# THE VOC GLACIER MANUAL

A manual for glacier travel techniques for the Varsity Outdoor Club

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**Thanks to Sam McKoy, Raz Peel, Zack Wentz and the 2018 VOC Executive Committee for their edits and contributions.**

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# INTRODUCTION AND DISCLAIMER

Alpinists face many challenges in the field and must make many complex decisions to travel safely. It takes a lifetime to learn how to travel safely in the mountains, and even then, safety is no guarantee. Mountaineering, as rewarding as it can be, is an inherently dangerous activity.

This document and its appendices were written to support the G1 and G2 Glacier School courses that the Varsity Outdoor Club hosts annually. It is written for participants to study before and reference after the course, and for anyone who is interested in learning an introduction to glacier travel and some basic rescue techniques.

There are many resources available for the budding mountaineer. 'Mountaineering: Freedom of the Hills' is considered to be the bible of alpine techniques, but there is a multitude of other good books available, as well as many online resources. Some further reading will be listed at the end of this manual.

Learning how to travel safely and employ rescue techniques in an emergency are essential skills for mountaineers at any level, but it is important to remember that communication with one's team is equally important. Above all, be honest with your team about your ability and comfort levels, and respect theirs.

# WHY GLACIER SCHOOL?

Glaciers are geographically ubiquitous in Western North America, in addition to many other mountaineering destinations around the world. They are commonly found in mountainous regions, precisely and non-coincidentally where the finest alpine objectives and ski touring areas are located. Therefore, learning how to travel on glaciated terrain is an integral part of both mountaineering and ski touring, both activities upon which the Varsity Outdoor Club was founded to help members pursue.

# WHAT IS GLACIER SCHOOL?

Glacier school, consisting of G1 and G2 courses, is a peer-instructed glacier education program with the Varsity Outdoor Club of UBC Vancouver. Courses run over a weekend in the field, but usually require a classroom session(s) in the evening in advance for contextual understanding of the learning material and preparation (these evenings are dubbed "dry school").

It is important to recognize that this is a volunteer-run program - most (and sometimes all) of the instructors are not professional guides and have no official certifications. However, they are knowledgeable and passionate individuals with glacier travel experience. This manual and the curriculum have also been reviewed and edited by several accredited members of the guiding and mountaineering community.

The purpose of these courses is to introduce some of the hazards that glacier travel entails, as well as some introductory practices to safe travel and basic rescue techniques. After taking G1, participants will hopefully know some of the more common hazards that glaciers present, and what techniques they should be practicing to manage the hazard. Participants in the G2 course will ideally walk away with some confidence in the execution of various rescue system and an understanding of more terrain management techniques, though the G2 curriculum was intentionally left with some flexibility.

Note: this is not an exhaustive exploration into every technique or practice that can be applied in the backcountry and further regular practice will be needed to attain proficiency. It is the responsibility of the participants after taking G1 or G2 to practice learned techniques and skills and continue their mountaineering education.

Please see Appendix A for the G1 and G2 curriculums.

# HOW DO I PREPARE?

The first thing participants of G1 and G2 can do to prepare for glacier school is to read this manual and its appendices in its entirety. This helps participants prime themselves for the material that will be presented both in dry school and in the field. Participants must also attend the dry school sessions that are held in the week running up to the course.

Having all the right gear is also a necessity: there will be a gear hours with a quartermaster available during one of the dry school sessions to ensure participants are able to rent any gear they do not own. Renting or purchasing at MEC is another option. Please see the packing list below for both G1 or G2.

| **Packing List** (please note the VOC will provide club ropes and is not responsible for damage to the ropes of participants should they chose to use their own) | |
|---|---|
| 1 x ice axe with adze | 1 x harness |
| 2 x 4-6m of 7mm diameter cordallette | 1x helmet |
| 2 x short prussiks (2m of 5-6mm) or the shortest hollowblock | 1 x belay device (preferably tube style or "ATC", with guide mode) |
| 4 x locking carabiners | 1 x pair of crampon compatible mountaineering boots |
| 2 x non locking carabiners | Waterproof layers |
| 1 x ice screw | Warm layers + gloves |
| 1 x snow picket (preferably V-shaped) | Sunglasses + hat |
| 1 x pulley | Winter camping gear (sleeping pad, mat, tent) |
| 1 x pair 12 point crampons (steel, automatic or semi-automatic) | Food and cooking supplies for 2.5 days |
| Optional: Microtraxion (recommended), probe, tibloc, extra pulleys, gaiters (recommended), thermos, deck of cards | |

TABLE 1 – G1 AND G2 PACKING LIST

Please note that for the 2018 G1 course, a knowledge of how to top rope belay and build sport climbing anchors is a **minimum requirement**. If participants do not know how to belay, they must sign up for a free belay lesson with the UBC Aviary before dry school, or take a lesson at their own cost and time. Direction to further reading on anchors will be provided at the end of this manual. **Participants must show up with sufficient background knowledge as detailed in this section.**

# 1.0 GLACIERS AND YOU

## 1.1 WHAT IS A GLACIER?

A glacier is an accumulation of snow and ice that has densified into a solid but deformable mass. They vary greatly in size (ranging in thickness from a few meters to up to a kilometer) and shape, and many great glaciers congregated together will usually form what is called an ice field. Due to self-weight, glaciers deform over time, causing cracks, crevasses and seracs. Glaciers, or relics of their existence, are more commonly found in colder regions and at higher elevations, but as long as there are mountains and adequate precipitation, a glacier is likely to be present, or have previously existed there.

## 1.2 HOW DO CREVASSES, SERACS AND BERGSHRUNDS FORM?

Glaciers deform and flow as they move over landscapes through a combination of gliding and viscous deformation. The shape of the landscape (convexities, slope tilt, obstructions, constrictions, turns, etc.) cause different rates of movement in the ice, such as the hub of a wheel versus its tire. Tension in the upper layer of the glacier creates cracks that widen towards the surface of the glacier, while deeper layers of ice remain shut due to the weight of the ice above and less stress. Picture bending a Snickers bar (as if to break it in two to share it), and the cracks that would develop on the top surface of the bar. In a snickers bar, these cracks are merely small holes in your snack, but in glaciers, these cracks are called crevasses, and they can range in depth from 5-50 meters deep in our typical north American alpine glaciers or up to hundreds of meters deep in larger ice sheets or fields.

Seracs are a general term for free standing pillars or pinnacles of ice. Seracs can be formed when ice flows off a precipice. These create beautiful icefalls as the “flowing” ice tumbles off the drop. Seracs are also formed by intersecting crevasses, or older crevasses that have been further deformed or reshaped.

Bergschrunds are another hazard that climbers and skiers should be aware of on glaciated terrain. Bergschrunds, or “schrunds” as they are sometimes called, are crevasses that form when a deforming glacier separates from the firn, rock or stagnant ice above it. These usually appear as a long crack at the foot of a mountain slope, and while they may be bridged or infilled by snow during the winter, they can still present the same dangers as any large crevasse and can be particularly treacherous during the summer and fall months.

Because glaciers are found in colder regions that experience precipitation, crevasses and seracs are often covered in snow, either perennially or at least seasonally. Snow tends to form “bridges” over the openings of crevasses, and can be safe enough to cross depending on the ratio of the depth of the snowpack to the width of the crevasse (among other factors). However, these features can collapse under stress if they are not crossed in ideal conditions.

