Technical Skills for Proficient Cavers

LEVEL I and LEVEL II SKILLS FOR
JOINT SERVICE PROFICENT CAVERS (CVP)
LOCAL CAVE LEADERS (JSLCL)
and
JOINT SERVICE CAVE LEADERS

September 2002

Prepared by WO1 S C Milton
CSCA Technical Training Adviser

CONTENTS.

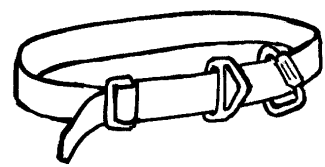
INTRODUCTION

1. The aim of this booklet is to provide information and guidance to cavers on the techniques for safely dealing with steep or exposed ground and simple ladder pitches. The information detailed in this booklet is taught to students attending the Cave Proficiency Course (CVP). This information may also be used as a reference guide for Local Cave Leaders (JSLCL) and Cave Leader (JSCVL) candidates in their preparation for assessment and for Cave Leaders and Instructors when running CVP courses at Unit level.

2. The ladder and lifeline techniques that are detailed are suitable for use on simple, straightforward ladder pitches using an Italian hitch and the double life lining method. The more advanced ladder and lifeline techniques for dealing with multi-pitched caves with exposed traverses are covered by the CSCA publication “Modern Ladder and Lifeline Techniques”.

3. This booklet has been produced in consultation with the Staff JSMTW (Ripon) and is in line with the Course Training Plan (CTP) for the CVP course and the Joint Service Caving Handbook, JSP 432. Any questions or concerns about the contents of the booklet should be forwarded to the CSCA's Technical Training Committee. Reproduction of this booklet is only permitted with the permission of the author.

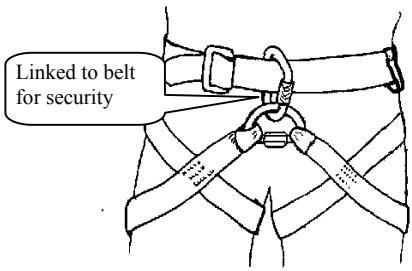
PERSONAL SAFETY EQUIPMENT

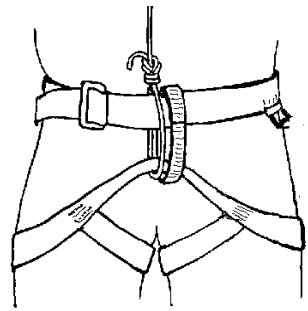


4. **Load Bearing Belt** Each members of the party should be equipped with a load bearing or belay belt. Not only is the belt able to support body weight for a short period of time but it can also be easily converted into a simple and effective seat harness which is suitable for climbing ladder pitches and emergency hoists (see section on improvised harnesses).

5. A rope must not be tied dirrectly to a load bearing belt. The belt is designed to have the load spread evenly across the whole width of the webbing. If the rope is tied dirrectly to the belt it can put all the load onto the thin edge of the webbing, which could cause it to fail. The prefered method is to have a "D" ring or a delta/semicircular maillon permanently threaded onto the belt and either attach the rope directly to the maillon or via a karabiner. It is acceptable to clip a large karabiner directly to the belt, however care must be taken to prevent loading the karabiner across its gate.

6. **Harness** Caving harnesses are designed for Single Rope Technique (SRT) and are normally designed to be used in conjunction with a chest harness. The SRT harness has a very low connection point and does not fasten above the hips. If no chest harness is fitted an inverted caver could slip out of the harness. For ladder and lifeline caving it is common practice not to use a chest harness. This is only safe if the SRT style harness is to link the centre maillon to a suitable load bearing belt using either a screw gate karabiner or maillon as shown below. The belt must be tightly fastened around the waist



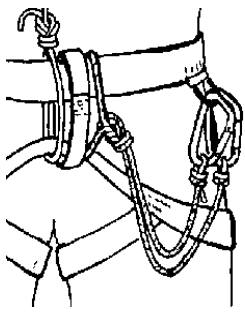


Caving Harness Climbing Harness

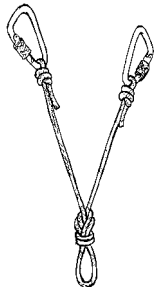
7. Climbing harnesses are probably better than a SRT harness for simple ladder and lifeline caving. They fasten around the waist, above the hips, and do not require a chest harness or linking to a waist belt. The disadvantage is that they are not designed to resist abrasion and the equipment loops tend to snag on the rock and get in the way (these loops are unnecessary and can be removed). If the central attachment loop on the climbing harness is designed for abseiling and belaying (see manufacturers leaflet) the lifeline can be attached to this central loop with a suitable screw gate karabiner. If there is any doubt over the load bearing strength of the central attachment loop then the lifeline must be tied directly into the harness. (Climbing harnesses as designed so the rope can be tied directly around the webbing. The webbing used is a lot thicker than the webbing used for the "Load bearing Belt" and it will not be damaged by the rope.)

8. It is important that whichever type of harness is used, that it is regularly and thoroughly checked for signs of damage, paying particular attention to the stitching and buckles. Harnesses are to be discarded at the first sign of wear to load bearing sections.

9. **Cowstails** These are not normally required for simple ladder pitches, however the leader may which to use them for his/her protection. They should be attached directly to the centre maillon of the caving harness or tied directly into the climbing harness.



10. Cowstails should be constructed out of a length of 10.5 or 11mm dynamic climbing rope, (2.5 to 3 metres). Caving rope MUST NOT be used for the cowstails as they are the only part of the safety system that is intended to absorb a shock load. If the cowstails are used for ladder and lifeline protection then the two tails can be the same length (60-80cm including karabiner). It is recommended that for security screw gate karabiners be used. One of the karabiners will often be behind the person when they are belaying and therefore out of sight, a snap gate could easily open.



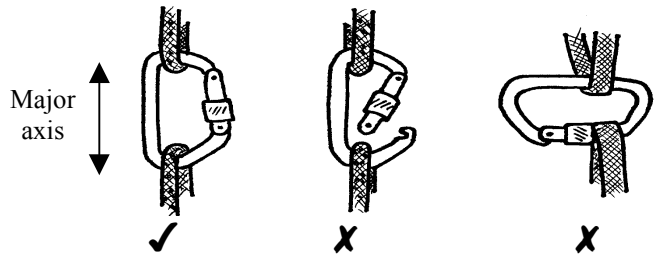
11. The cowstail is tied using a either an overhand or figure of 8 knot for the central attachment point (an overhand is less bulky). The karabiner is attached using either a figure of 8 or a ¾ Fisherman's. The ¾ Fisherman also known as a Barrel knot is only slightly weaker then a Figure of 8 but it has the advantage that it is less bulky, it holds the karabiner captive preventing the inadvertent loss of the karabiner and it has the ability to absorb shock load as the knot tightens. The knots can be protected against abrasion by using a short length of bicycle inner tube stretched over the knot. Mud can still enter the fibres of the rope underneath the rubber and cause unseen damage, by cutting the fibres internally, so it is important that when washing the cowstails that the protection is rolled back and all mud removed.

12. **Boots** These should have a well-defined heel and instep, this reduces the risk of the boot slipping off the rungs of the ladder. Boots should not have hook type lacing system, which can easily catch the wires of the ladder and immobilise the caver. Good quality "Wellington" boots are ideal.

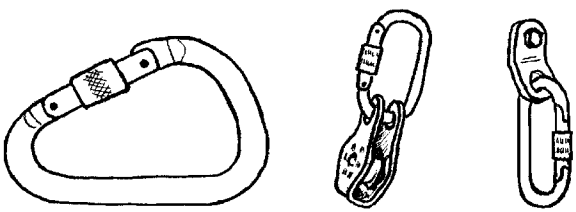
13. **Helmets** Only helmets designed specifically for caving are to be used. They must conform to the current safety regulations and be fitted with "Y" shaped chinstrap. Modified industrial helmets are not suitable for caving and must not be used.

GROUP EQUIPMENT

14. **Karabiners** There is a large range of karabiners available. For general caving D shaped screw gate karabiners are probably the best. The minimum strength should be 22kN (2,200kg) this minimum strength limit has been set by the climbers. It has been calculated that the heaviest shock loading that could be placed on a single karabiner during a "normal" climbing fall would not exceed 22kN. All karabiners are designed to be loaded along the major axis (along its length), with the gate shut. Karabiners are very weak when loaded with the gate is open or across the gate.



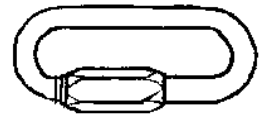
15. Screw gate karabiners should be positioned with the opening part of the gate downwards so that gravity helps to prevent the gate unscrewing. Resist the temptation to give the screw gate a final tighten up when the karabiner is loaded, as it can be very difficult to undo later.



Pear/HMS Oval

16. Pear Shaped and HMS karabiners are designed specifically for belaying using the Italian hitch. Oval Karabiners are required for fixed cheek pulleys and for certain early Petzl plate hangers. Twist locks and other complicated self locking karabiners are prone to clogging with mud which can prevent them closing and locking properly and care must be taken if they are used underground. Karabiners should be periodically lubricated with a small amount of a silicon based oil or grease. Petroleum based products may cause damage to nylon. (Harnesses & Rope)

17. **Maillons** Originally designed for joining chains, maillons are ideal for caving. They can take load in any direction. However they are VERY weak if the gate is not screwed up fully. For normal rigging 7mm (long) steel maillons are used which have a breaking load of over 25 kN (which equate to 2,500 kg).



18. Always use maillons which are "PPE certified" and manufactured specifically for caving or rope access. These can be obtained from reputable sources such as caving shops. Do not be tempted to buy cheep inferior item from hardware shops. Maillon should be washed and lightly oiled or sprayed with WD40 after use. Aluminium maillons are available but these are not suitable for general caving and are best left for extreme expedition use.

19. **Slings** Slings are extremely useful underground they have a large number of uses for example; providing a hand loop to assist a fellow caver up a short climb, for rigging pitches and for making an emergency harness. They can be purchased pre-sown in a number of standard lengths or can be made out of suitable length of tape or rope. The normal pre-sown length used for caving is 8' (2.4m) (which is the length of its circumference). It is very useful for the leader to carry and at least one 16' (2.4m) sling.

