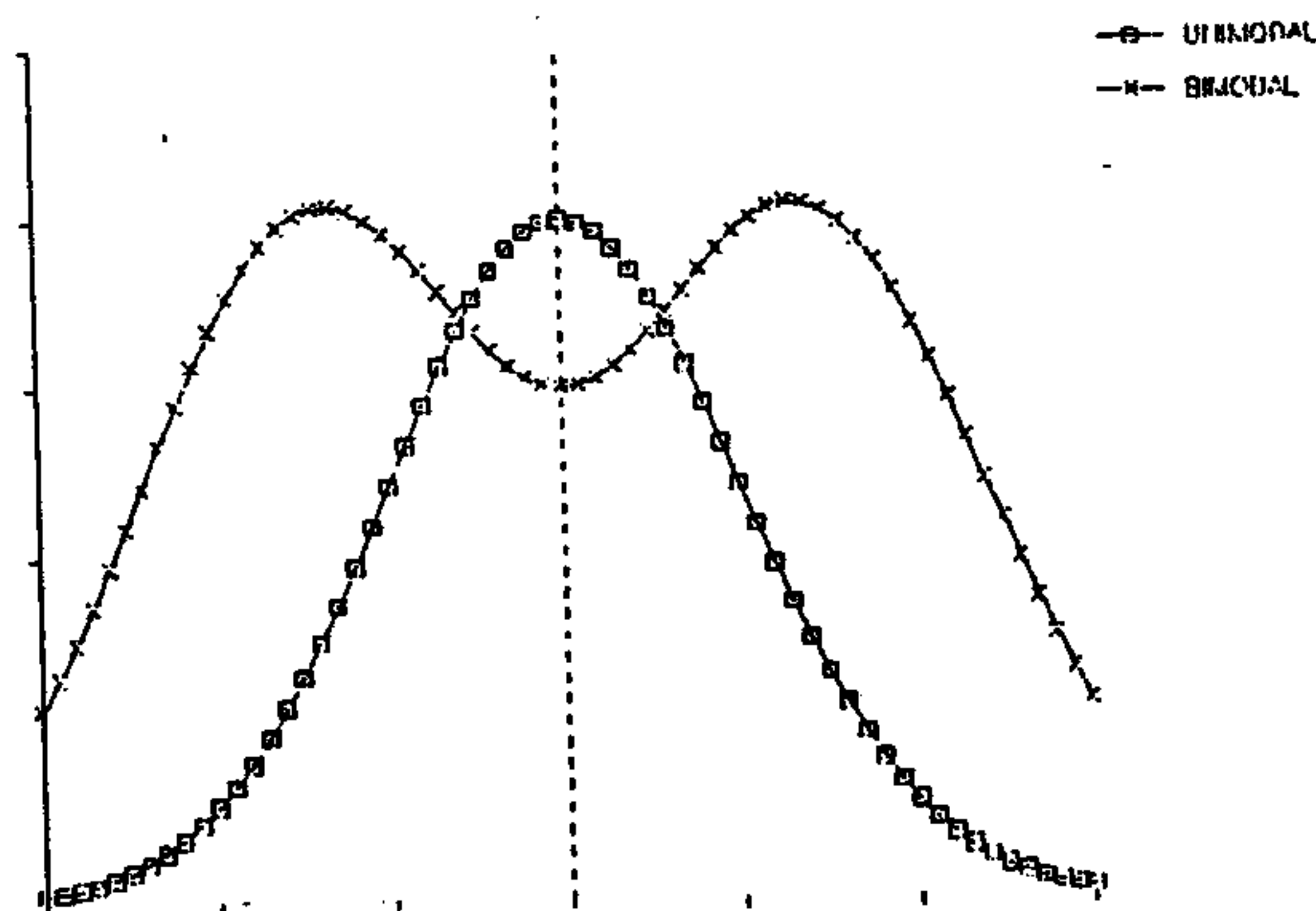


Figure 1: Sample Distributions

the distribution has. Unimodal distributions have one, bimodal two, and so on. I know of no reason why the strength of a proper weld in steel shouldn't have a Gaussian (normal) distribution — that's one hump. For instance, the more porosity that you have in the weld, the weaker it is. The likelihood of more porosity should drop as porosity increases — that is, if you have too much porosity, you're more likely to have a little bit too much porosity than a whole lot of over-porosity. So the number (or expected value) of really weak welds should be very small, a larger number slightly stronger, a still larger number even stronger, and so on till there is a peak at the mean weld

strength. Then the numbers taper off, many a little stronger than the mean, fewer still stronger, and so on.

I would expect a bimodal distribution to show up in something like a polymerization process that can turn out two different products depending on the temperature. Each peak represents the mean strength of each of the two outcomes. This distribution might also occur if there were two ways to join two parts of a structure — a right way and a wrong way. This might be the case if the weld was cracked because of improper welding technique. The upper (right) hump would be the mean of the uncracked welds and the lower (left) hump would be the mean of the cracked welds.

Obviously, the ultimate strength test is certainly loading the rack until it fails, destroying the sample. But there are non-destructive tests available. Dye penetrant tests fall into this category. In fact I recently bought a rack that had a tag saying that it had been tested in accordance with "MIL-I-6866." This is a dye penetrant test to look for cracks.¹ Hopefully this eliminates the bad welds (the left hump, if there ever was one) and we're back to a unimodal distribution.

1.2 Weld Strength Testing

Gary goes on to say that he feels that the welds are not adequately tested. He says that if "quality control was so bad that only 99.9 % of racks would be defect free, it would take perhaps 20,000 breakages to 'adequately' define the statistics of the defective .1 % ... Add another 20,000 unwelded racks as an equal size control sample and we have ... nearly 4 years of 40-hour weeks, breaking 6 per hour." Testing welds on racks is done to determine the statistics of the entire population, not just the defective proportion, but his key point is that such a large sample cannot be reasonably tested.

Perhaps this is true. Fortunately such a large sample isn't needed. First, let's suppose that we have a 'biner that is designed to hold 6,000 pounds. I want to test this. I test five and determine the mean strength to be 6,850. Then I test 45 more, for a total of 50, and, coincidentally, the mean is also 6,850. The means are the same, but is there a difference between the two answers?

Yes. I have more confidence in the second answer. That's pretty intuitive. The more that you test, the more comfortable you can be that your particular sample is really representative of the population (the whole group of 'biners in which I have an interest). If I break them all (all probably means an entire manufactured lot), then I have 100 percent confidence, but no 'biners. Break one, I have one datum point: an anecdote, not a statistic. The challenge then, is to determine what confidence I want in my answer so that I have some 'biners left while still being comfortable that they are OK. This answer tells me how many I have to test.

Example 1 Let's suppose that we make racks and that we have a lot of data from previous tests. (I'm not sure what alloys are used so I picked a stainless steel alloy and some data for it as shown in Table 1. [9] If a rack is 5/16 inches in diameter, then its cross sectional area is .07668 inches square and would have a yield strength of 7,284.60 pounds if made from stainless 304L)

We then know something about the population of all racks. If racks have a known standard deviation in strength (and these strengths are normally distributed), we can assume that our latest lot of racks has this standard deviation. Let's assume for our example that this is 50 pounds. That

¹MIL-I-6866 was superseded in July 1987 by MIL-STD-6866. I couldn't locate a historical copy of the old "mil spec." Unfortunately mil standards do not have criteria as mil specs do, so MIL-STD-6866 wasn't useful in determining the quality of the weld. Mil standards tell you how to test, rather than how good the results of the test must be to be acceptable.

Table 1: Properties of Selected Alloys

	Hardness	Yield Strength	Tensile Strength	Elongation
	Brinell	1000 lb./sq. in.		% in 2 in.
Stainless Steel type 304L cold drawn	277	95	125	25
Aluminum Alloy No. 5052-H38	77	37	42	8
Aluminum Alloy No. 7075-T6	150	73	83	11

means that over 99 per cent of all racks break within plus or minus 150 pounds of the mean. If we've designed the racks to hold 7,400 pounds, but they only need to hold 7,000 — our advertised strength — then we have a 400 pound safety design margin. Let's say that we want 99 per cent confidence that our racks true strength is within 10 pounds of our answer that we get back from testing a sample. (The mean strength is a point estimate; the plus and minus 10 pounds establishes a 99 percent confidence interval). Then the size of the sample that we must test can be determined from the formula [7]

$$n = \left(\frac{Z_{\alpha} \sigma}{E} \right)^2 \quad (1)$$

where n is the sample size

Z_{α} is the z value for a standard normal distribution

σ is the population standard deviation

and E is the allowable error

Z_{α} is the standardized transform of α , which is in turn determined from the expression $100(1 - \alpha) =$ confidence. Since we want the confidence of 99 per cent, $100(1 - \alpha) = 99$, or $\alpha = .01$. Z_{99} , determined from any standard normal table, is about 2.33.

Substituting back into Equation 1 yields

$$n = \left(\frac{2.33(50)}{10} \right)^2 = 135.7 \approx 136$$

This means that you would have to break 136 racks to achieve 99 percent confidence that the true breaking strength was within 10 pounds of the mean breaking strength of the sample racks.

If we want to be more confident we select the appropriate Z_{α} value and recalculate the sample size. Table 2 shows how varying the confidence affects sample size. It also shows how varying the allowable error changes sampling.