## 1.3 WHAT MAKES GLACIERS DANGEROUS?

Glaciers are home to many hazards and should not be taken lightly, even glaciers that peers describe as "mellow". Perhaps the most obvious hazard is falling into a crevasse. If there is no snow on the glacier (i.e. "blue ice"), then most large crevasses should be visible and simple enough to avoid. However, if crevasses form on convex slopes and rolls, then the possibility of slipping on the ice and sliding into a crevasse should not be ignored. If the glacier does have snow covering its crevasses, the possibility of a snow bridge failing exists. This is especially a hazard during late spring to early winter when the snowpack thin and snow bridges become unreliable to non-existent, but a snowpack of any depth can fail on a large enough crevasse. Falling into a crevasse can seem unlikely and humorous to inexperienced mountaineers when they first come to learn of this, but it is a very real and potentially fatal hazard. Please see the accident report in Appendix B.

**FIGURE 1 - CROSSING A SNOW BRIDGE (RICHARD BOTTOMLEY, QUORA.COM)**

As mentioned above, slipping is another hazard that may appear to be marginal but can be more dangerous than it sounds. "Slipping out", or losing one's footing on slippery ice or snow (even on a slope of moderate pitch) can result in uncontrollable sliding downslope, and the unlucky climber will likely not stop sliding until the pitch mellows out, or is intersected by a precipice or crevasse. Unless a safe runout clear of cliffs, rocks, crevasses or other hazards is entirely in sight, consider the loss of footing to be a very real hazard that accounts for a significant portion of mountaineering fatalities.

Seracs and icefalls also present another hazard: ice fall. In the late spring and summer months (considered the "peak bagging season") when the days are long and the weather is warmer, solar input onto ice causes the ice to melt. This and the movement of the glacier can cause seracs to "calve," or slide off unexpectedly. Such an objective hazard is akin to the hazard of severe rockfall. These slides and topples can leave a debris trail up to a kilometer wide in extreme cases, but if a climber were standing directly beneath an icefall, even a piece of ice the size of a baseball could do serious damage. Be warned of convoluted terrain and icefalls on warmer afternoons.

Backcountry skiers should be aware that glaciers can be found on steep slopes, and should be mindful of not only the hazards described above, but the compound dangers of avalanches on glaciers. As if avalanches weren't treacherous enough, the risk of getting pushed into a crevasse by debris must be tacked on to one's considerations. Mountaineers should not be blind to this hazard either - while summer heat will have likely already cycled most avalanches through in the first waves of heat, there is no guarantee of safety from avalanches. Go by the old adage, "if there's enough snow to ride, there's enough snow to slide."

### 1.4 SO HOW DO I STAY SAFE ON A GLACIER?

Much like the only way to never get caught in an avalanche is to never go ski touring, the only way to never fall into a crevasse is to never travel on a glacier. However, there are things that can be done to significantly minimize the likelihood of experiencing an emergency on a glacier.

The first line of defense when dealing with glaciers is using safe travel techniques to prevent an accident in the first place. This starts with continued learning about glaciers and how to travel safely on them. Learn good practices in terrain management and decision making, and build up experience navigating crevassed terrain slowly and with a skillful team. When you venture out onto glaciated terrain, ensure you're wearing appropriate gear for the conditions (crampons, ice axe, harness, gloves) and have learned how to travel in a rope team. This will be covered in section 2 of this manual and demonstrated during G1 and G2, but requires practice.

The second line of defense is to know how to execute a rescue on a glacier, but is certainly no substitute to knowing how to travel safely. The most likely rescue scenario, and what is detailed in section 3, involves hauling out a fellow climber from a crevasse, but this is by no means a complete rescue plan. Be prepared in the event of needing to dig a fellow climber out of snow or serac debris, and be aware that a fallen climber will more than likely need some sort of first aid. Be trained well enough to stabilize a team member until help can arrive and have an appropriate emergency beacon for when more help is needed.

## 2.0 SAFE TRAVEL TECHNIQUES IN GLACIATED TERRAIN

### 2.1 IDENTIFYING HAZARDOUS AREAS

Terrain management is a skill that can be developed continuously and will not be honed simply by reading this manual or taking a weekend course. However, the following pointers can be used to help with getting started.

If convexities are known to cause crevasses, then it should make sense that navigating in and around these types of landforms can become quite involved. Be aware that even on planar slopes below cliffs or convexities, crevasses may be present due to the deformation caused when the glacier moved over the landscape above.

When snow coverage exists, sags in the terrain may indicate the snows attempt to bridge a large crevasse. It should go without saying therefore that sagging areas should be avoided. Steep slopes should be avoided if possible, especially those with treacherous runouts due to the consequence of a fall.

Travel in convoluted terrain with overhead hazard (rockfall, icefall or spring avalanches) should be done as early as possible in the day. Ice, rock and snow are set loose to gravity when the ice crystals that hold them in place melt. Snow bridges also become less reliable throughout the day with solar input, hence the alpine start.

## 2.2 SAFE TRAVEL TECHNIQUES

Proper route planning is an important aspect of glacier travel. Most LANDSAT imagery (as found on Google Earth) is taken during the summer months when gaping crevasses can be seen without snow coverage. Make note on your map (or program into your GPS) where they are and plan a route that skirts around them. Seeking a vantage point when the opportunity presents itself to take a look for crevasses and/or sags is another clever tactic, as this will offer information about the present state of the glacier (which are changing more rapidly now due to increased temperatures).

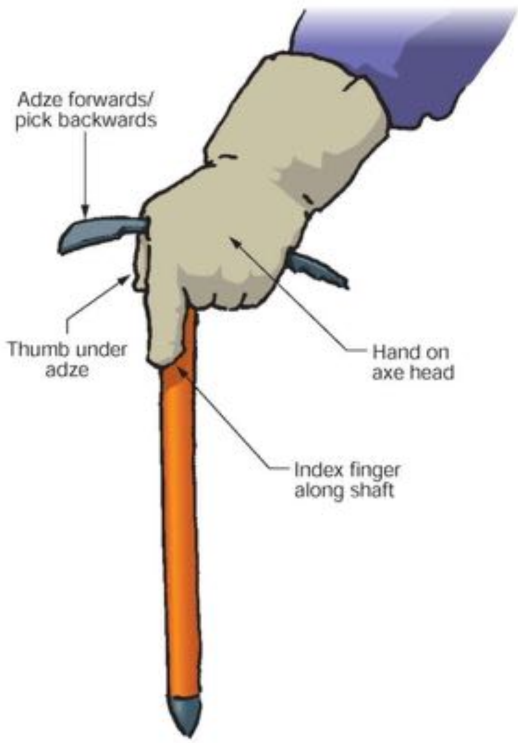
Identifying the longitudinal direction of crevasses is important: use google earth for this or make insinuations based on topography. Avoid travelling lengthwise across glaciers, thereby increasing your time (and number of team members) on a snow bridge. Diagonal “echelon” formations of travel in a team are handy to help avoid this.

Probing is another skill worth having in the armory. When snow coverage exists and the identification of crevasses isn’t easy, use a 3m avalanche probe to test for solid ice underneath the snowpack. This becomes especially imperative during whiteout navigation.