20. Slings should normally be joined together using either a karabiner or a maillon. However if the slings are only being used to assist a fellow caver and will not be subject to a heavy or shock load it is acceptable to link two or more slings together by passing one sling through the other to produce a "reef" type knot.

NOTE: Joining slings in this manner reduces the strength of the slings by 50%.

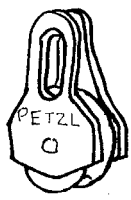
21. It is worth considering the width and material that is used for tape slings. The majority of tape slings are manufactured from a type of nylon and are 22 to 25mm wide, these are ideal for general caving. Spectra slings are now readily available, they are extremely strong but are normally only 15mm wide and this makes them particularly uncomfortable when they are made into an improvised harness. Soft tubular tape slings are not suited for caving as they tend to get impregnated with mud and grit and become very stiff.

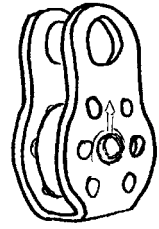
IT IS RECOMMENDED THAT EACH PERSON IN THE GROUP CARRIES ONE 8' (2.4m) SLING AND A SCREWGATE KARABINER

22. **Pulleys** There are 2 basic types of pulley in general use, the fixed check and the swing cheek. Information is given on the two most commonly used pulleys manufactured by Petzl. There are a number of other heavy-duty pulleys designed specifically for rescue and each model will normally have the maximum load stamped on them.

23. The Petzl fixed cheek have a normal working limit of 5kN (500kg) and a breaking strength of over 22kN (2200kg). The fixed cheek pulley are the better pulley for general caving use. They must be used with an oval or pear shaped karabiner so that equal load is placed on each side of the pulley.

Petzl
Swing cheek





Petzl
Fixed cheek

24. The lightweight Petzl swing cheek pulley is designed primarily for tackle hauling and self-rescue. It has a working load of 2kN (200kg) and a minimum (breaking) load of 12kN(1200kg). The lightweight swing cheek is suitable for normal double life lining, but must not be subjected to shock loading or used for heavy load rescues. This is because the entire load is taken on a single small diameter pin.

25. For added security and when the pulley could be subjected to a heavy load, a second karabiner should be used to back up the pulley. This karabiner must be large enough for the pulley to fit inside it.

ARTIFICIAL ANCHORS

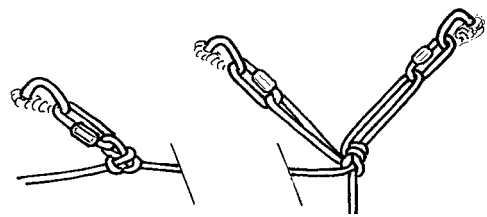
WARNING NEVER USE A SINGLE ARTIFICIAL ANCHOR IN A SAFTEY CRITICAL POSITION.

26. A single artificial anchor should never be used for the start of a traverse line or at a pitch head. The only exception is when the anchor is backed up by, or shares the load with a natural anchor.

27. **DMM ECO** The Eco anchor has been adopted as the preferred artificial "permanently fixed" anchor for British caves. These anchors are installed by teams of properly trained and experienced cavers using proven techniques with each anchor uniquely documented. Eco anchors are slowly being placed in the majority of major cave systems. A well placed Eco anchor installed in sound limestone has a strength in excess of 4000kg.

28. The Eco is manufactured out of 8mm diameter marine grade stainless steel and will therefore not corrode and should have an extremely long life. However, damage can be caused by repeatedly pulling muddy ropes through the eye of the hanger. If the hanger should become damaged it can be removed without damaging the rock and the hole re-used for another Eco anchor. In some places where excessive wear is expected (pull through caves) a maillon is permanently placed in the Eco hanger and the rope passed through the maillon.

29. A number of the early Eco anchors were installed with the eye vertically and with all of the eye proud of the rock, some of these early anchors have become slightly loose and can be rotated a small amount. This rotation was due to break down of the bond between the resin and rock, which was caused by a twisting action being placed on the anchor during use. The installation process has now been improved by using a different resin and orientating the anchor in the direction of the intended load. The eye is also bonded into a grove cut into rock to prevent rotation. It is important that the any load placed on the Eco is inline with the eye to prevent rotation



Rope tied so that load is inline with the eye of the anchor

30. **Eco Safety Checks.** The following checks should be carried out before using an Eco anchor:

- Loose or fractures of the rock in which anchor is placed.
- Excessive rotation of the resin within the drilled hole or the anchor and the resin. (Twist the anchor by hand, rotation or flexing of +/- 1mm is OK).
- Egress of the anchor from the resin or the resin from the hole.
- Groves or abrasion on the inside of the eye.

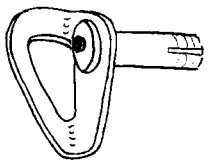
- Obvious damage to the anchor.

31. It is perfectly acceptable to tie a rope directly into the eye of the Eco hanger. The diameter of the metal is large enough that it will not significantly weaken the rope. It is becoming common practice to start a traverse line by tying directly into the first one or two ECO anchors and continuing the rest of the traverse with conventional karabiner or maillon rigging.

NOTE: *Any damage to Eco anchors should be reported ASAP to the local caving council.*

32. There are numerous other types of permanent anchor found in caves, such as the Petzl resin bonded anchor and the P38. Both of these anchors are made out of stainless steel and if installed correctly will be adequately strong. Unfortunately there is normally no knowledge of when and by whom such anchor were fitted. Before using any permanently fixed anchors check that the rock is solid and the anchors are not loose.

Petzl resin bonded


P38 Longlife

WARNING NEVER TIE A ROPE DIRECTLY INTO A P38 OR ANY OTHER PLATE TYPE ANCHOR.

33. Always use a karabiner or maillon to attach the rope to a plate hanger. These types of hangers often have sharp edges and being made out of thin steel the rope is weakened by being bent around such a small radius.

34. **8mm Self Drilling Anchors.** The majority of European caves have 8mm anchors fitted and they are also still used extensively during exploration. These anchors are often referred to as "SPITS" because they are manufactured by Special Purpose Industrial Tools Ltd. A hardened steel sleeve is fixed permanently into the rock and each caving group has to screw in there own hanger. Some of these anchors have been fitted for over 25 years and therefore all must be checked thoroughly before use.

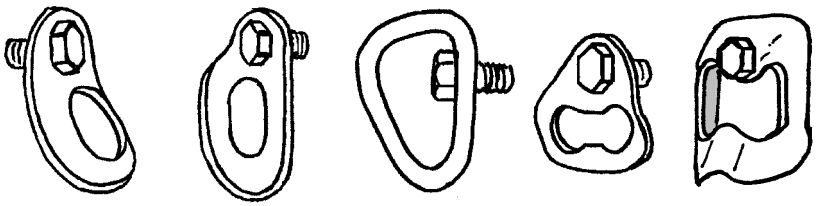
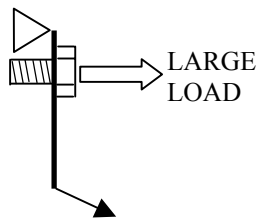


Plate Twist Ring Bollard Clown

35. There are five types of hanger in general use, the plate and twist hangers which require a karabiner or maillon to connect to a rope and the ring, bollard and clown, which are predominantly used for SRT, into which the rope is directly tied.

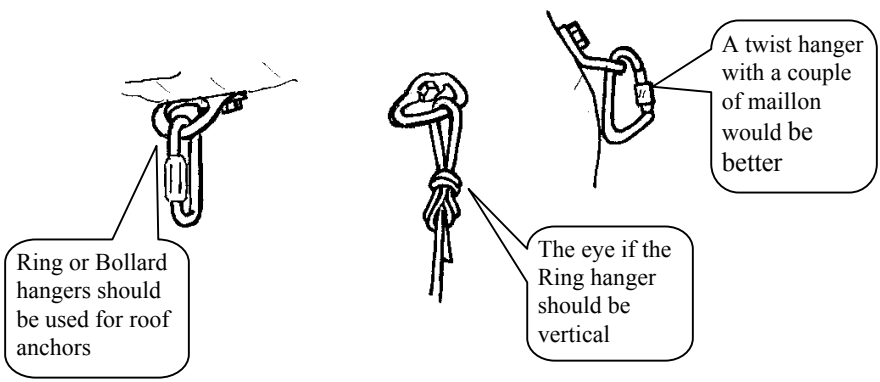
36. The maximum strength of this type of anchor is 1800kg, which is the sheer strength of the 8 mm diameter bolt fitted in a newly installed anchor. Any wear of the bolt or the sleeve and over tightening of the bolt will reduce this strength. The bolt should be able to be screwed most of the way in by hand and a 13mm AF spanner used for the final ½ - 1 turn. Do not be tempted to over tighten the bolt as it will only increase the stress on the bolt and reduce the overall strength of the anchor.

37. Care must be taken not to load plate or twist hangers at an angle greater than 45^{O} as this causes excessive leverage and strain on the bolt.



INCORRECTLY USED HANGERS

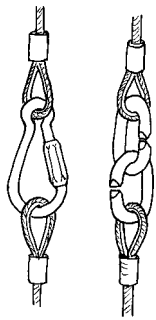
These 3 hangers are putting additional leverage onto the bolt which greatly reduce its strength.



LADDERS SPREADERS and TETHERS

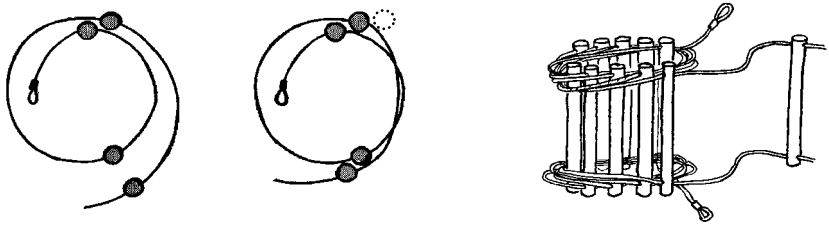
WARNING: LADDERS, SPREADER AND WIRE TETHERS ARE ONLY DESIGNED TO SUPPORT THE WEIGHT OF A PERSON CLIMBING, THEY ARE NOT CAPABLE OF ABSORBING ANY FORM OF SHOCK LOADING AND PROVIDE NO PROTECTION TO THE CAVER IN THE EVENT OF A FALL.