As we wish to increase the confidence and/or decrease the permissible error, the size of the sample required grows. But even to be 99.999 percent confident that the sample mean is within 25 pounds of the true population mean, we only need to test 64 racks. With a good design strength margin, this shouldn't be a problem. I'd guess that the design margins are a lot greater than 400 pounds.

Table 2: Sample Sizes for Various Confidence Levels and Allowable Errors

	Allowable Error					
	1	5	10	25	50	100
Confidence						
99	13572	543	136	22	5	2
99.9	23871	955	239	39	10	3
99.99	34411	1377	345	56	14	4
99.999	40000	1600	400	64	16	4

1.3 Establishing the Strength Criterion

So far we've addressed the confidence in our results from testing. But how good does our point estimate or our confidence interval have to be? Since the strengths of our racks form a continuous Gaussian distribution, the probability that a rack will have a strength below some value will never be zero. But it can be very, very small. So small that a non-statistician would consider it zero.

Look at Figure 1 at the unimodal function. The curve never reaches zero at either end. It approaches it asymptotically – gets damn close and gets slightly closer the farther you get from the mean, but never equals zero. The margins of this distribution are called the “tails”. We want the left tail to be very small below our minimum strength value. This means that the mean will be greater than this threshold.

Example 2 *Let's say we plan on testing 64 racks to obtain 99.999 percent confidence that the mean strength of the test samples is within 25 pounds of the mean strength of all of the racks. Then what mean strength must our tests demonstrate? We want the left tail of the distribution to be as small as possible. Most standard normal tables have z values down to -3.99, which correspond to a .00003 probability that the variable in question is less than $z = -3.99$. We want all racks to be at least 7000 pounds strong, so*

$$z = (x - \mu)/\sigma$$

or

$$\mu = x - z\sigma = 7000 - (-3.99)(50) = 7199.50$$

We want our lower confidence bound on the mean, so the the 7199.50 figure is interpreted as the lower bound and the mean point estimate would be 25 pounds higher. This means that we want our test samples to have a mean of 7224.50 or higher.

If we want to be fastidious, there are better ways to approach this problem but I thought that this would be more illustrative. One should always test one's assumptions, and a key one here was that the variance of our new racks was the same as we've seen from earlier testing of past designs. What we could do is conduct a hypothesis test using the F statistic. If it turned out that the variance of our new rack design is different, we can still handle it but must treat it differently.

1.4 Control Groups

Gary suggests that a second group of 20,000 racks are needed as a control. Control groups are useful when you don't have full control over or complete understanding of your test specimens or

the test process. Biologists use control groups because you can't build mice. You can't be sure that all your mice are identical, so you have a group that you don't treat with whatever your working with and compare them to the group that is so treated.

If I'm designing a new part, and a welded rack versus a non-welded rack is a new design, then I would have the old design as a control group. Since I already have data on the old design, I may not actually test the old design again. I would if I thought that the old design had evolved over time, of course. But once I've accepted the new design because its better (or I wouldn't have accepted it) then I no longer need a control group. If the old design held 7,000 pounds and the new one holds 7,400, then my new strength criterion for acceptance is 7,400 pounds. I need to test enough to achieve the proper level of confidence that quality is maintained in future, but I don't need to go back and test the old design again.

1.5 Other Considerations

The calculations above used the yield strength of the material. The term failure refers to the point at which the material begins plastic deformation. The same calculations repeated using tensile strength would show the point at which the device would break, and these numbers would be higher. Also note that the weld should be stronger than the parent material. Failure would most likely occur elsewhere.

Eavis [4] suggests that the rack is most likely to fail by the "pig-tail" unrolling or a bar snapping at about 1,000 pounds. Because of the date he wrote the article, I assume that he is referring to aluminum bars and that welded racks weren't available yet. He points out that a total catastrophic failure is unlikely in this way, as this mode allows gradual dissipation of the energy as long as the rack is not locked off.

2 Forces in Ropes

Gary discusses the strength of ropes: "I've seen climbers take 30-foot falls on a thirteen fall rope [and] ... remark 'that has been eight, five to go.' Maybe, maybe not."

Ropes are evaluated using methodology approved by the Union Internationale des Associations d'Alpinisme (UIAA). This involves testing under certain conditions ² This means that unless I weigh exactly the same amount as the test weight, and fall exactly as far, then a fall while climbing isn't the same as one of these test falls.

The force to which a rope and other system hardware is subjected when catching a falling non-compressible weight can be determined from [6]

$$P = W \left(1 + \sqrt{1 + 2h/\delta_{st}} \right) \quad (2)$$

where P is the equivalent force

W is the static weight

h is the height from which an object is dropped

and δ_{st} is the elongation under the static load

²According to one source [5], a climbing rope, in order to qualify, must sustain an 80-kilogram (176-pound) weight during two falls of five meters (16 feet) with force transmitted to the climber not to exceed 1200 kilograms-force (2650 pounds-force) on the first fall.

This equation would apply over some range of h 's that is unspecified in Gregorits. The velocity of the falling weight increases with height (until the force of gravity equals the force of air resistance, of course). At extreme heights the high velocity has to be absorbed over such a short time that this relationship may no longer hold. I suspect that this isn't true for the cases with which we are concerned.

Now that we have a way of predicting the force a fall imparts on a rope, let's look at a couple of cases and see how much this force can vary. If it varies a lot, then counting the number of falls in actual use of a rope is not an exact measure of rope use.

Example 3 *Let's assume that we have a climber on a dynamic rope with ten feet of slack in his belay rope. So, if the weight is 180 pounds, it falls ten feet, and the rope has a seven percent stretch, Equation 2 becomes*

$$P = (180\text{pounds} - \text{mass}) \left(1 + \sqrt{1 + 2(10\text{ft})/0.7\text{ft}} \right) = 1158.83 \approx 1159 \quad (3)$$

Example 4 *If our caver weighed 200 pounds rather than 180*

$$P = (200\text{pounds} - \text{mass}) \left(1 + \sqrt{1 + 2(10\text{ft})/0.7\text{ft}} \right) = 1287.59 \approx 1288 \quad (4)$$

The slight change of twenty pounds of weight of our caver or climber resulted in $1288 - 1159 = 129$ more pounds-force being transmitted to the rope.

Note that as long as we have any amount of slack and the stretch of the rope is a constant percentage of the total rope length, then it doesn't matter how far the climber falls, the force is the same. This is because the $2h/\delta_{st}$ term is a constant. If he fell thirty feet, and the rope stretched 2.1 (a constant seven percent), then this term is the same ($10/.7 = 30/2.1$). The weight didn't change (although it might very shortly afterward, if you know what I mean), and the stretch compensated for the longer fall, easing the increased load over a longer stretch.

Example 5 *Now, let's suppose that I'm climbing second. The leader is thirty feet above me when I call for slack because of an overhang. Murphy's Law immediately comes into effect and I fall with ten feet of slack in the rope. But since I've got ten feet of slack plus the thirty feet that would have been there even without slack, the rope will stretch 2.8 feet (assuming this is a seven percent rope). Then Equation 2 predicts*

$$P = (200\text{pounds} - \text{mass}) \left(1 + \sqrt{1 + 2(10\text{ft})/2.8\text{ft}} \right) = 770.71 \approx 771 \quad (5)$$

The additional amount of rope made $1288 - 771 = 517$ pound-force reduction in the amount of force that the rope had to hold.

Example 6 *A leader fall is the worst-case scenario. I'm leading and I'm ten feet above my belayer, no slack, and fall. I fall twenty feet but have only ten feet of rope to stretch. Equation 2 is*

$$P = (200\text{pounds} - \text{mass}) \left(1 + \sqrt{1 + 2(20\text{ft})/0.7\text{ft}} \right) = 1725.03 \approx 1725 \quad (6)$$

In the last three examples, I weighed 200 pounds and fell ten feet. But the force the rope was subjected to was either 771, 1288, or 1725 pounds-force. (Examples 2, 1, and 3). Obviously the situation greatly affects the amount of force that the rope must hold. The less that you weigh, the shorter the fall, and the more rope available to stretch, the less force on the rope.

The above discussion used a rope stretch of seven percent. This is the maximum limit for kernmantle climbing ropes under static body weight [1]. The actual stretch could be longer since it is actually being impact loaded. This amount of stretch, high when compared to caving ropes, is why the rope is called "dynamic."³ Ropes used in vertical caving (static rope) are designed to minimize stretch so as to reduce wear from abrasion. These stretch less than one percent, if memory serves. Substituting back into examples 2, 1, and 3 for this reduced stretch yields 1628, 3035, and 4205 pounds-force, respectively. Comparing these to the values in the previous paragraph, we see that the lack of stretch has increased the force loading of the rope, increasing the probability of rope or hardware failure. That's one reason that static rope should never be used for belaying.

Another reason is that the force in the rope and the force delivered to the climber/caver are an action/reaction pair. That means that the same amount of force that the rope is subjected to is also delivered to your body through your harness. You could be belayed by a steel cable and never have to worry about subjecting it to forces that would cause it to fail. But it would stretch very, very little. The variable δ_{st} in Equation 2 would be very small, making the term under the square root very large. This would make the force a large multiple of your weight. Getting a cable that could sustain that force wouldn't be hard, but your body couldn't absorb that much force without damage. One author[4] suggests that the human body can't sustain more than about 2,200 pounds-force without injury. He also points out that having components of a system that handle more than this, allowing for wear, knots, and other weakening, is superfluous.