And finally, roping up is almost always a good option. Tying all members into a rope has its advantages and disadvantages, but a solid understanding of ropework is an essential skill for glacier travel and will be the basis for the remainder of this document.

## 2.3 PREVENTING/RESPONDING TO A FALL

With successful route planning, any slopes with which team members are uncomfortable travelling on should be able to be avoided. However, a fall or slip can still occur by surprise, especially when underestimating terrain. Wearing crampons when the snow is stiff or firm and using an ice axe for balancing and steadying one's self on the ascent are crucial steps for preventing a fall. If a fall does occur, an ice axe can be used for self-arrest (i.e. plunging the blade of the axe into the snow to stop a fall - a skill that will be practiced in the field session of G1). Group arrests generally involve team members plunging the shaft of their axe into the snow and leaning into the slope to hold the weight of the climber. Note that self-arresting should be a last resort measure as it may not always work. Self-arrest becomes impossible on slopes that are too steep or with snow that is too firm or too soft.



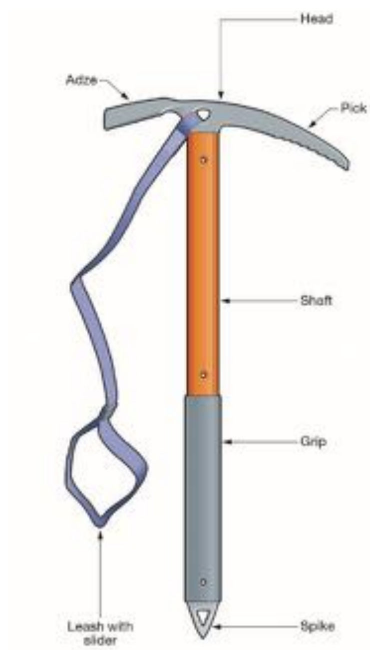




**FIGURE 2 - ICE AXE ANATOMY AND WALKING POSITION (LOU REYNOLDS, MOUNTAIN TRAINING)**

It is also worth noting that crampons have their own hazards as well: it is easy to catch crampons on each other, pant legs, or dangling slings/cords while walking and cause a fall. Furthermore, it is worth noting that crampons do not release from your boots like ski bindings - which means catching a crampon in the ice while sliding down can cause serious injury, akin to sticking a foot in a vice grip midway down a waterslide.

## 2.4 ROPING UP: WHEN TO DO IT

Carrying a rope is considered a minimum safety precaution when travelling on a glacier, and more often than not should be worn while travelling as a default. There are some circumstances in which wearing a rope adds more danger than safety (discussed below), but this is a decision made by the entire team, as are most decisions made in the backcountry. Tying all members into a rope means that if one member of the team were to fall into a crevasse or slip on a slope, the other members would be able to arrest the fall and hold the weight of the fallen climber. When a slope becomes too steep (or the snow is too hardpacked) to rely on the arresting power of the team alone, consider the option of placing snow pickets or ice screws to hold some of the load from the fall climber. This method will be detailed later in this section.

One disadvantage of roping up includes slower travel (which can be quite hazardous if racing against solar input on overhead ice). Another reason why a team may choose not to rope up is on a steep slope, or bare ice glacier, in which the arresting power of other team members would not be a reliable enough method of arresting a fallen climber, and pickets or screws cannot be placed to assist. In these situations, the result of one climber falling could be that the entire rope team is dragged down a slope or into a crevasse. This kind of decision is usually made in advanced terrain by experienced climbers and will not be discussed at length in G1.

## 2.5 TYING INTO A ROPE: CONSIDERATIONS AND TECHNIQUES

If a fallen team member relies on the arresting power of their teammates, it should be intuitive that the less team members there are to assist in an arrest, the more difficult it is hold the climber's weight. This is one reason why travelling in a rope team of two is particularly treacherous, and should only be attempted by experienced mountaineers. This also becomes a consideration especially during rescue situations when a fallen climber must be hauled out of a crevasse and will be revisited in section 3.

Unlike when tying into a rope when beginning a climb on rock, the tie-in points on a glacier rope are usually somewhere along the middle portion of the rope, leaving the last several meters as rescue rope to set up hauling systems if necessary. Team members will clip carabiners from their harnesses' belay loops to a bight in the rope, most commonly with an alpine butterfly knot or a figure 8 on a bight - please see Appendix C for some basic knots that are a must to know. Team members will usually be evenly spaced along the rope, with anywhere between 5-10 m of space between each party member, depending on the size of the crevasses. Larger crevasses will merit higher spacing between team members to prevent two climbers standing on a single snow bridge at one time. It is important to note that whatever spacing you choose between climbers to have an equal or larger amount of rescue rope on either ends. So for example, if three climbers are tied in together on a 40 m rope, they can have at most 10 m of spacing between them in order to have at least 10 meters of rescue rope on each end. The spare rescue rope can be then tied into a kiwi coil (instructors may demonstrate this in G1, or use the internet as a resource), or just as easily tucked into a backpack. After tying and a stowing the rescue rope, climbers will usually place prusiks onto the rope and clip them to their belay loops to save time if they are needed in an emergency.

One advanced technique that is sometimes used by climbers when they are concerned about their ability to arrest the fall of a group member (perhaps packs are particularly heavy, or they are travelling in a smaller team) is to tie knots in between the tie in point of the climbers (provided there is enough available rope). These knots simply act to create drag in the snow during a fall, and they vary from being extremely useful to a useless hindrance, depending on snow conditions. This technique is not recommended on blue ice.

## 2.6 ROPE TRAVEL: CONSIDERATIONS AND TECHNIQUES

When roping up to protect from a fall into a crevasse on terrain that would be otherwise gentle, often party members are satisfied simply with travelling together on a rope without placing extra protection, building anchors, or belaying. This is the most efficient way of travelling with a rope, and if team members are confident in their ability to arrest a climber's sudden fall, this is can be adequately safe. Knowing how to simply walk on a rope is a skill in itself, and some will be discussed during G1 field.

There are a few techniques that can be used to increase a team's safety on more difficult terrain which involve placing protection. These may be techniques that the rope team decide to use for the duration of their travel on a glacier, or just to protect a short but difficult section of travel (sometimes referred to as a "crux"). On blue ice or ice covered by only a foot or so of snow, ice screws are an excellent option. In areas with deeper snow, snow pickets are a good option (though cumbersome to carry). Understanding the limitations and the techniques for placing both ice screws and snow pickets is important and will be discussed during G1 field portion.