A LIFELINE MUST BE USED ON ALL LADDERS CLIMBS.



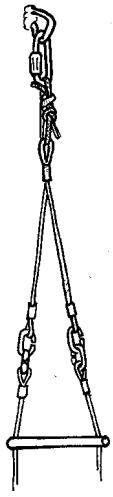
38. **Ladders** The majority of ladders are manufactured using 3 or 4mm galvanised steel cable, which can suffer from corrosion and can easily be weakened by kinking or putting tight bends in the wire. The weakest part of a ladder is usually the "C" links that are used to join ladders together. Some manufactures have now replaced these "C" links with captive maillons in order to give the ladder additional strength. It is acceptable practice to remove the old style "C" links and use 7mm (long) maillons to join ladders. However this could make these ladders incompatible with other people's ladders.

39. Ladders spreaders and wire tethers should be cleaned and inspected for damage after every caving trip, paying particular attention to where the wire rope passes through the rungs or around the swaged eyes. Ladders should preferably be carried in a tackle sack when underground, this prevent them snagging and helps to stop mud being forced into the wire rope.



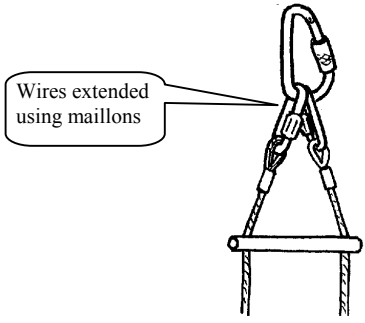
40. **Coiling** Ladders should be coiled carefully to prevent permanent distortion of the wire rope. The best way to make a tight neat coil is to put the third rung beyond the first rung, the forth beyond the second and so forth, each time putting the wire rope on the inside of the other wire rope. This systems works particularly well with the older style 25-foot long ladders with 12" rung spacing. The ends of the ladder can be fastened around the coil to keep it together whilst underground, but should be unclipped during storage to prevent permanent distortion of the wire.

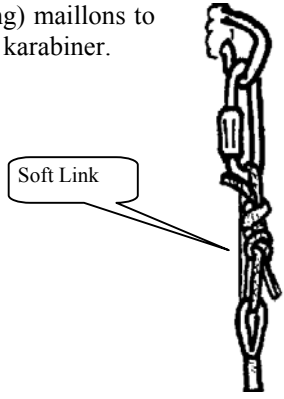
41. **Spreaders** These are used to connect a ladder to a single attachment point such as an artificial anchor or a sling. It is advised that the spreader/ladder is connected to the anchor with a "Soft link". If there is an incident on a pitch where the person climbing the ladder needs to be lowered, but is prevented from doing so because they are entangled with the ladders, the soft link can be cut to release the ladder. Some instructors and leader have a second soft loop already attached to the spreader, which can be used after the first has been cut.



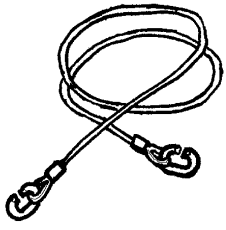
42. The soft link should be manufactured out of a short length of 7 or 8 mm rope, which is passed through the eye of the spreader and tied into a small loop with a double fisherman knot.

43. If a spreader is not available do not connect both "C" links into a single karabiner. This will put excessive strain on the wire rope as it comes out of the top rung. The solution is to use two 7mm (long) maillons to extend the wires and clip both maillons into the karabiner.





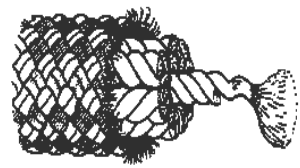
44. **Tethers** These are used to connect a ladder directly to a natural anchor such as a thread, spike or jammed boulder. They have become almost obsolete with the number of artificial anchors available and in most cases a rope or tape sling can be used in their place. However, tethers are especially useful where the limestone is particularly sharp or abrasive and when exploring new caves.



ROPES

45. There are basically two types of rope available, low stretch rope, designed for caving and rope access, and dynamic rope for climbing. Good quality low stretch rope of 10 or 10.5mm diameter should be used for general caving as they are designed to cope with the harsh caving environment and have adequate strength even when misused. Dynamic climbing ropes can be used they have the advantage that they are able to easily absorb energy limiting the loading on the belay system. However using the correct techniques will prevent a situation developing where a rope could be subject to a high fall factor. The disadvantage with dynamic climbing ropes is that their soft open weave construction easily allows mud and grit to penetrate and the rope and their stretchy characteristic can make it awkward when life lining, abseiling or hauling. Therefore unless involved with underground climbing or advanced exploratory techniques dynamic rope should not be used.

CAUTION Static ropes which have no stretch, such as Black Marlow abseil rope, should not be used for Lifelines or SRT. Their lack of stretch will result in a high loads being placed on the anchors and caver if there is a fall. However they make excellent hand lines



46. **Construction** Modern ropes are normally manufactured from a type of nylon and are of a kernmantel construction. The centre core, the "kern", of the rope comprises of a number of bundles each containing several hundred threads. The particular make-up of these threads will determine whether the rope is dynamic or static. Some manufactures now include an information tape within the rope that gives details such as date of manufacture, diameter and properties. The majority of the rope's strength is in the core. The outer lair, the mantle, is a tightly woven sheath that binds the loose kern together and protects it from mud and abrasion.

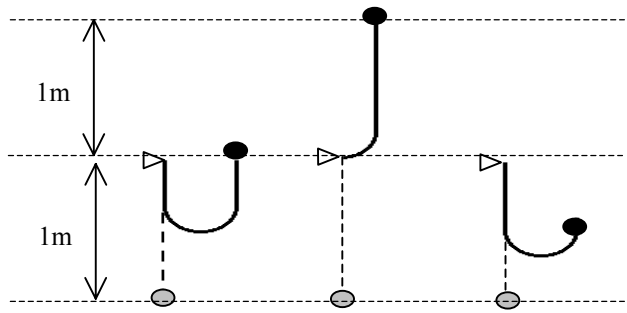
47. **Rope strength and life**. New 10mm low stretch caving ropes have a strength of over 23 kN (2.300 Kg), which is more than strong enough for normal use. There are many factors which reduce the strength of the rope:

- Knots have the major weakening effect on a rope and can reduce its strength to 33% (see CSCA technical publication "Caving Knots")
- Obvious effects such as abrasion and physical damage
- Water. Trials have determined that a rope is often 15% weaker wet than it is dry.
- Heavy load or fall.
- Age or chemical damage (these factors are harder to determine).

48. It is not possible to give a working life for any individual rope. Normally rope should be retired after 5 years of use, or less if they have obvious signs of wear or damage. A well-maintained rope, which is stored in a cool dry place, which is seldom used, could still be fit for use well beyond the 5-year point. It is recommended that a record of an individual rope's usage be maintained. This will help to give an indication of when to retire a particular rope. A "Rope Log" is particularly useful where ropes are used by various people. It is possible to send samples of rope to the NCA for drop testing in order to determine if it is still safe to use.

49. **Fall Factors** The strength of a rope on its own does not give a full indication of the suitability for use. A rope has to be able to withstand a shock load due to a fall or an anchor failure. The term "fall factor" is used to indicate the severity of a fall. It is defined as:

$$\frac{\textit{(Distance fallen)}}{\textit{(Length of rope in the system able to absorb fall)}}$$



Fall factor $\frac{1}{1} = \mathbf{1}$ $\frac{2}{1} = \mathbf{2}$ $\frac{½}{1} = \mathbf{0.5}$

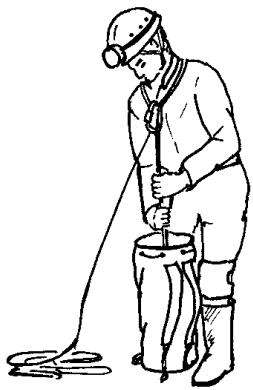
50. Dynamic climbing ropes are designed to stretch and absorb the energy from a large (factor 2) fall and limit the peak force to less than 12kN in order to protect a climber from a fatal shock load. A climbing rope will be rated at the number of factor 1.78 falls it can take before failure occurs. Currently the test is carried out with an 80kg test weight, this is likely to be increased to 100kg. A typical 11mm rope will have a rating of 7-9 falls.

51. Caving ropes are designed not to stretch more than 2-4% during normal use and are therefore unable to absorb large forces. A fall on caving rope with a factor of over 0.5 will put excessive shock loads onto the anchors and more importantly onto the caver. Manufacturers of caving/rope access ropes

normally rate their ropes at the number of factor 1 falls the rope can take before failing. These tests are conducted with a Figure of 8 knot tied in the ends of the rope. An average 10mm caving rope is rated at 12-14 falls. Using the correct techniques, particularly ensuring that there is no slack rope whilst life lining, will reduce fall factors to a minimum and prevent high shock loading.

52. **Shrinkage**. Rope can shrink up to 10% during their initial use. Therefore it is advisable to soaking all new rope for 24 hours and then dry them before use. This removes the lubricant used during its manufacture, shrinks the rope and tightens up the sheath. Once dry the rope's length can be measured. All ropes should be clearly marked with length and the date of initial use. Rope will often continue to shrink for some considerable time and it is therefore prudent to re-measure long rope periodically.

53. **Use.** Ropes should always be carried underground in a suitable tackle sack. The sack protects the rope from damage and prevents it getting dirty and tangled. It is normal practise to feed the rope loosely in the sack so that it is immediately available in an emergency. A quick and efficient way of packing a tackle sack is to feed the rope through a karabiner attached to the chinstrap of the helmet or to short sling around your neck. Both hands can then be used to feed the rope directly into the sack. Gathering handfuls of rope and stuffing them into the sack can result in tangles. A knot MUST always be tied in the bottom end of all ropes before they are put into a tackle sack, this prevents the possibility of anyone abseiling off the end of the rope.