Note also that the force calculations were for an incompressible body, like tying the end of the rope around a metal weight. Since a human body will absorb some of the force through deformation (being squeezed through the straps of the harness to a degree), the peak force will be somewhat lower, just as if the rope had dissipated it. One reference places this reduction in the range of ten to fifteen percent [1]. I suspect that this could be good or bad, depending on the harness design.

Just to be complete, let me mention an equation presented by Edelrid [1], the rope manufacturer, for calculation of the force in a rope.

$$K = (a + G) + (a + G) \sqrt{1 + \frac{2fM}{aW}} \quad (7)$$

where K is the impact force,

G is the weight,

a is a "stored up value indicating which portion of the entire fall energy leads to the impact force,"

M is the "rope modulus describing the connection between the braking force [B] and the rope elongation L (in %) when a fall is stopped according to the formula $B = M - L/100$."

f is the fall factor, determined from $f = \text{length of free fall divided by the length of rope}$

³Laid ropes can be even more "stretchier." Some laid nylon 7/16-inch climbing rope can stretch a third of its length under body weight

payed out, for a maximum value of two (stretch neglected).

I'm not sure how this equation was derived. I offer it only for completeness.

Just so that readers have some numbers to refer to, I dug up some figures for nylons. I'm not sure which nylons are used in ropes, so you get the ones that I found (easily). [2] [10]

Table 3: Properties of Selected Nylons (Solid Samples)

	Tensile Strength	Elongation to failure
	lb./sq. in.	% in 2 in.
nylon 66	12000	60-300
nylon 11	8000	300

Finally, here is some data on various ropes [3]. It is dated and so current versions of the ropes may have different properties. Cowlshaw developed the term shock strength. It is the amount of energy that the rope can absorb when loaded to one-half of the ultimate tensile strength. He felt that this is the most useful parameter. Dividing the shock strength by the weight of the caver in pounds yields the maximum fall factor that the rope can sustain and stay under the one-half tensile strength limit. Cowlshaw also calculated the peak loading of these ropes for a fall factor of .75 and a 80 kilogram (176 pound) caver.

Table 4: Performance Data for Selected 11mm Ropes

Rope	Tensile Strength	Elongation under 80 kg	Shock Strength	Peak Force
	pounds-force	%	foot-pounds/foot	pounds
Bridon Viking Nylon/Kevlar	3639.66	1.9	39.348	2495.38
"Typical Climbing Rope"	5620.22	5	337.269	1258.93
Columbian R. C. Goldline	5813.56	8.8	311.636	1191.49
Marlow SRT	6350.85	0.9	97.583	3282.21
Pigeon Mountain Industries	6501.48	0.9	155.818	2495.38
Bluewater II	6505.97	1.1	147.274	2765.15
Edelrid Speleo Superstatic	6946.60	3.1	206.183	2158.166
Suggested Limits (Eavis)	4496.18	2		2697.71

One can see that the characteristics vary between different brands. Also the best rope in one category may not be the best in another. While one would expect the hardware in the system to be loaded to about the same degree as the rope, one source recommends considering the load on carabiners used as protection in rock climbing to be a third again higher [5]. This is supposed due to friction of the rope over the 'biner. I'm not quite sure of the rationale for this additional loading.

3 Fatigue

Now that we've discussed the forces in the rope from a fall, it's important to note that the fall rating of a rope is a fatigue failure criterion. Not only does it address a specific controlled situation, but this situation is repeated until failure. This cyclic nature is important.

If a caver weighs 100 pounds, then Equation 2 says that a fall would produce half the force of a 200 pound caver. That doesn't necessarily mean that the rope can absorb twice as many falls of the lighter caver, however. The number of falls at any significant weight has some effect.

The point at which a weight becomes significant is called the endurance limit or fatigue limit. Any number of cycles of successively applying and removing a load will not cause failure when the load is below this limit. But not all materials have such a limit. This behavior is typical of ferrous metals, but nonferrous metals typically fail eventually at any load. Figure 2 shows generalized curves for these two metals.

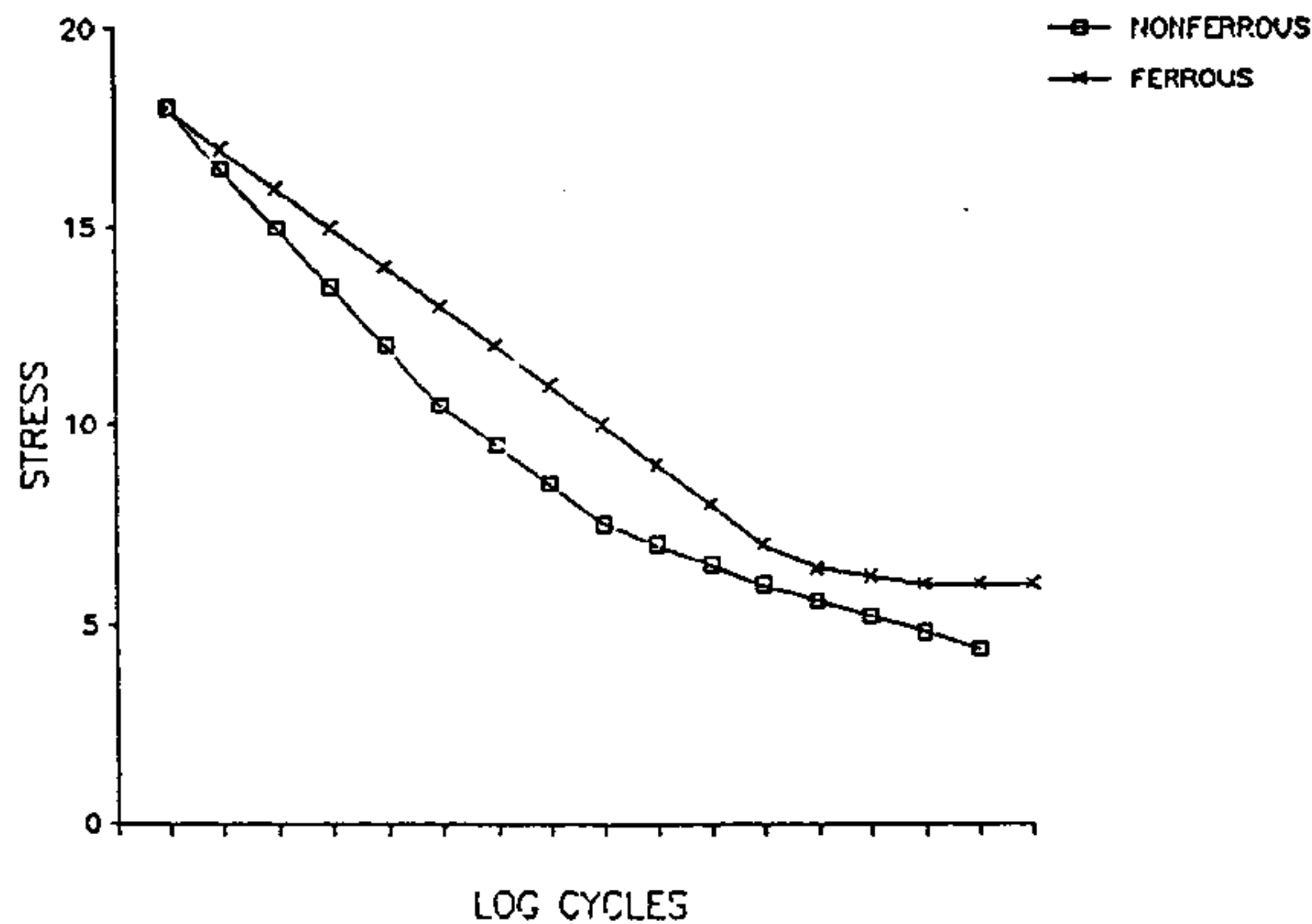


Figure 2: Typical Fatigue Curves, after Keyser [8]

Polymers may or may not demonstrate a fatigue limit. According to Rodriguez [10], nylon 6 has no fatigue limit. I take this to mean that any non-trivial loading lowers the ropes ability to handle stress. (I assume here that the other nylons behave in similar fashion as nylon 6). Figure 3 shows nylon 6 fatigue behavior. [10]

4 Water

The molecules of nylon are oriented as they are drawn into fibers. Apparently the molecules are attracted to one another through hydrogen bonding. When water is adsorbed into the fiber bundle, the water competes for the hydrogen bond sites, weakening the fiber strength. Incidentally, this is in contrast to some other fabrics. Cotton gets stronger as it gets wet; the wetter cotton is able to shift and spread the stress to more molecular chains.