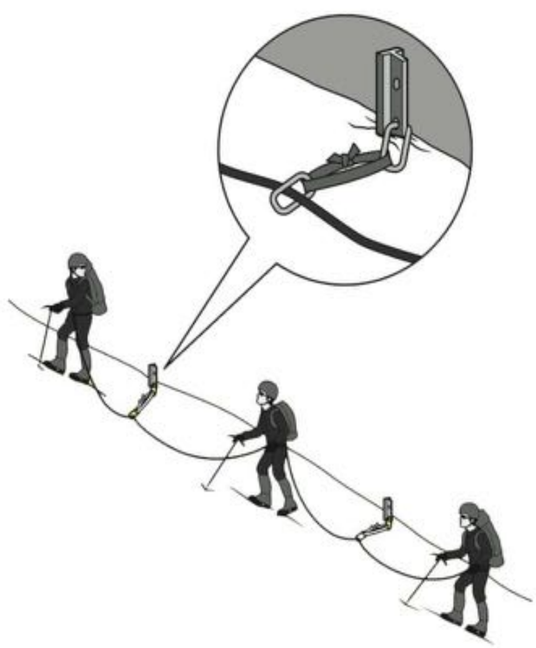


**FIGURE 3 - SIMUL CLIMBING WITH PICKETS (CLIMBING MAGAZINE 2014)**

### 2.6.1 SIMUL-CLIMBING

The fastest method of travelling involves the leader placing a piece of protection which they then clip into the rope behind them. Any subsequently climbers will then unclip the piece of protection as they pass by it, ensuring to clip it back in to the rope behind them, until the last climber collects the snow picket or ice screw as they pass by. By this point, the leader should have placed at least one more piece of protection. This technique is called simul climbing. It is easy to imagine that at some point, all of the pickets or ice screws originally held by the leader will eventually end up in the possession of the last climber of the rope team. It is at this point that the leader will likely want to build an anchor with the remainder of their protection and belay the rope team members towards the anchor. This may be difficult to visualize without a concrete example, which will be demonstrated during the G1 field portion.

### 2.6.2 Protecting short cruxes

Another method of placing protection involves travelling unprotected between anchors. An anchor will be built, and then a climber will lead climb (belayed by a fellow climber at the anchor) until there is not more slack between the leader and the climber at the anchor (or until the leader has passed the difficult section of travel). At this point, the leader will build another anchor and top belay the climber(s) below to the new anchor. This usually requires less protection than simul-climbing, but can become more complicated with larger teams. This method is not recommended for a full length of rope, but rather for short difficulties and cruxes.

### 2.6.3 Pitching it out

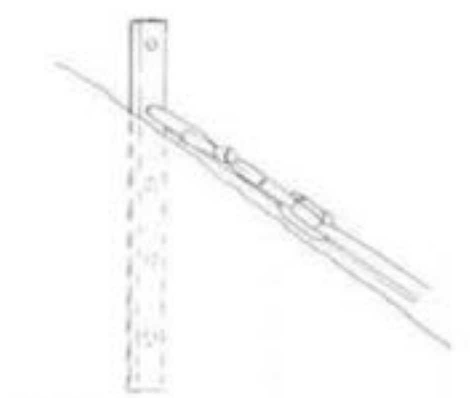
If a section is at the risk-threshold of what the team is comfortable with, the team may choose to pitch a section out. This is more time consuming, but is by far the safest method. It is analogous to a multi-pitch in rock climbing, in which an anchor is built, then a lead climber will be belayed upwards, placing protection as needed while climbing. The leader will then build a new anchor when they reach the end of the rope or the pitch they wish to climb. At this point, the climber will top belay the other climber(s) from the old anchor to the new one and repeat the cycle as necessary.

### 2.6.4 Improvised belays

If difficulties are short lived, team members may not require a full anchor to be constructed, but instead an improvised belay from the leader. Techniques such as the sitting belay will be practiced during the G1 and G2 field school.

## 2.7 SNOW PROTECTION

Protection has been mentioned in the sections above, and hopefully the concept of protection is apparent. This section will go over some common types of snow and ice protection.



### 2.7.1 Snow Pickets

Snow pickets are long metal shafts that can be placed vertically (faster) in the snow or horizontally (stronger if done properly but more time consuming). When placing a picket vertically, stronger placements are usually more difficult to make. In other words, a strong placement involves hammering several blows onto the tip, whereas if a picket sinks easily into the snow, it is likely not very suitable as a piece of protection. Pickets should be set back 10 – 15° from vertical.

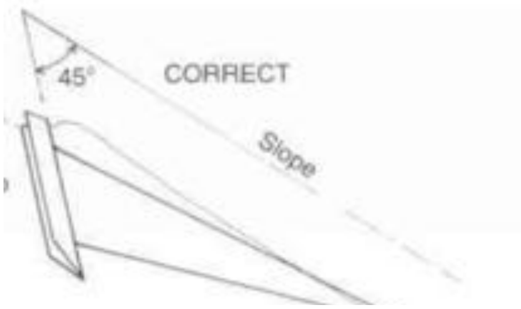



**FIGURE 4 - SNOW PICKET (ABOVE), SNOW FLUKE (BELOW). (NEIL'S CLIMBING COURSES)**

### 2.7.2 SNOW FLUKES

Snow flukes look like metal shields – they are not as long as a picket but have more surface area. These work best in moist, heavy snow, and must be fully buried in hard, homogenous snow to avoid dislodging.

### 2.7.3 ICE SCREWS

If the ice on the glacier is bare or shallowly buried by snow, the best option for protection is an ice screw. These small pieces of protection are intuitive to place, but climbers should be cautious about the quality of ice in which they are placed. Unlike pickets and flukes, they are placed roughly in the direction of loading.

## 2.8 ANCHORS

Understanding what makes an anchor safe and reliable is an integral part of any climbing or mountaineering activity. Anchors are used in mountaineering for beefier belaying systems (see section 2.6), to rappel, and to create hauling systems in rescue scenarios (see section 3). Learn the EARNEST acronym by heart as a baseline and refer to Appendix D for more information.

An anchor is usually two or more pieces of protection that follow the EARNEST acronym. This may look like two well placed and equalized ice screws or pickets. However, there are some anchor configurations that are quite specific, and if constructed properly in good conditions, may not require redundancy.

One of the more common anchors in mountaineering and ski mountaineering are T-Slots. These involve digging a long, narrow slot in the snow and placing a picket, ice axe, or ski inside. A properly dug out T-slot anchor will:

a) Be deep enough for the snow conditions (roughly 0.5 to 1 m) in dense snow, but lighter, less consolidated snow needs a deeper T-Slot)

b) Have a slot dug out from the buried picket/axe/ski for the master point that is in the direction of pull.

c) Have an in-cut in the face wall to prevent upward pull on the anchor out of the slot.

d) Ideally be backed up by another piece of protection.

Consider work hardening the surface area ahead of time as it will quickly set after. In soft snow do not disturb the face wall of snow. Note: the balance point of the axe should be used to attach the cord as shown in the image below, not the physical center.