54. After every caving trip, ropes should be washed as soon as practical to remove mud and grit. If mud is left on the rope it will get forced into the fibres during life lining and abseiling, this will cause unseen damage to the fibres of the rope and increase the wear on both descenders and alloy karabiners. After washing, ropes are to be inspected for damage, loosely coiled and then storage in a cool well-ventilated place. Damaged rope must be clearly identified and kept separate. If damage is limited to one place it is normal practice to cut the rope at that point and re-measure and mark both lengths.

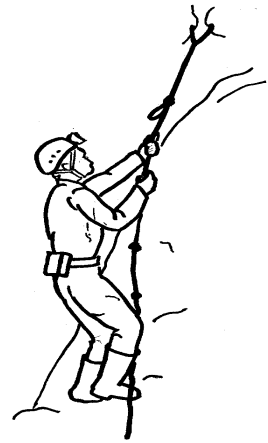
55. **Knots.** All the knots used for caving are detailed in the CSCA Technical Publication "Caving Knots".

SECURITY ON STEEP GROUND

56. Caves have many short climbs and steep slopes that do not require a ladder to descend. However, they may often require the use of a rope for either direct assistance or for safety. A relatively easy climb on the way into a cave may become a major obstacle on the way back out many hours later with a tired or injured caver or due to increased water levels.

57. All proficient cavers must be able to provide assistance to fellow cavers by being able to rig a handline, belay each other and rig a simple ladder pitch.

58. **Handlines** A handline is simply a rope tied to a suitable anchor at the top of a climb, steep slope or exposed traverse. Many of the frequently used caves have fixed handlines already in place but do not assume that they will always be there. These fixed handlines may have been in the cave for many years and must be checked to ensure both the rope and the anchor are safe. If there is any doubt rig a new rope.

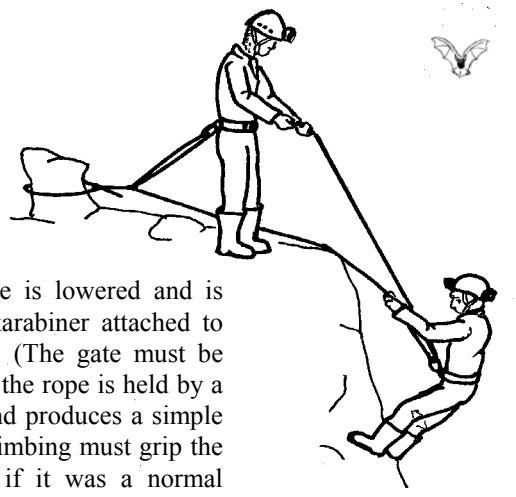


59. It is very difficult to grip a small diameter rope particularly with cold and wet hand. It is beneficial to tie a number of overhand or butterfly knot in the handline to aid grip.

WARNING ALWAYS CHECK THE STATE OF FIXED ROPES. IF IN DOUBT RIG YOUR OWN.

60. **Assisted Handline** An assisted handline is used to give direct help on a climb or to control a descent. It is particularly useful for giving aid to a novice or tied caver up a short climb.

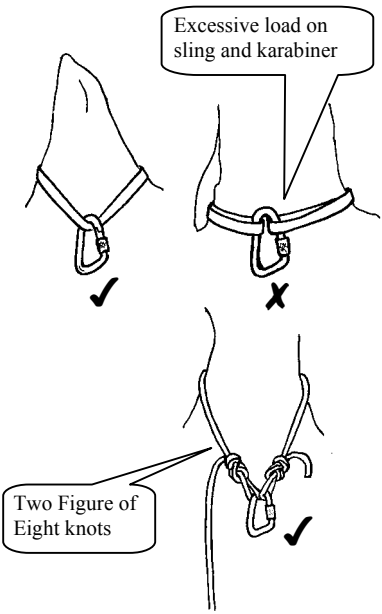
61. The safety rope is securely anchored at the top either to a single natural anchor or to two artificial anchors. The caver at the top should normally be attached securely to prevent him/her from being pulled over the edge if the person climbing slips or panics and grabs hold of them. The easiest way is to tie a long loop into the rope with a butterfly knot and clip the loop into the load-bearing belt. The loop should be long enough so that no load is placed on the person at the top of the climb when the rope is pulled from below. Alternatively a sling can be used to attach directly between belt and anchor/s.



62. A loop in the safety rope is lowered and is passed through a screw gate karabiner attached to the caver's load bearing belt. (The gate must be screwed shut). The free end of the rope is held by a caver at the top of the climb and produces a simple 2:1 haul system. The person climbing must grip the FIXED rope and climb it as if it was a normal handline. The person at the top provide assistance by pulling on the FREE end of the rope or controlling the rate of descent.

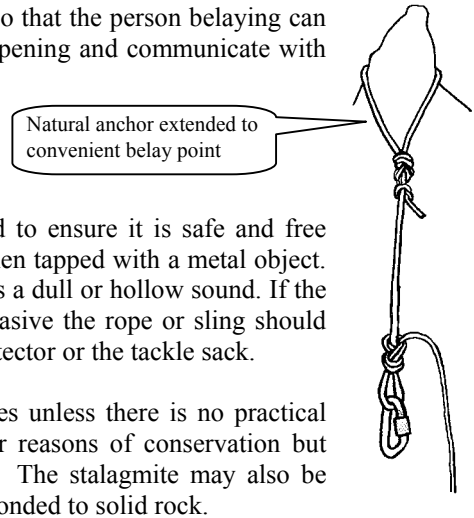
SIMPLE RIGGING FOR BELAYS and LIFELINES

63. **Natural Anchors** The simplest rigging system is to use a sling around a substantial natural anchor such as a thread, spike or securely jammed boulder and belay directly from the sling. Make sure that the sling is long enough to prevent a three-way load being placed on the karabiner or excessive load will be placed across the gate of the karabiner and on the sling.



64. If you do not have a sling or it is too short the end of the rope can be used by tying two Figure of 8 knots.

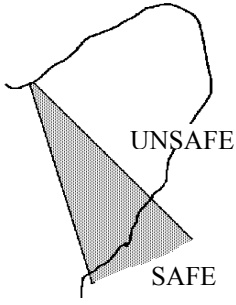
65. The rope can also be used to move the belay point closer to the top of the pitch or climb so that the person belaying can get a better view of what is happening and communicate with the person climbing.



66. The rock must be checked to ensure it is safe and free from cracks, it should “ring” when tapped with a metal object. Do not use the anchor if it makes a dull or hollow sound. If the rock is particularly sharp or abrasive the rope or sling should be protected by using a rope protector or the tackle sack.

67. Do not rig from stalagmites unless there is no practical alternative. This is not just for reasons of conservation but stalagmites can be very brittle. The stalagmite may also be sitting on mud or sand and not bonded to solid rock.

68. Great care must also be used when rigging from boulder. Make sure that they will not move and release the rope when heavy load is applied. Solid limestone should always be the first choice for a belay.



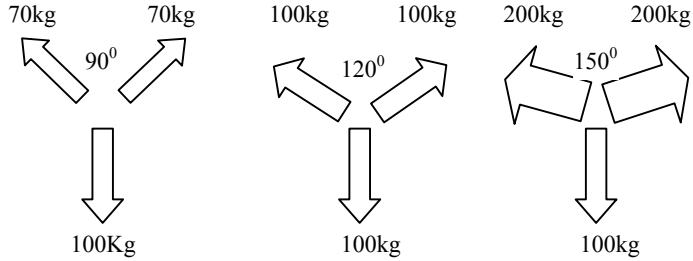
69. If you are using a spike make sure that the sling or rope will not jump off the top when a shock load is applied or released.

USING ARTIFICIAL AND SHARED ANCHORS

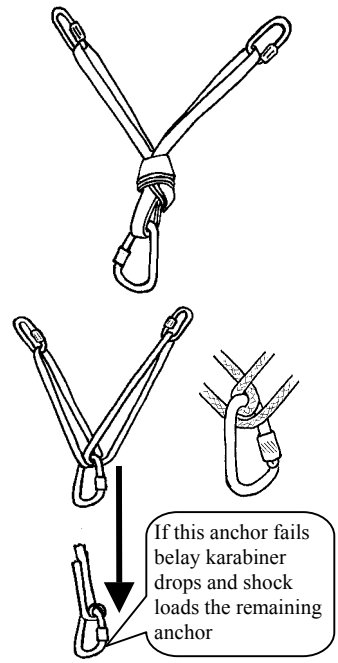
70. When using artificial anchors, two independent anchors must be used at the start of a traverse or at a pitch head. NEVER USE A SINGLE BOLT. This is vitally important when using 8mm bolts. The "two bolt" rule should equally be applied to resin bonded anchors. Single bolts can be used for intermediate anchors and rebelays. There may also be occasions when it is necessary to use two natural anchors to get a suitable belay position.

71. When two anchors are used for a belay system they should be connected in such a way that the load is shared equally between the two anchors. In the event of one of the anchors failing the remaining anchor will not be subjected to a shock load and the belay system should remains secure. This load sharing system is often referred to as a Y hang. A Y hang can be rigged using a sling, however it is often easier to use a short length of rope.

72. The angle of the Y hang is very important. The angle must not exceed 90^0 or excessive load will be placed on the anchors.



73. **Using Slings** A suitable length sling can be used to connect into two anchors. The preferred method is to clip the sling into karabiners attached to both anchors and then tie an overhand knot in the middle of the sling to provide an attachment point for the belay karabiner. This makes a very secure belay and minimises shock load if one anchor fails. When tying the knot make sure that all parts of the sling lie flat and parallel. The knot can be hard to undue if it has been subjected to a heavy load.