Figure 4 shows behavior of the tenacity of these two fibers as a function of humidity [10]. Tenacity is expressed as force per denier. A denier is defined as the weight of a fiber 9000 meters

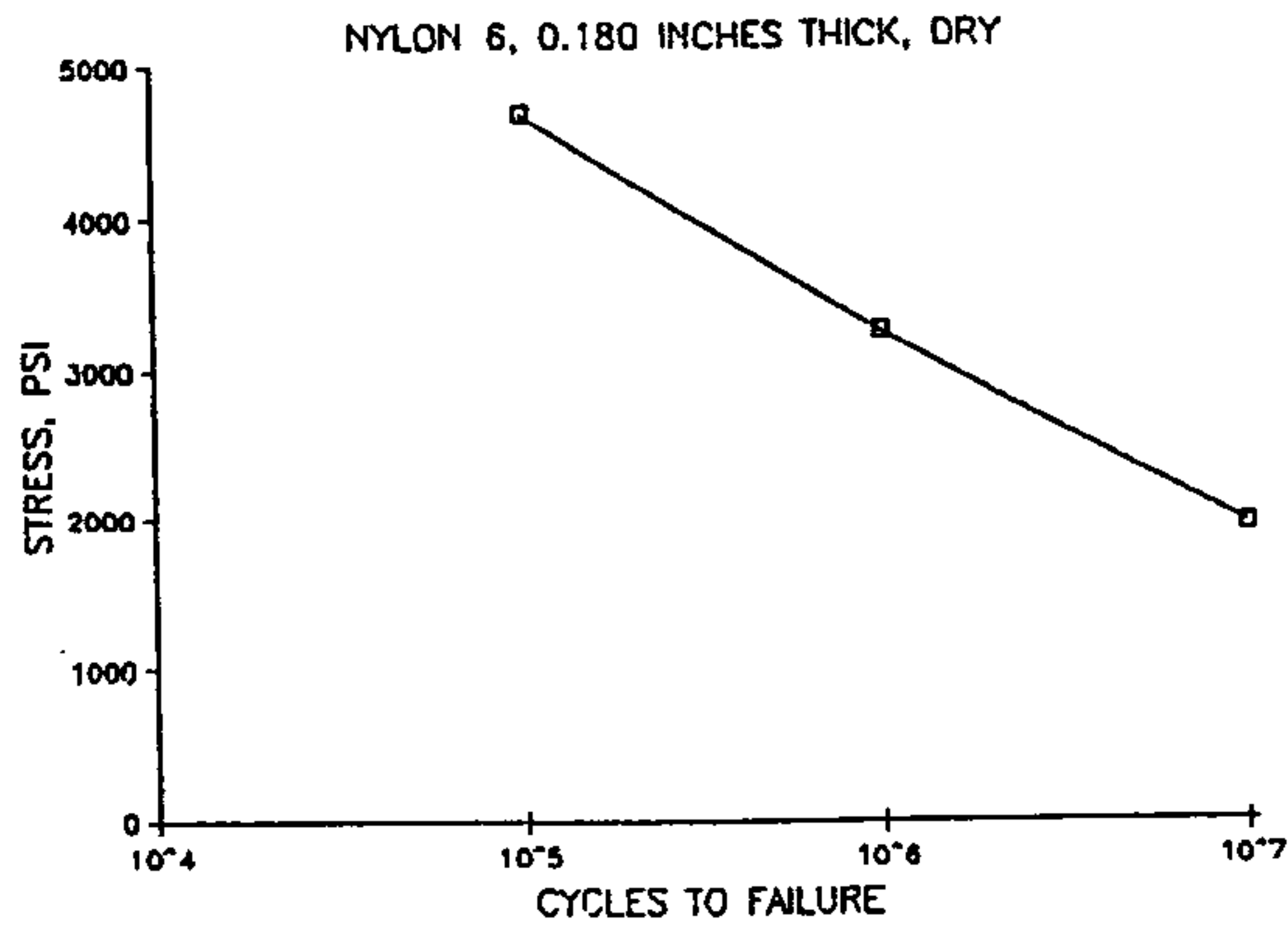


Figure 3: Fatigue Life Curve, after Rodriguez [10]

long in grams and is determined by the expression

$$\text{Denier} = 2.25 \times 10^5 (\rho D^2) \pi \quad (8)$$

where ρ is the density and D is the diameter of the fiber

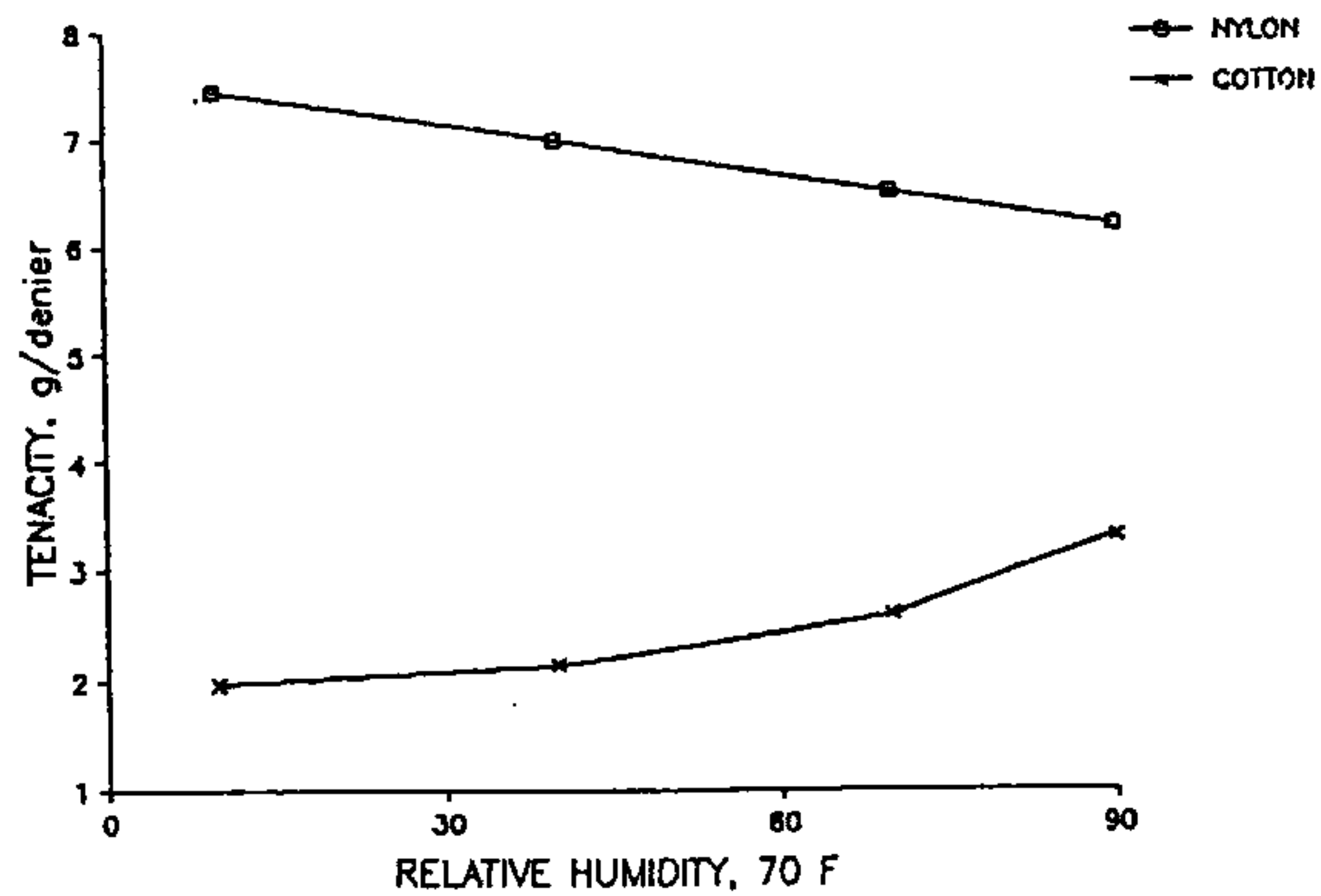


Figure 4: Selected Strength versus Humidity Curves, after Rodriguez [10]

5 Temperature

The strength of nylon decreases with temperature. Figure 5 shows that nylon 66 loses about half of its strength between ambient temperatures and 400 deg F [10]. As nylon 66 melts between 480 and 500 deg F, a rappel device hot enough to glaze a rope can threaten the rope strength if the heat is allowed to penetrate into the core of the rope. While this seems to be on the margin of the probable, I've heard of a case where someone on a long, very fast rappel had braked to a stop and the rope melted through from the heat of the rack. Possibly melting was not all of the cause of failure.