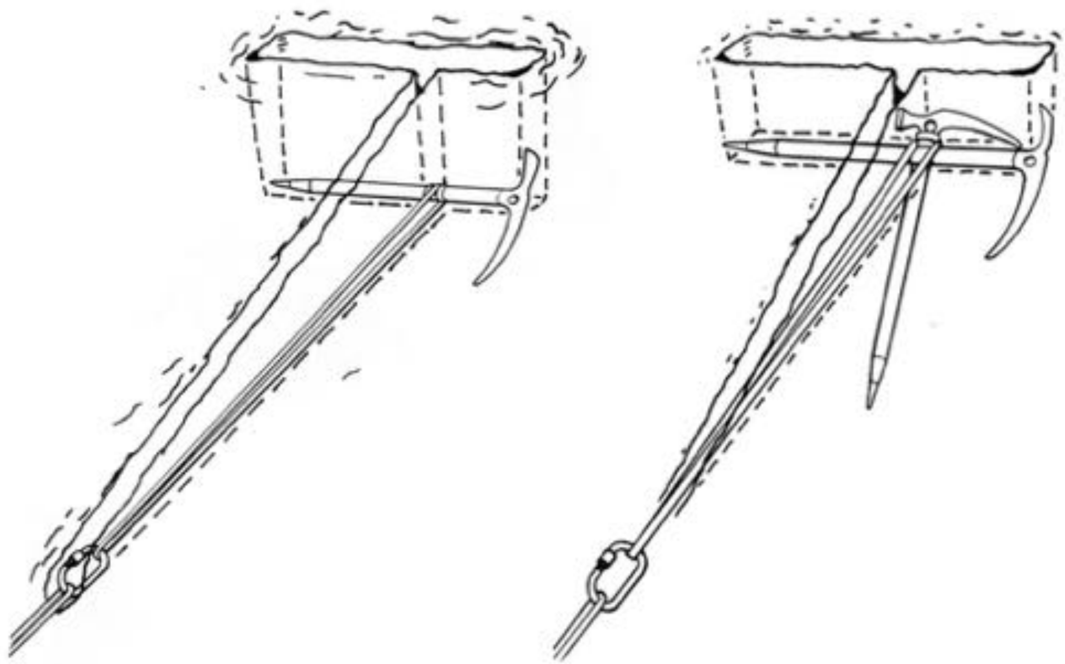


FIGURE 5 - TWO TYPE OF T-SLOT ANCHORS USING ICE AXES (OFFGRIDWEB.COM)

Other advanced options for anchors include snow bollards and V-threads, which are a part of G2 field curriculum. Details of this are not included in this manual, though references to further reading is provided for those who are interested at the end of the manual.

# 3.0 SO YOU'VE FALLEN INTO A CREVASSE

## 3.1 WHAT HAPPENS WHEN A TEAM MEMBER FALLS INTO A CREVASSE?

The first steps in a crevasse rescue happen within a second of the climber falling: the team must arrest the fall and hold the weight of the climber. Group arrest and self-arrest positions are by far the most effective ways to do this, however, getting a good low centre of gravity may be enough to hold the weight of the climber, depending on the terrain. The rope may cut into the snow and the friction may 'catch' the fallen climber to some extent- this is very situation dependent. Practice with different members sliding out on a safe but inclined slope and feel what effort it takes to arrest and hold the weight of a climber - remembering that they may be free hanging in a crevasse. Practice different members of the team falling. It is most likely that the first climber on the rope team will be the one to fall into a crevasse since they are the ones testing the snow bridges first. However, this is far from a guarantee: a snow bridge can be weakened by other climbers until the third, fourth, or tenth climber loads it to collapse.

The most ideal situation if a team member has fallen into a crevasse is to have enough team members to simply walk backwards, hauling the fallen climber out of the crevasse. This should not be done without communicating first with the climber and staying in communication throughout the fall. There have been case histories of climbers breaking their backs due to being smashed repeatedly against a snow lip. This is the only method of crevasse rescue discussed in this manual that does not required an anchor. Should this not be a possibility, an anchor must be constructed and a hauling system with a mechanical advantage should be configured.

Consider a fall where the first team member falls into a crevasse. After the fall is arrested and all members are holding the weight of the fallen climber, the climber closest to the crevasse (the "middle climber") will continue to hold the weight while the farthest climbers prusik along the rope towards the middle climber, where they construct an anchor between the climber holding the weight and the crevasse. This weight transfer will be practiced in the field portion of G1.

Ideally and with practice, an anchor should be able to be built in a timely and efficient manner. However, this does not translate to a rush job. Back up anchors so that they are redundant, test them, and run through the EARNEST checklist and provide a large margin of safety. Once satisfied with the anchor, slowly release the weight of the fallen climber from the other team member to the anchor by tying a long prusik hitch onto the rope of the fallen climber and clipping it into the master point of the anchor. This is considered the **load transfer** stage. Tell the other team members to approach the anchor and inspect it as well before moving in front of it - the moment they do, the entire team relies on the anchor, and its failure could be result in everyone falling into the same crevasse. Team members may choose to untie from the ropes, but unless there is certainty of the location of the crevasses, should at least remain prusik'd to the rope.

Hopefully after reading this section, it is clear as to why travelling in rope teams of two in heavily crevassed areas without extensive experience is frowned upon. To arrest a fall, hold the weight of the climber (and their pack) and build an anchor is a tall order for someone who will no doubt be in panic.

## 3.2 WHAT IF I FALL INTO A CREVASSE?

Bad luck! Hopefully, the climber hasn't been injured by the fall or knocked unconscious.

1) The fallen climber should yell to communicate their condition (i.e. injured or not) and what they see. It may be difficult to communicate over the lip of the crevasse and noises can be quite muffled.
2) If unroped and in a precarious position, place an ice screw should blue ice be within reach.

3) If the climber is able bodied, walking/climbing out of the crevasse is the fastest and most ideal way to exit the crevasse. The rope team above will capture the climbers progress by either belaying off the anchor, or capturing progress of the rope from the master point.

4) If the fallen climber is able bodied but the crevasse is too steep to attempt to climb out, ascending the rope is another option. One method of doing this requires two prusik cords (or progress capturing devices) and will be covered in the next section and during G1.

5) If the fallen climber is injured and unable to climb out or ascend, communicate this with the rope team. It is time for a hauling system.

## 3.3 ABLE BODIED CLIMBER ASCENDING OUT OF THE CREVASSE

If the fallen climber is conscious, uninjured and well-practiced, often the fastest way to extricate them from the crevasse is not to haul them, but to climb out. After the rope team above has constructed a solid anchor, the next step is to transfer the load of the climber into the anchor with a long prusik (see image 6 below).

The fallen climber will then begin ascending the rope - this does not mean the rope must be pulled upwards to retrieve the climber, but may instead stay in place while the fallen climber moves up the rope. This is done using two prusiks (one 2 meter prusik and one prusik roughly twice the length of the climbers body) and carabiners. This method (and there are many others) will be practiced during G1 dry.

Step 1: Tie a long prusik into the rope using a prusik hitch roughly 1/3 of the way through the prusik cord. Tie a figure 8 on a bight into the short end of the cord and clip in the belay loop). Tie a loop into the long end of the cord - this will be the foot loop.

Step 2: Tie a prusik at arm's reach into the rope and clip it to the belay loop. This is the waist prusik

Step 3: Extend the waist prusik fully, weight it, then shimmy up the foot prusik. If the cords are tied correctly, the prusik knot of the foot prusik should still wind up below the knot of the waist prusik when the foot loop is roughly thigh height (or the height of a big step)

Step 4: Stand into the foot loop, holding the rope for balance.

Step 5: Shimmy up the waist prusik and weight it. Rinse and repeat.

FIGURE 6 - ASCENDING A ROPE (CLIMBING MAGAZINE)

## 3.3 HAULING

While hauling a climber out of a crevasse is the most widely discussed technique in crevasse rescue, it remains the last resort in real-life scenarios: if a climber requires hauling out of a crevasse, they are likely injured or unconscious. However, while it is not a frequently used technique, it is a technique that should be thoroughly understood and practiced for when it is required.

The first steps remain the same as for the previous rescue techniques: group arresting, holding the weight, building an anchor, and backing up the fallen climber's position with a prusik.