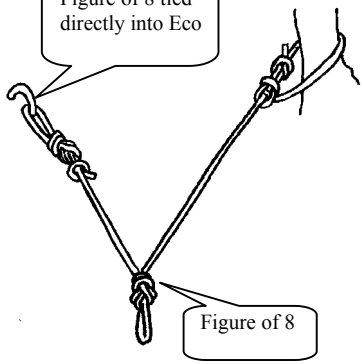
74. At one-time climbers recommended using a self-equalising method by clipping the sling into both anchors and putting a twist in one part of the sling to produce a loop and attaching the belay karabiner through this loop. This method is not as secure as the overhand knot method and is no longer used by climbers. It should not be used for the following reasons. If one anchor fails the remaining anchor will be

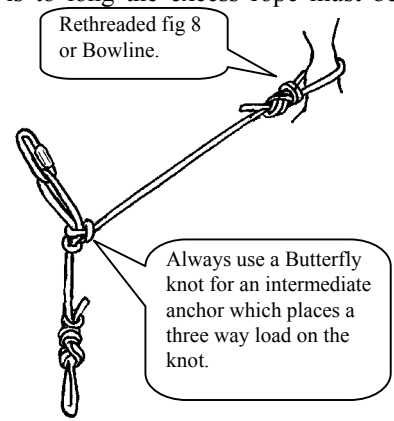
subjected to a shock load as the belay karabiner slides down and then stops at the end of the sling. Because cavers use low stretch ropes this shock load will be very high. If a twist is not placed in the sling the central belay karabiner can slide off the sling if one anchor should fail.

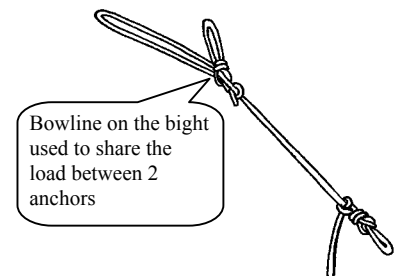
75. **Multi point rigging with rope.** Using rope rather than slings to create a belay point allows the belay to be set up in the best possible position, rather than where the length of a sling dictates. One end of the lifeline or safety rope can be used for the belay, but it is easier if a separate short length of rope is used. A second length of rope for the belay will be necessary if the last person climbing is going to be protected using the double life lining method.

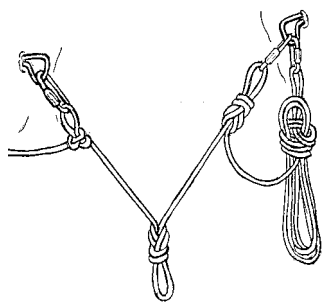
76. The rigging rope can be tied into two or more anchors using a number of different knots. For details about individual knot see the CSCA Technical Publication "Caving Knots". A few examples are shown below:

77. If the rope that is used for rigging is to long the excess rope must be coiled up neatly to prevent it being mistaken for the lifeline.









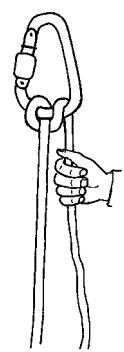
BELAYING TECHNIQUES

78. On steep ground, including climbs already rigged with a handline, a quick and simple lifeline, using the "safety rope", will give both confidence and security to other members of the caving group. The techniques for belaying on a climb or a simple ladder pitch are identical. This booklet only covers the use of the Italian hitch; other more complicated methods using descenders and pulley-jammers are detailed in the CSCA Technical Publication "Modern Ladder and Lifeline Techniques". All proficient cavers should be fully conversant with the Italian hitch belay method and double lifelining techniques.

79. **Direct Belay** The term "direct belays," means that the Italian hitch karabiner, or any other belay device, is fastened directly to the anchors or rigging and is not connected to the Caver's harness or belay belt. This has the great advantage that there is no load placed on the person belaying and they are not part of the belay "safety system". In the event of an incident the person belaying can lock off the belay and is then free to give assistance if required. The direct belay method should always be used at the top of a pitch.

80. **Indirect Belay** An Indirect belay is when the Italian hitch karabiner or belay device is attached to the caver's harness or belay belt. The harness or belt is then attached an anchor or rigging rope.

81. **Italian Hitch** The Italian hitch is a quick simple and very effective belay method that requires the minimum of equipment. The knot works by the friction generated by the rope running around a karabiner and back around itself. Because the point of friction is constantly moving, insufficient heat is generated to cause damage to the rope. It is essential that a large karabiner be used because the knot only functions properly if it can reverse itself by swinging through the karabiner. HMS or Pear shaped karabiners designed for this. If using the Italian hitch frequently, particularly in muddy caves, consider using a steel karabiner. Alloy karabiners will wear significantly at the point of moving rope contact and worn karabiners have reduced strength.

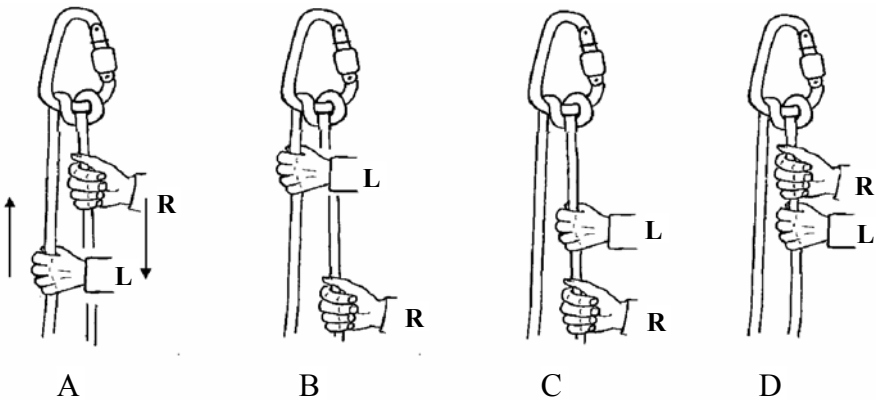


82. **Using the Italian Hitch.** Where ever possible the Italian hitch should be rigged at chest height and in a position clear of the rock. This allows for the correct operation of the hitch and prevents the rope rubbing or the knot jamming against the rock when lowering.

83. One hand must always have hold of the "free" end of the rope (that is the end that is not connected to the climber). The free end must also be held in front of the karabiner in order to gain maximum friction. When belaying at the top of a climb "in front" will be below the karabiner as shown on the previous page. Many belay devices used by climbers such as Stitck/belay plates require the rope to be held back behind the karabiner, doing this with a Italian hitch will reduce the effectiveness of the knot because it greatly reduces the amount of friction

84. When belaying a climber down a pitch the free rope can be allowed to slide in a controlled manner through one hand while the other hand is used to make sure the rope is not tangled. Belaying someone back up a pitch requires a deferent technique to ensure that the rope is securely held at all times. There is usually to much friction to simply haul the rope through the karabiner.

Belaying someone up a climb or pitch.



A B C D

[For simplicity the discription uses the right hand as the "Safety" hand.]

A&B The right hand is the "safety" hand and grips the free end of the rope below the karabiner. The left hand is used to pull up the rope.

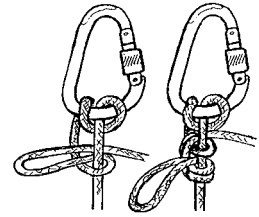
C. Left hand is moved across and grips the free end of the rope.

D. Right hand is then re-positioned above the left hand.
The left hand can then be used to pull up the loaded rope again.

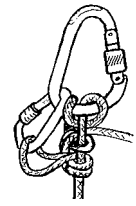
WARNING DO NOT ALLOW A LOOP OF SLACK ROPE TO DEVELOP.

85. If the person belaying cannot keep up with the person climbing, they

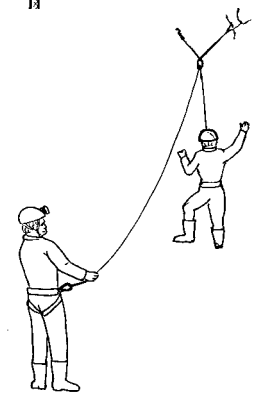
must tell the person climbing to slow down or if necessary stop. If a loop of slack rope develops and the climber subsequently falls the resultant loading on the belay and anchors will be much greater than if they had fallen onto a relatively tight rope. If the climber falls near the top of the climb it would be worse than a fall near the bottom because there would be less rope to absorb the energy. (See Fall Factors)



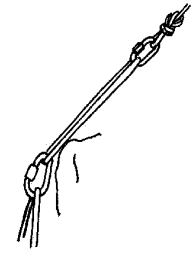
86. The Italian hitch can be locked off with a Half hitch tied beneath the knot, a second Half hitch MUST then be tied to prevent the first hitch coming undone. A tight grip of the free end of the rope must be maintained at all times when locking off the Italian hitch. For additional security the loop can be clipped back into the karabiner. The knot can be easily released when under load, yet again it is important that a firm grip is maintained on the free end of the rope at all times and that it is released smoothly to prevent a sudden drop.



DOUBLE LIFELINING



87. To provide protection for the last person down a climb/pitch or the first person up the "double lifelining" method must be used. This by its nature requires a rope twice the length of the drop. Before descending the climb or pitch the last man unties the Italian hitch and passes the rope through the screw gate karabiner or pulley and attaches him/herself to one end of the rope and is then lifelined from below. It is more efficient particularly on a long pitch if a pulley is used. If you do not have a pulley and want to reduce the friction, two equally sized karabiners or maillons can be attached to the anchor point with the rope passing through both of them. This effectively increases the diameter of the bend and reduces friction.

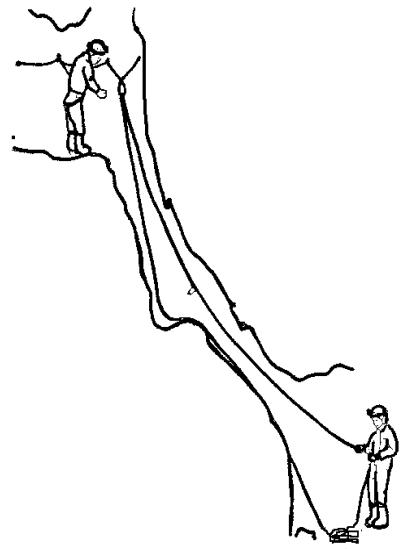


88. When ever possible the pulley or karabiner should be visible from the bottom of the pitch. This will help to reduced friction and prevent twisting and jamming of the ropes. It may be necessary to use a sling or the end of the rigging rope to extend the belay.