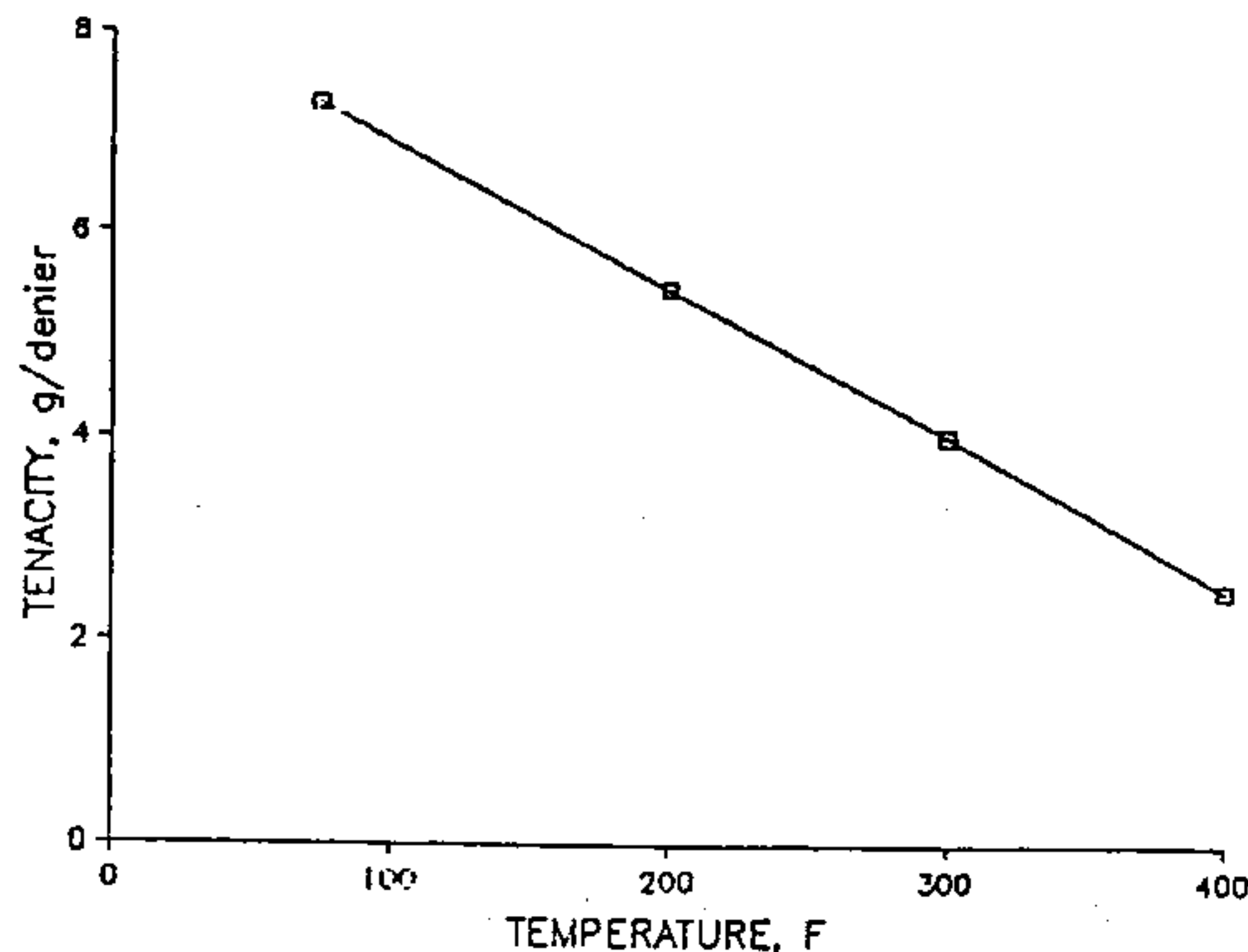


Figure 5: Strength of Nylon 66 as a Function of Temperature, after Rodriguez [10]

6 Conclusion

Well, enough rambling. I hope that this was illuminating. Please keep in mind that I'm not vouching for the safety of any particular items in use. I have no idea what any manufacturers are doing in their specific processes and I don't know what they've used for design parameters. But adequate testing of gear is certainly attainable. And ratings of gear are for certain standard conditions that may vary quite a lot from the actual conditions of use.

7 Acknowledgements

My thanks to Mr. Lou DeLattre for reviewing this article and verifying that I haven't forgotten everything I once learned about statistics and to Dr. Jim Liu for his review, verifying that despite not having taken the courses that he recommended, I still did a passable job with the dynamics.

References

- [1] Benk, et al. *A Guide to Mountaineering Ropes: 3rd Edition*.
 - [2] Brick, et al. *Structure and Properties of Engineering Material*. 1977.
 - [3] Cowlishaw. "Choosing a Rope for SRT." *Proceedings of the Eighth International Congress of Speleology*. Volume 1. 1981.
 - [4] Eavis. "The Weak Link." *Proceedings of the Eighth International Congress of Speleology*. Volume 1. 1981.
 - [5] Ferber. *Mountaineering; The Freedom of the Hills*. 1979.
 - [6] Gregorits. *Professional Engineers Examination — Mechanical Engineering*. 1982.
 - [7] Hines and Montgomery. *Probability and Statistics in Engineering and Management Science*. Second Edition. 1980.
 - [8] Keyser. *Materials Science in Engineering*. 1974.
 - [9] Perry, et al. *Chemical Engineers' Handbook*. Fifth Edition. 1973.
 - [10] Rodriguez. *Principles of Polymer Systems*. 1970.
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LETTER TO ANONYMOUS

TO: Author, Joy of Caving, Chapter Seven, Instant Cave

Dear Anonymous

I Found your article on CRH to be most informative. Enclosed you will find an account of last years Close to the Edge trip. To come right to the point, are you interested in joining us for this year's trip? Would you like to go for Glory? CTTE has the potential to be the deepest cave north of Mexico.

There have been numerous letters back and forth among the team, analyzing last year's problems and how to correct them. If you want to come, I will mail you copies of all the correspondence. All members of the team have been working on their climbing rigs and techniques. The weak point in the system is our blasting capability, as our total combined experience is not great and we, at this time, do not have a CRH. I've created a fiberglass CTTE hat, shaped like a chinese cookie hat, 22" in diameter, mounted on a light backpack frame, for the falling pebble problem. We will probably chopper up and hike down. If you are interested, get in touch with me, A.S.A.P. at RR#1, Hornby Island, B.C., Canada, V0R 1Z0, ph# (604)-335-2416. If you aren't, thanks for the article. It was most informative.

yours,

Dale Chase

SINGLE ROPE TECHNIQUE: AMERICAN, EUROPEAN AND IN BETWEEN

by Steve Knutson

reprinted from the NSS NEWS: American Caving Accidents, December 1898

First, let me say that no one can nor should tell another what system or style of SRT he should use - personal strengths, local caving environments, equipment availability and other factors will dictate. One must try different personal setups and rigging systems to discover what is best suited. Rather let us look in a general, rambling way at the present SRT scene, for it is now a bit confusing - European techniques have found a place in American caving.

I - Personal Rigs

By personal rig, I mean the harness(es) and ascenders used by an individual. There seem to be three main set-up in use.

1) **Mitchell.** I define as a Mitchell, any rig using a chest harness with a device for the main line to run through, intended to hold one upright and close to the rope. Then, there are two or three ascenders or knots, one just above the chest device (with the caver standing normally) and attached by sling to one foot, a second ascender at just above knee level and attached by sling to the other foot and a third (optional) on a short sling to the seat harness, and held in reserve. All ascenders should also be linked by sling to the seat harness for safety, should part of the rig fail.

Thus rigged, the caver has one hand on the upper ascender, one on the lower (or sling to his seat harness) and ascends in a ladder climbing motion, one foot stepping up after the other, the ascenders being pushed up with each step. This works very very well in free space. Against walls, especially on sloped drops or the sloped portion of a drop, one switches to a "Texas", where the main line is released from the chest device, and the upper ascender and/or third ascender are used so that the caver sits in his seat harness, supported by the upper or third ascender, while he pulls up the lower ascender. He then steps up supported by lower, while he slides the upper one one up, sitting back on the seat support as soon as the upper completes its motion, to conserve energy. Thus it is easy to ascend slopes. Obviously, one can switch back and forth on complex drops. Jumar-type ascenders are usually the ascender of choice.

2) **Rope Walker.** Here an ascender is attached to or just above a foot; a second is at knee level and attached by sling to the other foot (and safetied to the seat harness). A bungee cord can aid the performance of the knee ascender (and sometimes is used on the foot ascender as well). A chest harness and device to hold the main line is employed to hold the person upright; this can take the form of a sling running diagonally across the chest, over one shoulder and down the back, attached to the seat harness in front and back and with an ascender attached at the shoulder. Thus the caver ascends free space with an upright, walking motion. Slopes are done with the main line out of the chest device or the shoulder ascender sling off the shoulder,

allowing one to stand upright on the slope. Gibbs ascenders are the device of choice.

3) **The Frog.** This is a combination of Texas with the ascenders switched, and the old Inchworm technique. In the Frog, with the caver in standing position, one ascender is at belly-level and attached as closely as possible to a low set seat harness. The second ascender is just above the first and attached by separate slings to both feet. One ascends, as in the fashion of the old Inchworm, by doing a "squat" and standing back up. That is you sit, supported by the seat (lower) ascender, and slide the upper ascender up - then you stand up. A bungee cord in a figure-8 around the shoulders is attached to the seat ascender to pull it up as you stand. Then you sit down and repeat the process. Since you have no real chest harness, the method works without modification for free space or slopes.

Before we can evaluate these, we must realize that their strengths and weaknesses will be relative to the rigging system used - European or American.

II - Rigging Systems

1) European

Europeans have evolved a style of rigging quite different from the American. The basic premise is that the main line should not touch rock as it hands, or at least that there be no bad contact, rope to rock, where the rope would fray in ordinary use. Thus, a rope will be rigged initially so that it hangs out away from the edge of the drop rather than passing over the edge in an angle. Then, if a ledge is encountered, or a sloping descent becomes a free hanging descent, the rope will be re- anchored so that it will not wear at the ledge or breakover. Thus, a single pitch might be broken up into a number of rope portions. In addition, a rope may be suspended in a desired position by a re-directional, where it is not actually anchored, but sits in a carabiner attached by a sling to an anchor, so that the rope is held away from edges or waterfalls or whatever. Obviously, in ascending or descending, each of these obstacles must be passed.

2) American

The American style seems to have evolved relying on the toughness of rope to handle wear and with long, free drops in mind. The rope is anchored at the top and allowed to run free over the edge and down, a single rope for the full depth of the drop. If wear is expected or observed, a rope pad is employed to protect the rope.