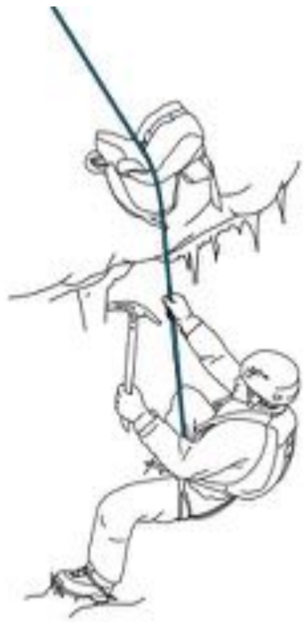


FIGURE 7 - CLIMBER BEING HAULED OVER A LIP PADDED WITH A PACK (PETZL.COM)

Communication is always essential in an emergency - whether it is a self-rescue or a haul - but when a haul is necessary it becomes more important than ever. The fallen climber needs to be aware that they are going to be hauled to prevent any injuries to themselves during the hauling process, and if they are unconscious, they should be supervised during the majority, if not the entirety, of the haul. As described in section 3.1, climbers have had their backs broken due to improper hauling. It may be difficult to hear the fallen climber, but there should be no efforts made to haul without making contact.

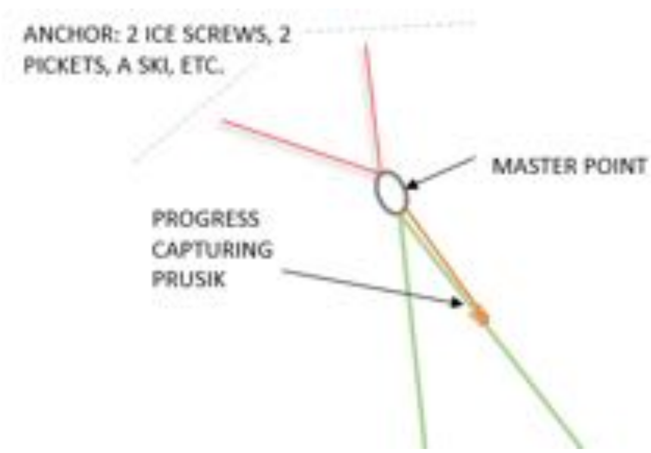
After contact has been established (or a team member has investigated that the fallen climber is unconscious), the next step in the rescue is to pad the lip of the crevasse. This is because the line that the climber is tied into might be entrenched into the snow - buried in stiff snow and ice due to the weight of the fall. This friction and slicing from the fall may even freeze the rope solid into the snow. Padding the lip is to kick out and shave away all the snow and ice surrounding the rope. This involves a climber approaching the edge of the crevasse, and as such they should be prusiked into the main line. After the rope is extricated from the snow and ice, place an axe, tool or bag underneath the rope to prevent it from becoming dug in again. Ensure the tool or axe is seated well enough so that it doesn't become dislodged and fall on the injured climber - back it up with a second axe if necessary.

Now it's time to set up a hauling system. There are several options depending on the size of the rope and team and if there are any additional rope teams around to assist with rescue. If there are enough people around, simply picking up the main line and hauling with brute force while someone captures the progress will work. For a fallen climber with a heavy pack, this may require up to three rescuers. If using brute force doesn't work, it's time to set up a mechanical advantage.

### 3.3.1 THE 3:1 Z-PULLEY

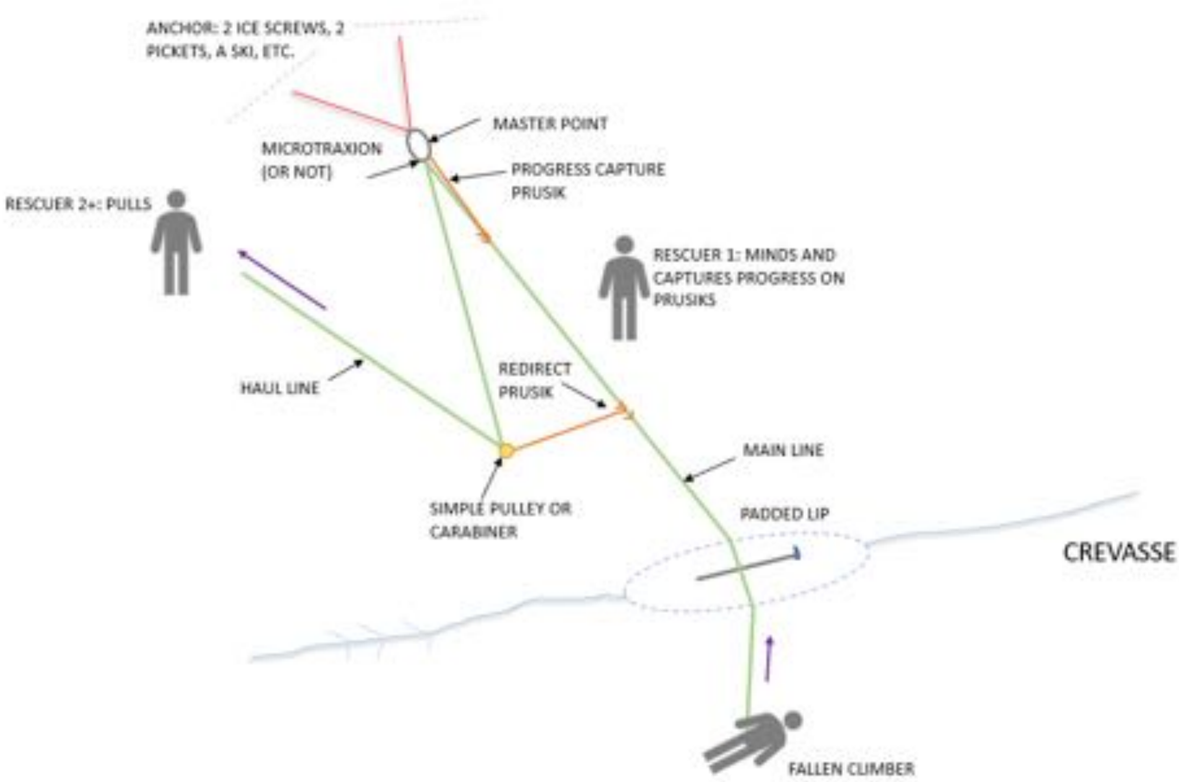
One of the faster setups for a reasonable mechanical advantage is the 3:1 Z-pulley, in which the main line (the rope that the fallen climber is tied into) is pulled upwards to haul the climber out.

After padding the lip, return to the master point of the anchor. Here the load of the climber has been transferred onto a long prusik, and it may look like this:




Note that if you have a microtraxion, placing it at the master point is an excellent backup to the progress capturing prusik, but isn't necessary. Next, tie a prusik hitch a few meters down the main line towards the climber. Attach a carabiner on the end of the prusik, clipping in the rescue line (the unweighted rope of the other side of the master point). A simple pulley is useful here, but not required.

The 3:1 system is now set up. At least one person will need to haul, perhaps two, and every few hauls the lower prusik will need to be adjusted, and the progress on the main line will need to be captured with the prusik attached to the main line (this will be demonstrated during G1 field). It will seem like a lot of pulling - this is because a 3:1 advantage means that 3 meters of rope will need to be pulled by rescuers in order to haul the climber 1 meter upwards. The higher the advantage, the easier the pulling, but the more rope that needs to be pulled for the same amount of progress. The entire setup should look like this:




Remember to communicate with the climber throughout the hauling process. It is entirely possible that the rope may be too dug in to properly pad the lip, or the mechanical advantage is simply not enough to haul the climber out. In which case, another system will have to be set up.