89. When belaying from the bottom of a pitch it is normal practise to use an indirect belay. This involves using and Italian hitch with the karabiner clipped directly to the central attachment point of the harness. If using a load bearing belt it is advisable that the belt is modified, using a sling, into a simple harness. This will reduce the load on the person belaying if the climber needs to be lowered. Consideration has to be given to the difference in weight between the person climbing and the person belaying. The additional friction gained by using a single karabiner rather than a pulley at the top of the pitch will enable a light person to safely belay a heavier person.

90. It may be necessary for the person belaying to use a bottom belay by either attaching the Italian hitch directly to a suitable anchor at the bottom of the pitch or by attaching themselves to an anchor with either the rope or a sling and belaying from the waist. It is easier to belay from the waist rather than directly from a ground level anchor, however the person belaying is then tied into the belay system. If no suitable bottom belay is available a second member of the party can attach themselves to the person belaying by using a sling or the end of the rope.

91. **Pull-Back system** When lifelining a caver up a pitch from the bottom it will be necessary to get the end of the rope back down to the bottom, once he/she has reach the top, of the pitch so the next person can be attached to the rope. It is advised that the person climbing ties onto or attaches both ends of the rope to their harness. When safely at the top of the pitch both end of the rope can be joined and pulled back to the base of the pitch. This Pull Back system can also be used when belaying from the top of the pitch, particularly on a constricted or inclined pitch, so the end of the rope can be return to the bottom of the pitch for the next person.

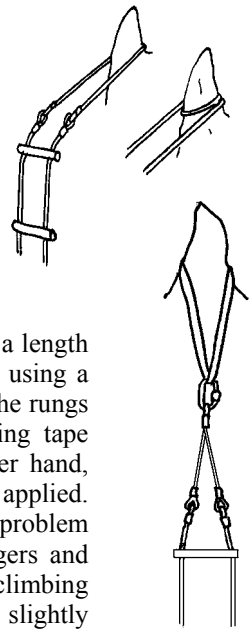


RIGGING SIMPLE LADDER PITCHES

92. The ladder should be rigged so that it hangs free from any hazards e.g. water or loose rocks and has easy access. The ladder need only be attached to a single anchor which can be one of the anchors used for the lifeline system or could be a totally independent anchor.

93. **Using Natural Anchors** The traditional ladder rigging technique is to attach the ladder to a suitable natural anchor using a wire tether. Various lengths of tethers are required so that the belay can be extended to the very edge of the pitch. Therefore allowing only the minimum length of ladder to be carried. With the number of artificial anchors in caves this technique has become almost redundant. However, tethers still have a use.

94. There are a couple of problem associated with tethers. Firstly, if unequal load is placed on the two side wires of the ladder the tether may slip around the anchor and cause the ladder rungs to be inclined at an angle. If a long enough tether is used it should be rapped around the anchor to prevent this slippage. Secondly the repeated use of wire tethers will cause environmental damage to the cave by cutting groves into the natural anchor, particularly if it is relatively soft flowstone.

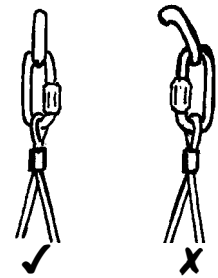


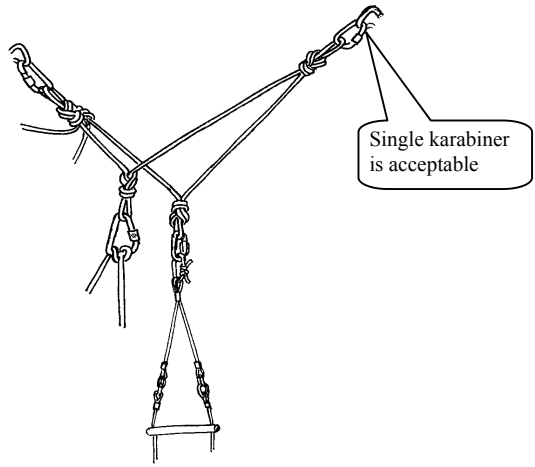
95. It is common practice nowadays to use a sling or a length of rope around a natural anchor and attach the ladder using a spreader and karabiner. This prevents the problem of the rungs sloping. There are no problems associated with using tape slings because they do not stretch. Rope on the other hand, even caving rope, will stretch slightly when load is applied. The longer the rope the greater the stretch. This is a problem when the ladder hangs against the rock, because fingers and hands will get rubbed up and down the rock as the climbing action causes the rope to stretch and ladder to bounce slightly up and down.

96. **Using Artificial Anchors** As stated earlier the ladder need only be attached to a single anchor. The ultimate safety for the person climbing is provided by the lifeline system, which must be attached to at least 2 artificial or one substantial natural anchor. The ladder should be attached to the artificial anchor using a tether and karabiner. It is advisable that a "soft link" is included so that the ladder can be easily released. (See para 41).

CAUTION DO NOT PUT A TWISTING LOAD ON A ECO ANCHOR

97. If an ECO anchor has been set with its eye vertically in the rock then the ladder can be hung from the single anchor. However, there are a number of pitch heads where the ECO anchors have been deliberately set at an angle so that when correctly rigged for SRT the load from the rope will be in line with the hanger. If the ladder is clipped to one of these angled ECO anchors the repeated motion of climbing the ladder may eventually cause a breakdown of the bond between anchor, resin and rock and allow the anchor to become loose and rotate.





98. If there are no other suitable anchors other then anchors set at an angle for SRT then the ladder must be suspended from both anchors to prevent any twisting action. The ladder will need to be rigged in a similar way as a belay Y hang. A sling could be used, but it is probably easier to use the end of the rigging rope that is being used for the lifeline belay. It is acceptable to use the same karabiners to attach the ladder and the lifeline to the anchor, providing the karabiner is not subjected to a three way load.

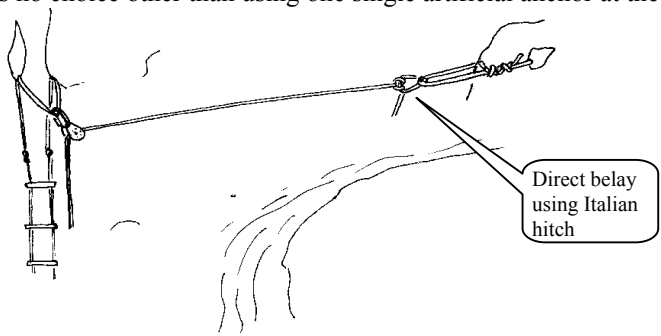
99. It is good practice to keep the ladder and the belay attachment point slightly apart so the hands of the person belaying with the Italian hitch are well clear of the ladder.

REMOTE BELAY POINT

100. It will sometimes be impractical to belay directly from the top of a pitch due to the constricted nature of the pitch head or the lack of a suitable stance. If the belay point for the lifeline is some distance horizontally from the ladder a fall from the ladder may cause the caver to swing under a waterfall or into another hazard. Therefore a pulley or karabiner should be placed at or near the top of the ladder so that if the caver slips off the ladder they can still reach it and will not swing into danger.

101. The main lifeline belay point further back from the edge must be attached to either a single substantial natural anchor or a minimum of 2 artificial anchors. Likewise the pulley or karabiner at the top of the ladder should also be attached to a single natural or double artificial anchor. This will enable the pulley/karabiner at the top of the ladder to be safely used to belay the last person down using the double life-lining technique. The pulley/karabiner may share the same anchor as the ladder.

102. If there is no choice other than using one single artificial anchor at the top



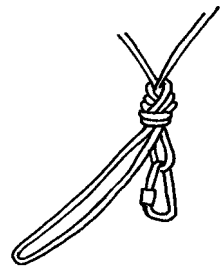
of the ladder it can be used to redirect the rope whilst belaying from the pitch head, but must not be used on its own for the double lifeline. To adequately protect the last person to descend the rope would have to be passed through the pulley/karabiner at the top of the ladder as well as a second pulley/karabiner attached to the main belaying point . This will cause an increase in friction that may make lifelining form the bottom of the pitch difficult.

103. The main problems associated with belaying some distance away from the ladder is poor communications between belayer and climber and the fact that the knotted end of the lifeline will have to be retrieved before the next person descending can be attached. This could require an exposed traverse. One solution could be to use a karabiner at the top of the ladder. Once at the bottom of the ladder the caver unties the knot from the end of the lifeline and

the rope is pulled up through the karabiner. Once the next person is attached they are lifelined out to the top of the ladder where they clip the lifeline through the karabiner screw shut the gate and descend. Alternatively both ends of the lifeline can be joined together in a modified "Pullback" system".

SAFETY & GROUP MANAGEMENT

104. **Leader Safety** For simple ladder pitches a cave leader may choose not to wear and use cowstails. However when belaying he/she should normally be attached to the belay system for their own security. This is particularly important if the pitch head is exposed. This can easily be done using a sling and screw gate karabiners to link waste belt or harness to the lifeline rigging. Alternatively a Bowline on the Bight or a Double Figure of 8 on the bight can be tied with uneven loop sizes. The smaller loop for the belay karabiner and the longer one clipped to the waist belt or harness of the person belaying.



105. **Group safety** Good group management at and around a pitch will have the great effect on the overall safety of the group. There will always be the temptation to try and watch others climb. The cavers who are waiting to descend must remain at a safe distance from the top of the climb/pitch and only come forward one at a time when instructed. Each person must be attached to the rope and the Italian hitch connected to the belay whilst they are still in a safe area away from the edge. It is prudent to send the deputy leader or another experienced caver down the ladder first. If there are problems with the ladder being snagged or it is not long enough they will be better able to deal with the problem then a novice. At the bottom of a climb group members must stand well back out of danger from falling rocks that may be dislodged or kit that is dropped.

106. There will be a number of factors that will influence where the leader stands at the pitch head. It is important that he/she is able to see the person climbing for the majority of the pitch. The leader should normally stand between the pitch head and the rest of the group who are waiting to descend and act as a physical barrier however, in a narrow cave passage it may be advantageous to stand beyond the pitch head so that the other cavers do not have to squeeze around them. There is no single solution; each pitch will be slightly different.