III - Evaluations

1) Rigging

The European style will allow the use of smaller diameter ropes and rope with inferior abrasion characteristics. It will also extend the life of any rope and is good for project or expedition situations that will be long-term and where occasional replacement of ropes would be impractical. Obviously, Americans have used

this style, on occasion, to hand a rope so that it misses a waterfall or other obstacle.

This style also allows the ascent of a multi-anchored pitch by several cavers at the same time. In some situations this would save time and keep the party together. Rocks dislodged by a caver above would be an additional hazard, however. In the low-probability case of rope failure, of course, the whole party might be jeopardized.

The American style saves greatly on time spent rigging, equipment used rigging, time spent each time the pitch is descended and, in some cases, time spent ascending. It is also inherently safer, since each re-anchor and re-directional that is passed in the European style, is a point where you can err and be at risk. With American caving rope, at least, and in sizes down to 9mm, there is quite obviously no need to re-anchor a rope just because it runs over a lip or hits a ledge. Quite often, such points show no appreciable abrasion. With American caving rope, there have been, to my knowledge, no rope failures due to abrasion. Dangerous spots are signaled by obvious wear and fraying and the situation is corrected.

One seems forced to the conclusion that the utility for the European style is the following:

- a) Project or expedition caving where rope replacement is impracticable.
- b) Where you can't get good quality caving rope.
- c) Where you want to go to very small rope sizes - say 5-7 mm.

2) Personal Rigs

The Ropewalker is easily the fastest and most efficient style, followed by the Mitchell and way behind, the Frog,

for ascent of a free drop. In a European style rigged pitch, the Frog becomes quite handy, but obviously wastes energy between re-anchor points. Passing a re-anchor is easy for the Frog, with both ascenders above the waist, but it is almost as easy for the Mitchell. Obviously, a chest box like the Simmons double roller or Fritzke Alpine box is best, in that one can get the mail line out while leaving the upper ascender in. The Ropewalker is not recommended for anything but free ascents since the foot ascender is hard to get at for passing re-anchors.

The frog is very good for hauling loads, since both legs are used in the move that hoists the load. It also seems to be the lightest and most compact rig. Europeans claim that they have may pits that are very narrow and the Frog is good for this, but I can't see why it would be better than anything else, unless the pit is so narrow that a chest box would get in your way.

My personal conclusions are these: With American caving rope of 9 mm and up, a re-anchoring of the rope is seldom necessary. A mitchell is quite usable in European rigging and superior to the Frog on any free pitch or portion, but you must be able to covert to a Frog to have equality in hauling loads. A Ropewalker is not advisable in many technical situations. A Frog must be convertible to a Ropewalker to gain parity with the Mitchell. A Frog is not advisable on American-rigged pitches since it is impossible for it to pass some breakovers.

In general, remember this: Whatever your personal preference, if you get around much at all, you had better be ready to deal with European rigging. There is an obvious utility for it and it is now part of the American Scene.

SECRETARY'S REPORT--NSS VERTICAL SECTION

JUNE 25, 1990

Number of Single Members.....	851
Number of Family Members (number of people).....	66
Total Number of Vertical Section Voting Members.....	917
Number of Nylon Highway Subscribers.....	87
Number of Nylon Highways Sent Free (ex. libraries).....	10
Number of Nylon Highways Exchanged.....	26
Total Number of Nylon Highways To Be Mailed.....	1007
Number of Members or Subscribers Paid Through 1990.....	346
(This number of 1990 members or subscribers have NOT YET renewed)	
Number of Members or Subscribers Paid Through 1991.....	338
Number of Members or Subscribers Paid Through 1992.....	191
Number of Members or Subscribers Paid Through 1993.....	59
Number of Members or Subscribers Paid After 1993.....	25
Number of Members who desire the Vertical Section to represent them at the NSS Congress of Grottos meeting.....	131

The Control Loop Highline: Highrise Emergency Egress System

Developed by Michael G Brown

and

**The Virginia Department of Fire Programs, Heavy and Tactical Rescue Team, and
"The H.E.A.T."**

The Control Loop Highline is a rope rescue system that is designed to quickly and safely remove a large number of people from a highrise structure fire when all other means of egress have been rendered unsafe. This system has been designed to be used by and taught to competent fire and rescue professionals. The Control Loop Highline can be quickly rigged by a trained team in about 30 minutes using currently available rescue quality rope equipment. It is safe, controllable, redundant and can easily remove up to four people per minute from a highrise structure 300 feet in height. The system can be installed on any structure or natural formation that has access to an opposing building, cliff, ground area or parking lot at least half as long as the building is tall.

Equipment requirements for a 20 story tall building:

(2) 300 foot section of rescue quality (R/Q), 1/2" diameter static kernmantle rope.

(2) R/Q, 1/2" x 4" single sheave ball bearing pulleys.

(1) 4:1 haul system. This can be any 4:1 or 5:1, simple or compound haul system and can be built in the field. We have found that a RSI "Haulsafe" (double sheave, locking cam, w/becket) works extremely well in this capacity in the 5:1 configuration as it is entirely adjustable and locks automatically.

(8) Steel locking carabiners of at least 9000 pound tensile strength.

Assorted rigging and connecting straps.

(8) 8mm x 24: to 30" prussik loops.

(2) Evacuation sacks or "hasty hitch" webbing configurations.

The design of the Control Loop is similar to the old Chicago clothes line system where a loop of rope is extended to an adjacent building via a pulley system. Clothes can then be hung out, extended and retrieved from a window location. With the Control Loop Highline, the loop is actually rescue quality rope and is extended from the roof to a ground location anchor. Victims are placed one or two at a time into evacuation sacks or hasty hitch webbing configurations and ride the revolving loop to the ground. The returning line hauls back the empty victim sacks or hitches for the next rider(s). The system is, in fact, an angled tyrolean or telfer line that removes people from structures or natural formations without the necessity of a tag line to control descent speed. This tag-lineless system greatly reduces evacuation time by eliminating having to haul back the tagline every time another victim is lowered.

To rig the Control Loop Highline, the two 300' lengths of

rope must first be tied together. A tracer eight knot works well as the total knot profile is very low and the figure eight knot maintains about 85% of the total strength of the rope. The knot tails should be made to extend at least 10 inches and taped down to the rope using duct tape. You now have a 600' continuous rope loop. Should it become necessary for the loop to be shortened, the tracer eight is just re-tied and the excess coiled and secured to the loop. The knot and coil will never have to pass one of the main pulleys because the control loop never has to completely rotate, it just zig-zags when in use and the knots never have to pass the pulley.

The rope is then stretched from the edge of the structure to an acceptable ground anchor. A properly secured heavy squad or fire truck works well for this purpose and offers some variance in the ground anchor location. The top and bottom anchor locations should be chosen to keep the rope loop as far as possible from liberated fire gases and preferably on the upwind side of the structure. The angled design of the system prevents the rope from having to travel through potential fire gases. This is an advantage that truly vertical emergency descent systems do not enjoy, and unless the fire is venting from directly under the top anchor or loading sites, the Control Loop configuration will remain unaffected for the entire height of the building.

The top anchor must, of course be "bomb-proof" meaning that, when all else fails, the integrity of the anchor site is never in question. Arrange a connecting point for the top pulley near the edge of the chosen loading site. When at all possible, arrange this attachment point so that it is supported from overhead. When the top attachment and loading sites are on a roof location, it is best to rig a change of direction pulley onto an elevator tower or the like. A tripod also works well to hold the loop up high so that loading can take place at body level instead of loading the victims over the side. A preferable method locates the top anchor site on the roof or the floor above and the loading site is located on the floor below. The evacuation sacks arrive at body level and loading is extremely quick, safe and efficient.

If there is not an easily located, bomb proof anchor where you want it, find the anchor that is bomb proof and extend it to the loop attachment site using a separate piece of rope and change of direction anchors. Use caution when choosing change of direction anchors. These anchors must be very strong because, depending on the resulting angles, forces can be double at these points, similar to the 2:1 mechanical advantage created in haul systems. The rope loop can then be reeved to the 4" pulley and the pulley carabinered to the anchor attachment. The loop is then lowered to the ground and walked to the bottom anchor.

The haul system is anchored and the advantage side connected to the bottom anchor main pulley. The loop is

placed in the main pulley and the haul system contracted to tension the loop. The loop only needs to be tensioned enough to allow the descending load to be safely lowered to the ground. If at this point the pre-tied loop is too long, remember that the tracer eight knot can be re-tied to shorten the loop and the remaining rope can be coiled and secured to the loop. Once again, the knot and coil never have to pass either of the main pulleys because the loop only goes one half of one revolution and then returns to repeat itself.

The descent speed of the load is controlled entirely by the tension that is transmitted to the loop from the haul system. If the load is coming down too fast, then a small amount of tension can be added to the haul system and the descent will slow. If the load is coming down too slow, then some of the tension can be let out of the haul system and the rate of descent will increase. You will find that the load generally starts descending rapidly, but at the half way point, it slows for a gentle landing. Therefore, start with maximum tension and reduce tension as the load descends.