### 3.3.2 The 2:1 Drop Loop/Drop-C

Yes, the 2:1 drop loop does have less of a mechanical advantage than the 3:1 Z-pulley, but it does allow for a simpler transition to a 6:1 system that will be covered in the next section.

Since the 2:1 system hauls off the rescue line and not the main line, this system works well if the main line has been extremely dug in and cannot be padded after the fact (or the team is concerned about kicking snow and ice down on the fallen climber). This is quite common in ski touring when the snow is very deep.

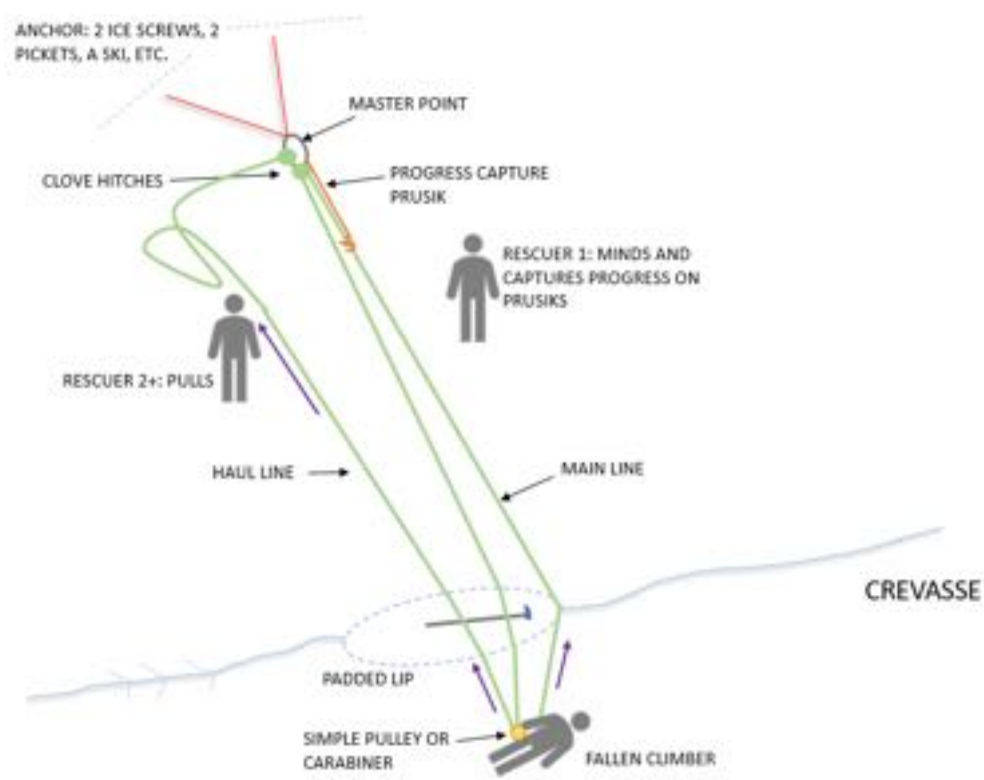
After the load of the fallen climber is transferred onto the prusik clipped into the master point, tie the main line into the master point (behind the prusik) with a clove hitch.

Now pad the lip where the drop loop will be running over the lip, which is offset of the main line by a meter or two. Another drop loop advantage is that the rescuers are not kicking snow and ice down onto the climber as they pad the lip.

Tie the end of the rescue rope into the master point (to refrain from dropping the end) and drop down a loop (the "drop loop" or "drop-C") with a carabiner on it to the fallen climber. A simple pulley is useful here to minimize friction, but not required. The fallen climber will clip the carabiner into their belay loop.

Now tie a prusik into the main line and clip the end of the drop loop closest to where the tie in is (the "pull line"). A microtraxion to capture progress is useful here, but again is not required.

To begin hauling, pull on the pull line on the other side of the carabiner. Again, someone will need to mind the prusiks and capture the progress along the main line. Even though the main line is not being used to haul, slack with develop as the climber is pulled upwards with the drop loop, and that progress must be captured in case the rescuer lets go of the drop loop. The system should look like this:



This system has another underrated advantage: the climber and their pack can be hauled upwards in two separate hauls if they are too heavy to haul together. So while the advantage is only 2:1, the weight of the haul can be significantly reduced. However, should this still not be enough mechanical advantage, the 2:1 drop loop sets the scene well for a third option.

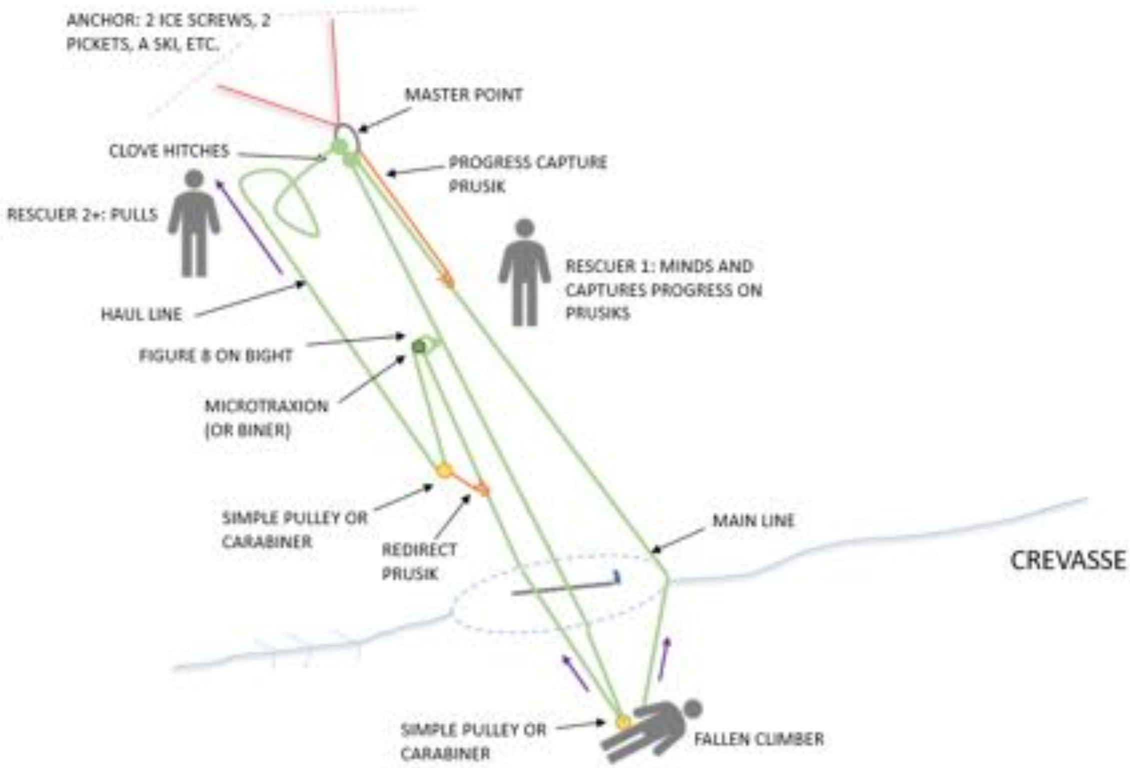
### 3.3.3 The 6:1 Drop Loop with Z-Pulley/Drop-C with Z-Pulley

If there is enough rescue rope available to execute this system, this is the king of hauling systems. Between the ability to haul the bag and climber separately and the whopping 6:1 advantage, this is the system that will do the trick when the situation demands it.