WARNING: IN THE EVENT OF A FALL ANYONE LEFT HANGING BY A WAIST BELT CAN DIE BY ASPHYXIATION WITHIN 15 MINS

107. **Climbers Safety** If there is the potential that a person who slips from the ladder could be left hanging fully supported by lifeline, such as a fall from a vertical ladder or slip from an exposed climb, and can't be immediately lowered, they must be wearing a suitable harness. If left supported by a waist belt alone the belt will crush the abdomen compressing the diaphragm and prevent proper breathing. A fully conscious and uninjured person may die in less than 15 minutes.

CLIMBING CALLS

108. It is necessary to have a set of common calls to enable good unambiguous communications on a pitch. The following calls are common for both climbing and caving.

Climbing Calls	
Climber	**Lifeliner**
Once attached to rope. **"Take In"**	Takes in rope until tight.
When rope is tight. **"That's me"**	Checks Italian hitch is correct and karabiner gate screwed up. **"Climb when ready"**
Climbing now"	**"OK"**
Starts to climb.	
Calls whilst Climbing	
If rope to loose. **"Take In"**	Takes in rope keeping slight tension.
If rope to tight i.e. preventing getting off at the Pitch head. **"Slack"**	Feeds out a small amount of rope whilst, maintaining a safe belay.
To take in the rope tightly, (problem or needing a rest) **"Tight"**	Takes in the rope tightly and prepares to lock off the Italian hitch
Climber in a safe position off the ladder. **"Safe"**	Can stop belaying.
Climber disconnected from the rope. **"Rope free"**	Free to prepare for the next climber.

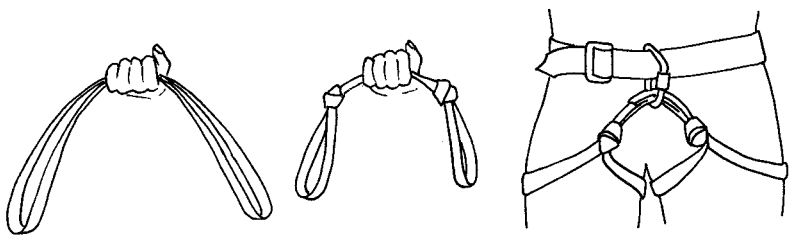
Warning Calls	
"Below"	If anything is dropped or knocked down the pitch
"Rope Below"	When about to drop the end of the rope back down the pitch.

109. **Whistle Calls** The noise from a waterfall or the acoustics of a large shaft or cavern can make verbal communication difficult. A simple whistle call system can be used. The following system is internationally recognised.

Number of Blasts	Meaning
1	STOP
2	UP
3	DOWN
4	PROBLEM / HELP

IMPROVISED HARNESSES

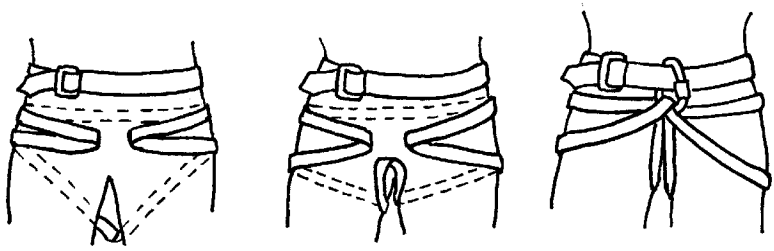
110. **Leg Loop Harness.** Providing a caver has a load-bearing (belay) belt a simple and safe sit-harness can be constructed out of a single 8' (2.4m) sling. This type of improvised harness is ideal for the occasional ladder pitch and is far superior to the Dulfour harness detailed later.



111. To create the harness, hold the sown joint in the one hand with an equally sized loop each side. A knot is then tied in each loop close to and either side of the hand. Depending on the size of the cavers legs either an Overhand, Figure of 8 or Figure of 9 knot should be tied. It is important that the loops are a reasonably good fit around the upper thigh to prevent the loops slipping down and hindering movement

112. The central attachment point of the harness must then be attached to the waist belt with a screw gate karabiner or maillon.

113. **Dulfour Harness**. This sit harness is also made out of a single 8' (2.4m) sling. It is very quick and simple but not as comfortable or as secure as the Leg Loop harness. It is made by passing the sling behind the back and bringing one part of the sling forward between the legs to make three loops. The three loops are then clipped together with a screwgate karabiner or preferably a large maillon and attached to the waist belt. A maillon is preferred because the sling can put a three or even four way load on the karabiner. The harness should be attached to a properly tightened waist belt to prevent the climber falling out of the harness if they get inverted. Unless the harness is reasonably tight it will tend to slip down and impede climbing, attaching it to the belt also helps to prevents this happening. In an emergency the harness can be used without a belt.

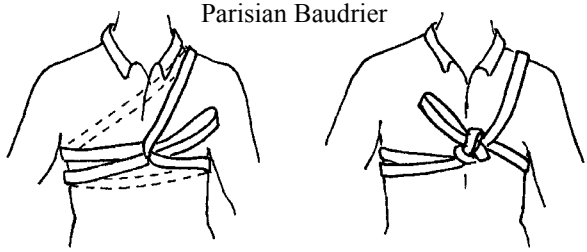


114. When using the Dufour harness on a child or very small adult the sling may be to long. An overhand knot may need to be tied in one leg loop to reduce the size of the sling so that the harness is a tight fit. If the person is a very large adult the sling may be too small and it could be difficult to attach the Dulfour harness to the waist belt. If necessary use two maillons or screwgate karabiners to extend the sling.

115. **Chest harnesses** A chest harness is not normally required for ladder and lifeline caving However if a caver is particularly tired or has sustained a minor injury, climbing a ladders will be difficult and a chest harness will help. Using a combination of seat and chest harness linked or tied together will keep the caver in a reasonably upright position, this will reduce the load on the arms if they are attempting to climb themselves. Alternatively a casualty could be hauled up the pitch without risk of them inverting.

116. A suitable chest harness called a Parisian Baudrier can be made out of a single 8' sling. One arm is passed through the sling; the other end of the sling is passed behind their back and under their armpit. The sling is then tied with a Sheet Bend.

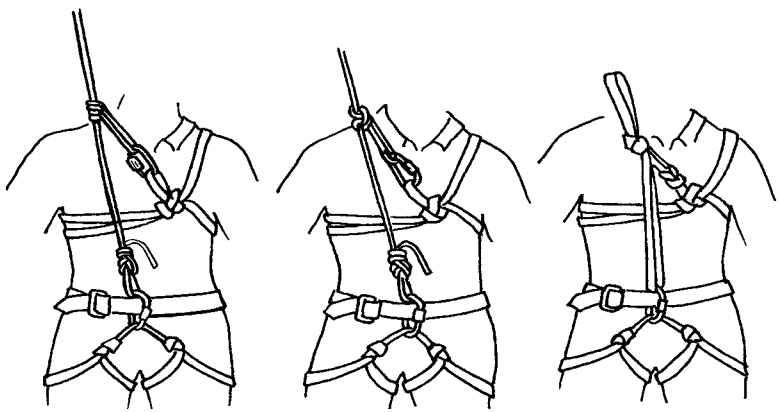
Parisian Baudrier



WARNING: DO NOT USE A CHEST HARNESS ON ITS OWN. IT MUST BE USED INCONJUNCTION WITH A SIT HARNESS.

FULL BODY HARNESS

117. A chest harness must never be used on its own, it is only used to support a casualty in an upright position while their weight is taken by a sit harness. If a person is left hanging from a chest harness their breathing will be restricted and they will eventually suffocate. The Baudrier as well as the sit harness will have to be attached to the lifeline or haul rope. There are a number of options.



A B C

a. Use a Prusik knot attached around the lifeline and clipped to the chest harness. This allows easy adjustment to get the right load distribution between chest and sit harness. Its drawback is that the knot can be pushed back down the rope if it snags on a rung of the ladder or a protruding piece of rock.

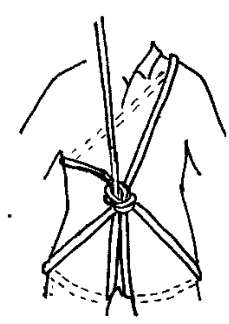
b. Attach the rope to the sit harness then tie a Butterfly knot in correct position in the haul rope and attach the Baudrier to the Butterfly with a screw gate karabiner or maillon. Alternatively a Bowline on the bight can be tied with unequal loops so that the sit and chest harnesses are separately attached. This is a very secure method however; both knots can take a while to adjust to the correct length and they result in a large knot right in front of the casualty's face.

c. The third and preferred option, particularly if the casualty is to be hoisted up a number of pitches, is to use another sling to link both the sit and chest harnesses. This sling is then tied in an over hand knot to provide a single lifting point. This method has the great advantage that once adjusted the casualty can keep the sling attached and it is a simple matter of attaching the lifeline or haul rope at each pitch or obstacle. The lifting sling can be threaded through the loop of the Baudrier rather than joining them with a karabiner. This keep the lifting point closer to the casualty and helps to keep them more upright.

ROPE ONLY HARNESS

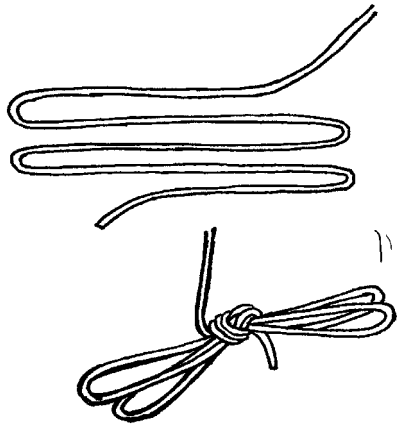
118. If there are no slings available to make an improvised sit harness a couple of different harnesses can be made out of the lifeline or safety rope. Both are difficult to adjust once tied and a number of attempts to get the knot the right size may be required.