The main pulleys of the Control Loop Highline are obviously the components of the system with the greatest amount of tension on them. Attention must be placed on choosing a top quality pulley for this purpose. The SMC 4" ball bearing, the RSI 4" single heave and the CMI 4"

stainless steel have all been tested in this capacity and work well. However, some method of back up is incorporated in the unlikely event that one of the main pulleys should fail. A heavy duty steel carabiner is placed over the loop and allowed to hang freely as the loop rolls. This carabiner is then attached to another anchor point via a figure eight or figure nine knot and a length of rescue rope. A shock absorbing configuration (see diagram) using tandem 8mm prussiks should be used to help alleviate some of the dynamic forces that could develop if one of the main pulleys should fail. In this event, the suddenly increased friction of the loop running on the carabiner causes the descent speed to slow dramatically, by letting out some of the haul system tension, the load can be safely ushered to the ground.

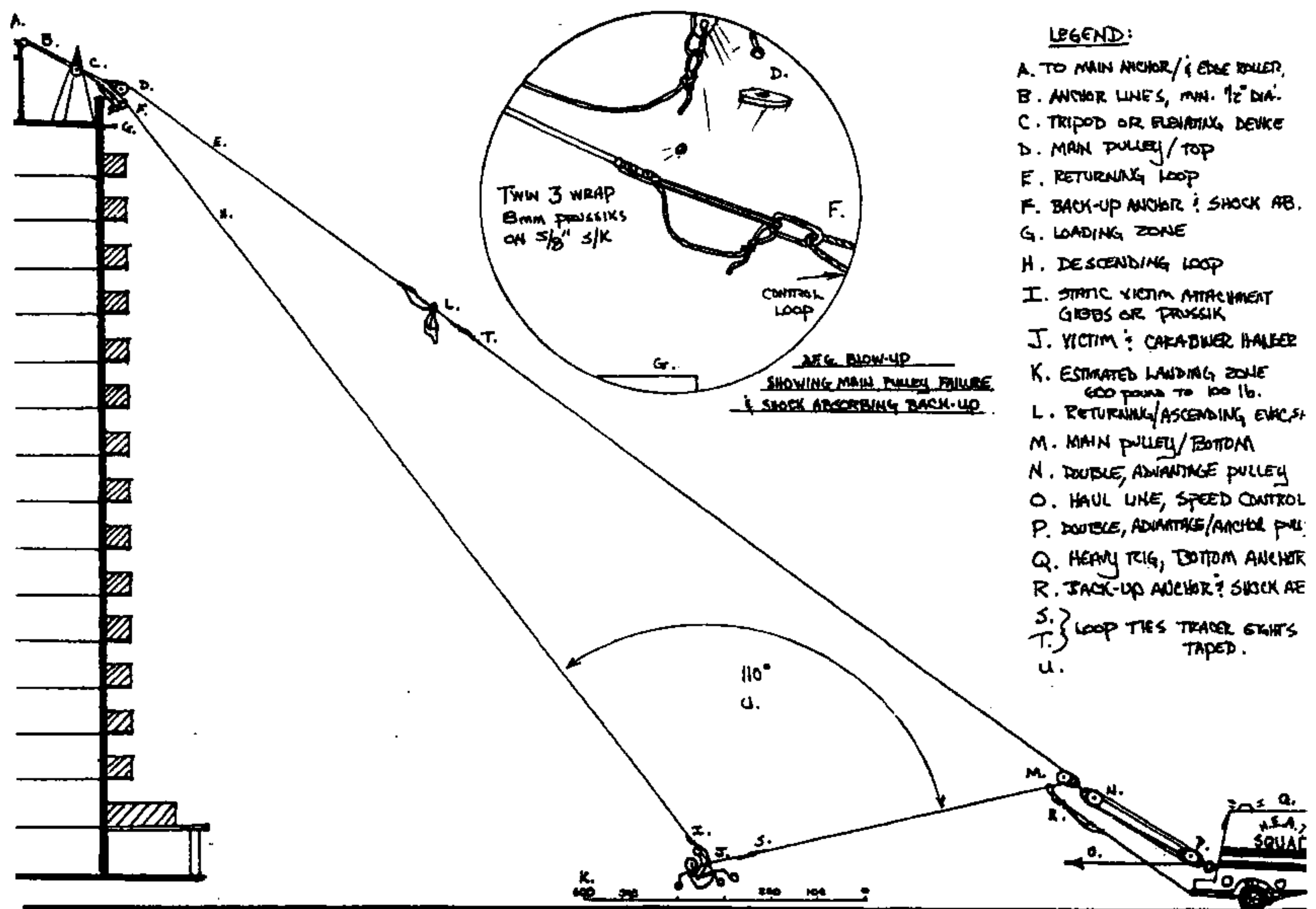
For more information on this and other rope rescue systems contact:

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Control Loop Highline

MG. BROWN

NSS VERTICAL SECTION

MEETING MINUTES

JULY 9, 1990

The 1990 NSS Vertical Section meeting was held on Monday, July 9th, 1990 in the Poultry Barn at the Siskiyou Golden Fairgrounds in Yreka, Ca. Executive Committee members present were Bill Cuddington, Gary Bush, Maureen Handler and Bill Bussey, who conducted the meeting. Vertical Section Chair Allen Padgett and Editor Bruce Smith could not make the meeting. Approximately 55 members were in attendance.

Bill Bussey opened the meeting at 12:30 p.m. by introducing the Executive Committee.

Secretary's Report: We have 917 voting members. Would mail 1007 **Nylon Highway's** as of June 25th.

Treasurer's Report: Total Income \$6247.95. Total Expenses \$6622.42. Net loss \$374.45. Reasons for the loss included extra cost of printing and mailing membership poll. **Nylon Highways 29 and 39** were both typeset costing extra.

Editor's Report: Bruce Smith is stepping down. Bruce was congratulated with a round of applause for the excellent job he has done of the years as editor.

Chairman's Report: Allen Padgett has been working very hard on the Soviet Exchange Program. Would like to be chairman again.

Vertical Session and Forum: Maureen Handler reported Kirk MacGregor, Bob Thrun, Paul Smith, Steve Knutson and Peter Ludwig would panel an open discussion on vertical caving and techniques immediately after the meeting. After this Vertical Forum will be a Show and Tell session.

Contest Chair Report: Bill Cuddington reported a waiver must be signed by all climbers. Climbers under 18 must have parent or guardian sign the waiver. climbers should try to provide their own rope puller. Sit/Stand Category being added with open age classes. Have an extra contest rope this year.

Vertical Techniques Workshop Report: David McClurg noted there will be two sessions because of the large demand. Frog System as well as Petzl bobbin instruction being added this year. Would like to build up sets of vertical equipment for Workshop use. This would eventually eliminate need for ruse of instructors equipment. Donations are welcome. Discussion on having ;a children's (ages 8-15) workshop.

Training Committee Report. Jim Hall reported they have come up with day long and semester long courses. Something on Day long course will be in **Nylon Highway** before next convention.

Membership Poll Committee Report: Gary Bush reported 41% return on poll. Summary in **Nylon Highway #30**. He hit on the highlights. There was some discussion on caving practicality of rigs uses in contests, as well as the vertical rebelay course. Gary Bush will chair a committee on the rebelay course.

Soviet Exchange Program Report: Bill Bussey reported \$2442.50 had been raised by Section. Soviets scheduled to arrive August 16th. Section responsible for them through August 31st.

Under Old Business, Bussey brought up that in its meeting, the Executive Committee decided to reverse last year's decision to replace existing Caver Information Series with bibliography of information sources on vertical techniques. Are now looking for writers to update or write new Caver Information articles. Also need someone to do an Index by subject of **Nylon Highway's 1-30**.

Nothing ever came of a motion at last years meeting to form a committee to prepare a list of considerations for changes in the contest pending the outcome of the membership poll. As this issue has already been addressed, this concern is now considered resolved.

There was discussion on the practicality of Vertical Section's Fiscal Year being the calendar year. Maureen Handler moved and Marlana Wall seconded that the Vertical Section's Fiscal year be changed from the present January 1 - December 31 year to June 1 - May 31st. Passed unanimously.

After discussion on having a rotating set of Executive Committee members, Gary Storrick moved and Gary Bush seconded that the Bylaws published in **Nylon Highway #30** and as amended earlier in this meeting, be accepted as the official set of Bylaws for the NSS Vertical Section. Passed unanimously.

Gary Storrick will check out the 1991 Convention facilities for both the Vertical Contests and Vertical Technique Workshop.

Under New Business the first reading of a change in the Vertical Section Constitution was presented. This will be voted on at the 1991 Vertical Section meeting Monday, July 1, 1991 in Cobleskill, NY. It reads:

Bill Cuddington moves that Section 3, Paragraph 1 be amended to read: "The Vertical Section shall be governed by an executive Committee made up of a Chairman, a Secretary-Treasurer, an Editor, a Contest Chair, a Vertical Techniques Workshop Chair and three Committee members At-Large.

This reading was followed by discussion on whether these added positions should be appointed or elected. It will be printed in **Nylon Highway** for overall membership review. In a straw vote, the membership overwhelmingly supported appointing the Contest and Vertical Technique Workshop Chair. If this passes at the next meeting, the bylaws affected by the amendment will also have to be changed

In other New Business, Ed Sira moved and Dick Desjardines seconded that: "The Vertical Section grant one year's membership or subscription to students participating in the Vertical Techniques Workshop." The measure carried with four voting against.

A straw vote was taken on whether to raise the registration fee for the Vertical Techniques Workshop. The overall majority supported raising the fee, however two voted against it.

David McClurg moved and Maureen Handler seconded that: "The Vertical Section set aside up to \$300 to buy vertical gear for the Vertical Techniques Workshop." It was recommended that Dave request donations from vendors and manufacturers. After discussion, the measure passed with one opposition.