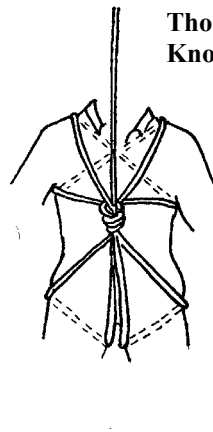
119. **Triple Bowline harness**. A large triple bowline is tied in the end of the rope and the end secured with a stopper knot. Each legs is passed through a loop and the third loop is passed diagonally across the chest and over one shoulder.



Triple Bowline

120. **Thompson Knot** This knot is often taught to climbers. It is very simple, but does use a lot of rope. The rope is flaked out to form four loops, one for each limb. The whole bundle of rope is then gathered together and tied with an overhand knot in the middle. The legs are put through two loops and the remaining two loops are for the arms with the rope passed diagonally across the back.





Thompson Knot

PROBLEM SOLVING AND INCIDENTS

NOTE: The techniques described are for simple lifeline systems using the Italian hitch either as a direct belay from the top of the pitch or double life lining from the bottom.

121. All CVP personnel particularly those who are nominated, as a deputy leader must be able to deal with simple problems and incidents on a ladder pitch or climb. The most common problem particularly when caving with young or novice cavers is their inability to climb the ladder pitches due to tiredness, poor technique or lack of upper body strength. In the majority of cases it is possible to assess people prior to them starting to climb the ladder. The simple rule is "*Do not allow a caver to start a ladder climb unless you are confident that they can get to the top*".

122. Providing a tired caver is reasonably dry a short rest before starting to climb may be sufficient, however a tired wet person will gain little from a rest in a cold and draughty cave. If there is any doubt about their ability to complete the climb a simple haul system should be set up to prevent a problem occurring rather than dealing with a potentially serious problem half way up a long pitch.

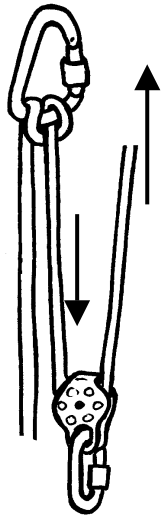
Tired Caver Mid Pitch

123. **Resting** Fatigue is often caused by lack of arm strength due to climbing with the hands too high. When a person says the cant continue climbing the normal procedure is to take in the lifeline very tightly and if necessarily lock off the Italian hitch. Instruct the climber to rest in their harness and relax their arms by hanging them by their sides. A short rest and verbal encouragement will normally be sufficient to allow them to continue the climb. If the Italian hitch has been locked off it is important to warn the climber before releasing the lock as they may feel a jolt. Keeping a firm grip of the free end of the rope as it is released the hitch and instructs the climber to "*Climb when ready*". If the climber can't or won't continue to climb there are two options either to lower them back down or haul to the top.

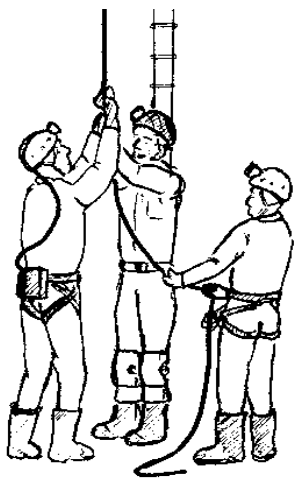
124. **Lowering** Lower them to the bottom of the pitch is a quickest solution. However the caver will still have to climb the pitch at a later time, but they can be rested and a simple haul system prepared to give them assistance if required. When lowering someone down a pitch get him or her to hold the ladder out to the side to avoid them becoming entangled or snagged in the ladder.

125. **Pitch head Hoist** It is not possible to haul a casualty by pulling the rope through an Italian hitch. However providing there is sufficient rope it is easy to create an effective hauling system. (If double lining there will be enough rope providing the climber has climbed more than the first 1/3 of the pitch.)

- Lock off the Italian hitch and get caver to rest in their harness
- Lower a loop of rope with a karabiner or preferably pulley and karabiner. For safety always use a screw gate karabiner. Try to prevent the rope twisting.
- Instruct the caver to clip the karabiner to central attachment point of their harness then take in all the slack rope. This rope should be securely tie off
- Warn the caver that you are about to unlock the Italian hitch. Carefully unlock the hitch taking in the slack rope. Host the caver by pulling the rope rising from the karabiner/pulley. If there is a second person at the top of the pitch they can haul whilst you maintain control of the Italian hitch
- Instruct the caver to either attempt to climb the ladder or pull down on the rope that is moving down towards him/her.



126. **Bell Ringing** When belaying from the bottom the simplest way to assist a tired climber up a pitch is for two or three other cavers to gather around the rope and pull down using their body weight. To prevent the casualty from falling back down the pitch, if all the hauling team happen to let go at the same time, one of cavers at the bottom MUST belay the lifeline at all times.



Injured caver mid rope

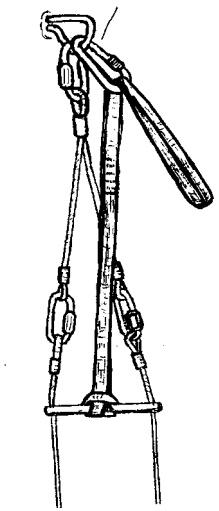
127. The most likely causes would be due to a rock fall or dropping heavy equipment down a pitch. If the casualty is conscious and able to follow a couple of simple instructions then they could be hoisted up the pitch by locking off the hitch and lowering a loop as described earlier.

128. An unconscious casualty midway down a pitch is a very serious situation and they must not be left hanging from their harness for more then a few minutes. The quickest option is to lower the casualty back down, however do not lower them into water or any other hazard unless there is someone at the bottom of the pitch to give assistance. This may require another member of the party to be lowered to the casualty or to the bottom of the pitch. If double lifelining there will be sufficient rope for a second person to climb or be lowered down the pitch. It is probably the quicker option.

129. If the pitch is sloping the casualty could snag partway down as they are lowered. It will be necessary for a second person to descend or ascend to the casualty and help to control the lower. .

Leg jammed in ladder

130. Lowering a casualty down a pitch may be prevented if they have a leg or inserted through the ladder. If a soft link is fitted to the spreader attaching the ladder to it's anchor it can be cut to release the ladder. Prior to cutting the link it is recommended that the ladder is attached to either the end of the lifeline or a second rope so that it does not land on top of the casualty midway down the pitch. The ladder may only need to be lowered sufficiently to allow the leg to be removed or it may need to be lowered all the way to the bottom of the pitch.



131. If the ladder is connected directly to an anchor with a maillon or karabiner, without a soft link, it will be necessary raise both the ladder and the casualty sufficiently to release the ladder. To do this the Italian hitch must first be locked off to safeguard the person on the pitch. The ladder can then be raised by connecting a sling or short length of rope to the top rung of the ladder and passing it through a karabiner or pulley attached to the anchor above the ladder. Using their body weight as a counterbalance the person at the pitch head can stand in the sling and raise the ladder sufficiently to undo the karabiner, maillon or 'C' links. Once the ladder has been released the hitch can be unlocked and the person lowered to the bottom of the pitch.

SELF RESCUE

132. If you have an accident or a member of the caving party is suffering the effects of cold or fatigue you will be faced with a number of choices: Either to stabilise the casualty and send for help or start a self rescue, if the injures are minor it may be possible to exit the cave without assistance, or start to move the casualty towards the surface whilst waiting for the CRO.

133. The Leader must to consider the following:

- Is self-rescue possible without doing more damage to the casualty?
- Are the injuries such that the casualty can be moved without expert assistance?
- Is the party capable of performing the rescue?
- Does the party have the necessary equipment and knowledge?
- What would be the effect on the casualty of remaining static? (Cold and hypothermia) and would this outweigh further damage to minor injuries in the event of moving out of the cave.

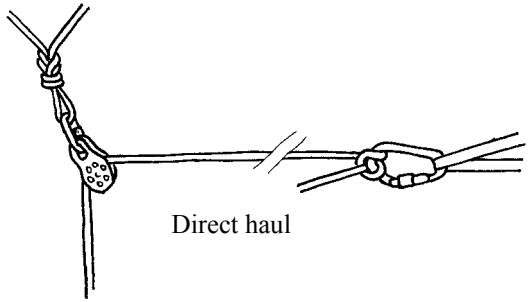
HAULING A CASUALTY

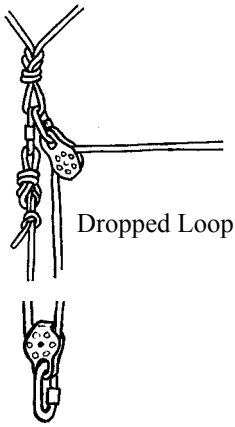
134. Exiting a cave with a very tired or injured caver will be slow and difficult. Short climbs and ladder pitch may become major optical. The casualty should be fitted with an improvised full body harness as described earlier. Climbs may need to be rigged and ladder pitches modified to make hauling the casualty easier for the rest of he caving group.

135. The simplest way to haul a casualty up a pitch is to use the “Bellringing” technique as described earlier. The pitch should already be rigged for this. It will be necessary to send the deputy leader or a competent caver up the pitch first so that they can assist the casualty at the pitch head.

136. Hauling from the top of the pitch is much harder then bellringing. It is not possible to haul the casualty up the pitch with the lifeline through the Italian hitch, as there is far too much friction. A direct haul can be used by passing the lifeline through a pulley or karabiner at the top of the climb and the rest of the group pulling on the rope. The end of the rope must be belayed

through an Italian hitch anchored further back up the cave passage. The direct haul is strenuous and only effective if there is a large group to haul.





137. **Dropped loop** Because the pitches will have been rigged for double lifelining there will be sufficient rope to allow a simple 2:1 ratio haul system to be rigged. The rope will have to be re rigged with one end securely tied to the pitch head. A loop with a pulley or karabiner is then lowered to the casualty and attached to the casualties harness. The rope is then passed through a second pulley or karabiner attached at the top of the pitch. If only one pulley is available it should be used at the top of the pitch.

138. Two or three cavers can easily haul the casualty up the pitch. The end of the rope must be taken in through Italian hitch anchored further back up the cave passage.

139. More elaborate systems using jammers and descenders are detailed in Modern Ladder and Lifeline Techniques.