In elections, Bill Bussey was re-elected Secretary/Treasurer. Maureen Handler was elected as the new **Nylon Highway** Editor. Gary Bush, Bill Cuddington, Allen Padgett and Ed Sira were elected at large Executive Committee Members.

The meeting was adjourned at approximately 2:30 p.m.

Later that day, the Executive Committee met and selected Allen Padgett as Chair. Ed Sira, as the newest EC member, will organize and emcee the Vertical session at the 1991 NSS Convention.

Respectfully Submitted,

Bill Bussey

VERTICAL ETIQUETTE

(or, Miss Manners Says...)

by Phil Kirshtein and Angela Morgan

reprinted from The Huntsville Grotto Newsletter, Vol 32, No. 4

Vertical Caving is one of the more physically demanding and rewarding aspects of underground sport. However, if approached in a haphazard or inconsiderate way, vertical rope work can become the most dangerous sport on earth. After a recent training exercise and discussions of what could have been done better, the authors decided that the subject of vertical etiquette is basically untouched in caving literature.

We have compiled the following list of "vertical manners" as an introduction or neophyte vertical cavers with the high hopes of making pits everywhere safer places to be. We don't claim it to be comprehensive nor do we think every experienced vertical caver down there will agree with every point we make. We are open for all comments and suggestions (even if they are stupid!)

Just a few (a very few) words about rigging

-Gardening the lip: clean loose dirt, rocks, etc. off the lip before rigging. Try to avoid rigging in poison ivy.

-Lower the rope into the pit; do not throw it. Before lowering the rope, always tie a figure 8 knot in the end, making a loop large enough to stand in. This will come in handy if the drop has been short rigged: it will keep you from rappelling off the rope, and gives you somewhere to stand to facilitate a changeover.

-If you don't like something about the rigging, say something about it!

-Never fiddle with the rigging anytime between an "on rope" and an "off rope" call. If you see something that needs to be done to the rigging, check with others present before doing it.

-Never lower a rope into a pit while someone is on another rope. If you want to rig another rope, check with those at the bottom and the top of the drop before lowering it. Whenever possible, it is best to rig all ropes before anyone descends.

-Put on your descending gear before beginning to rig a rope. This way you will be able to clip a safety into the rope while placing rope pads, lowering the rope into the pit, etc. It is all too easy to ignore this important safety point and take chances, all because you didn't want to stop what you were doing to put on your seat harness.

Take care o' those nylons!

A rope owner is very particular about his rope, and rightfully so! If a rope owner gets angry at you about something you've done to his rope, don't take it personally. Most importantly, his life (and everyone else's) depends on it; also, rope is not cheap. Following are some guidelines for taking care of the rope (whether it's yours or someone else's), and keeping the owner happy. (A disgruntled rope owner may not let you use his rope again.)

-Do not step on the rope.

-Do not allow the rope to be unnecessarily dragged through mud or dirt.

-Do not let any corrosive materials get near the rope. If you have a lead-acid battery with open vent holes, tape them shut! Keep batteries away from the rope in general.

-Extra care must be observed when using a carbide lamp on rope. Keep the flame well away from the rope. Obviously, the nylon rope will melt quickly. Some insist that carbide lamps should not be used on rope; however, since the authors are both die-hard carbide cavers, we cannot support this view. Flame on!

-When crossing a rope pad (either rappelling or climbing), make sure it is positioned properly and the rope is lying on the pad after you pass.

-Always be alert for spots where the rope may be abrading and a pad is needed. If you see such a problem, it is your responsibility to correct it, or call it to someone else's attention.

-Never toss anything (especially rocks) down a pit while a rope is in the pit. The object could strike the rope and cut or damage it.

-Figure eights are not accepted by some people as allowable rappelling devices on their ropes because they impart a twist in the rope. You should respect the owner's feelings on this matter.

-Some rope owners don't like alloy bars being used on their ropes because they leave (a lot of) aluminum oxide (a well known abrasive substance) on the rope. Offering to wash this person's rope every once in a while might make him a bit more amenable. In any case, you should certainly respect the rope owner's wishes.

-Most rope owners prefer not to lend out their ropes.

-Care of the rope is always your responsibility.

Can we talk? (or, vertical communication)

Good communication is imperative to the success and safety of any caving trip. There are many different signals and protocols that are used in vertical caving. Any group of vertical cavers should agree upon the protocol to be used before beginning to descend the pit, to avoid confusion. The following is a protocol that is recommended by the authors. It differs somewhat from other, more widely used protocols, for safety reasons.

-When approaching the rope to rig in for rappel, call "on rope". Don't wait until you have rigged in! When you are ready to rappel, call "on rappel".

-When rappelling, do not call "off rope" until you are derigged from the rope, are out of the rock fall zone, and are ready for the next person to proceed.

-When preparing to climb, call "on rope" before entering the fall zone. When you are rigged into the rope and are ready to climb, call "climbing".

-When climbing, do not call "off rope" until you are derigged from the rope, have checked rope pads, are safely away from the lip (i.e. when there is no danger of your knocking rocks, etc. down the pit) and are ready for the next person to proceed.

-"OK" may be used as an acknowledgment to any of the signals. "Repeat" may be used to request that the last signal be repeated. "Stop" has an obvious meaning...

-When shouting up or down a drop, allow echo time between each syllable, more or less depending upon the depth of the drop.

-If you drop or knock anything down the pit, immediately call "Rock rock rock!" (Three times in rapid succession.) Use the word "rock" no matter what is falling. The courteous caver will call "rock" even if it is his body that is falling down the pit.

-If you hear someone above call "rock", don't look up!

-While waiting, listen carefully for signals from above or below. It is best to keep noise levels at a minimum, because otherwise, important signals may be missed.

What goes down must (usually) come up...

...and hopefully come up in the same condition as it went down. This includes people and ropes, but not rocks! Rocks don't come up (and you don't want them to go down in the first place). Some tips on getting the rope and everyone down and up the pit safely.

-When rappelling or climbing, double check all your gear before beginning. If you are at all unsure about it, don't be embarrassed to ask someone else to check it for you.

-The first person down the pit should take responsibility for doing a little "housekeeping". Take the excess rope, untie the loop in the end (you did tie a loop in the end didn't you?), coil it neatly and place the coil, with the loose end down, in a spot out of the fall zone, if possible. (Alternate to coiling, the rope could be piled neatly.) This keeps other rappellers from stepping on the rope, keeps falling objects from hitting the loose rope, and prepares for pulling the rope up by ensuring that it is not tangled. (A tangled rope is likely to snag on the way up.)

-The first person down the pit should know how to do a changeover, and should be prepared to do such, in case the drop was short rigged or adverse conditions exist. (Ideally, of course, everyone should know how to do a changeover.)

-The last person to ascend the pit should double check that the loop has been untied and ensure that the excess rope is positioned such that it will not snag or become tangled while it is being pulled up.

-Climbing tandem is not as cumbersome as some people make it out to be; in fact, some people prefer it because they can bounce the pit more times. (It also gives the climbers some company and moral support on long drops.) The top tandem climber may request for the lower climber to stop climbing while negotiating the lip.

-Traditionally, the order of ascending the pit is the same as the order of descending it.

-Don't be embarrassed to ask for a belay if you want one.

-When waiting at the top of the pit, be sure that you don't knock anything down the pit (stay well away from the lip).

-When waiting at the bottom of the pit, stay well out of the fall zone, unless you enjoy being hit by falling rocks, packs, etc.

-When rappelling or climbing, have everything (pack, etc.) securely attached to your body. Do not detach items from yourself unless absolutely necessary; if you do find this necessary, use extreme care not to drop anything! Of course, you know what to call if you should happen to drop something...

-When rappelling, always have full ascending gear with you. When climbing, always have a rappel device with you. You never know when you may have to switch from one to another.

It's 2 a.m. Do you know where your rope is?

At some locations a rope guard is a necessity at the top of the pit. During a recent night trip to Natural Well, at 12:30 a.m., three rather unsavory individuals appeared. Just because it's late at night doesn't mean a rope guard is unnecessary!

-having or not having a rope guard is usually a judgment call. When in doubt, leave one.

-Reasons for having a rope guard include avoiding stolen, cut or damaged rope and other (possibly not vertically competent) individuals trying to use your rope. The rope guard also serves as a pit guard, to keep passerbys from doing nasty things such as throwing rocks and beach balls into the pit. Should rope guards be armed? That's up to you and the rope guard

-Tying the rope to a rock at the bottom, if no rope guard is available, is considered by some as an alternative. This keeps your rope from being stolen and gives you something to look at while you're waiting for your call out time to pass. (You did tell someone where you were going and when you would be back, didn't you?)

We all have vices...

-Caving under the influence is frowned upon by a majority of organized cavers who view such activity as an accident waiting to happen. If you must imbibe, wait until afterwards when you won't endanger yourself or your companions.

-Sex on rope should be attempted only while climbing with a safety (this giving five points of contact). You do practice safe sex, don't you? It can be tricky on rope... Good luck!

Okay! So we just threw a "hole" bunch of high (low) sounding rules at you. Really it all comes down to consideration, thinking about what you're doing before you do it and common sense.

Thanks to Roger Haley for his input and suggestions.

Keep bouncing those pits.

THE DROP



by Joanna Florio Jeffreys