Begin the same as for the previous drop loop: tie in the main line with a clove, transfer weight to the anchor on the prusik, clove hitch the end of the rescue line in the master point. Before dropping down the loop to the fallen climber, tie a figure 8 on a bight into the rescue line that runs from the anchor. Now drop the loop to the climber (with a simple pulley if one is handy) and clip what would be the old pull line on a 2:1 system into the bight. Using a microtraxion here is very useful, but can be replaced with a simply pulley or a carabiner.

Now tie a prusik into the old pull line and clip into the line coming from the microtraxion. Again, a pulley here is useful. This is your new haul line, and will still require someone to mind the prusiks, but this time, the hauling can probably be done by only one rescuer.

Please see the photo below for a visual of what this setup should look like:




Similarly to the 2:1 drop loop, this system is most effective if the climber is conscious and can clip the carabiner into their belay loop. If the 3:1 Z-pulley is out of the question and a drop loop must be used, it is worth knowing how to rappel down to the climber to clip them in. This is also a useful technique in case the fallen climber needs immediate first aid (i.e. to stop a serious bleed). However, due to the tight G1 schedule, this is a technique that is generally reserved for G2 field.

## 3.4 RESCUE METHOD COMPARISON

It would be a waste of time for rescuers to attempt every setup mentioned above in order to find the one that works in the moment. It is useful therefore, to understanding the advantages and limitations of each of the systems. Please see the table below.

| **3:1 Z-Pulley** | **2:1 Drop Loop/Drop C** | **6:1 Drop Loop with Z-Pulley** |
|---|---|---|
| Moderate advantage | Low advantage | High advantage |
| Fast, even if climber is unconscious | Requires rescuer to rappel in to climber if unconscious | Requires rescuer to rappel in to climber if unconscious |
| Cannot haul bag/skis separately | Can haul bag/skis separately | Can haul bag/skis separately |
| Cannot use if main line too dug in to salvage | Can use if main line too dug in to salvage | Can use if main line too dug in to salvage |
| Padding lip kicks snow/ice debris onto fallen climber | Padding lip is offset from climber | Padding lip is offset from climber |
| Must know how to pass knots on loaded rope | No passing knots required on loaded rope | No passing knots required on loaded rope |
| Requires little rescue rope | Requires rope length equal to distance between climbers | Requires more rope than distance between climbers |

TABLE 2 – COMPARISON OF HAULING SYSTEMS

## 3.5 HAULING AND RESCUE CONSIDERATIONS

Often, a difficult portion of the rescue (whether it be self-rescue or hauling) is as the climber crosses the lip of the crevasse. If ascending, consider transitioning to climbing out here, using the prusiks to capture progress. If team members are hauling, instruct the climber to sit low in their harness with their feet against the lip and stand as they continue to haul.

After rescuing the climber from the crevasse, the next phase of rescue begins. This includes any first aid the climber requires, and the initiation of an exit strategy if the climber is too injured to continue. This is where personal locator beacons come in handy, as there is unlikely to be cell service.

## 3.6 REVIEW OF RESCUE PLAN

1) Arrest the fall
2) Communicate plan with team members – does an anchor need to be built, or are there enough climbers to simply walk backwards to haul the climber out? If not…
3) Load transfer weight to appropriate team members.
4) Build an anchor
5) Slowly transfer load of climber onto anchor (clove into main line, clip middle person's tie in point onto main line, or prusik to capture weight)
6) Establish communication with climber (decide on rescue strategy, determine if immediate first aid if required)
7) If self-rescue is not possible, begin by padding the lip of the crevasse
8) Construct rescue hauling system
9) Haul! Ensure to communicate with climber continuously
10) First aid
11) Re-evaluation of exit or continuation strategy

## 3.7 A FINAL NOTE

Simply knowing the details of crevasse rescue will do climbers very little good unless cemented in one's mind. Imagine trying to execute a 6:1 system in a complete state of panic, with frozen fingers and a heavy pack. Imagine that you hadn't practiced it for two years, and couldn't figure out where the prusiks went or what line to attach them to. Now imagine a friend's life is at stake. It's not an unlikely scenario in the backcountry, and in the event of an emergency, the only thing within your control is to have practiced hauling systems to the point of having them dialed in. Practice techniques not just until you get it right, but until you can do it without thinking or ever getting it wrong.

It is also worth mentioning that while crevasse rescue is the most commonly discussed topic in glacier travel and the easiest to practice, it is not the only component of glacier travel worth thinking about. Recall that rescue is a last resort, and that the first barrier to harm is to know how to avoid getting caught in a crevasse. It is imperative to practice safe travel methods, decision making, route finding, and good communication within a team. These are perhaps more difficult skills to quantify, but are equally as important. Be curious and learn continually, and appreciate that no matter how much you know, the mountains will always have something to teach you.

# FURTHER READING AND RESEARCH

*Mountaineering: The Freedom of the Hills, 8th edition,* by The Mountaineers

*Climbing Self-Rescue: Improvising Solutions for Serious Situations,* by Andy Tyson and Molly Loomis

*Anchors in Earnest*, by Cyril Shokoples
http://rescuedynamics.ca/articles/pdfs/EarnestAnchors3.pdf

*How to Calculate the Mechanical Advantage of Hauling Systems*, by Tim Fox and Mick Holton

http://efclimbers.net/wp-content/uploads/2013/02/Mechanical+Advantage+Paper.pdf

*Animated knots* by Grog

https://www.animatedknots.com/indexclimbing.php

*Save Yourself! A Guide to Self Rescue* by Climbing Magazine

https://www.climbing.com/skills/save-yourself-a-guide-to-self-rescue/

*Ice Anchors* by Andy Kirkpatrick

https://andy-kirkpatrick.com/articles/view/ice_anchors

*Learn This: Build a Snow Bollard Anchor* by Climbing Magazine

https://www.climbing.com/skills/learn-this-build-a-snow-bollard-anchor/

And many, many more…check out videos created by Outdoor Research in collaboration with the American Mountain Guides Association (AMGA), the 'Skills' Blog on Climbing Magazine, and the books section of any climbing gear store. Happy learning!

# Appendix A - G1 and G2 Curriculum

## G1 Curriculum

### <u>Dry School Day 1 (3 hours)</u>

**Prerequisites:**

Knowledge of top rope belaying, anchors, and familiarization with packing list. Participants must have read section 1 of the Glacier Manual.

**Agenda:**

As one group:

-Introduction to G1

-Introduction to the hazards of glaciers and glaciated terrain

Split into two groups:

-Group 1 organizes carpooling

-Group 2 organizes gear

-Switch

### <u>Dry School Day 2 (4 hours)</u>

**Pre-requisites:**

Possession of all necessary gear and a knowledge of how to assemble/wear it, must have read section 2 and 3 of the Glacier Manual and be familiar with Appendices and further reading as necessary.

**Agenda:**

As a group:

-Discussion of travelling techniques on rope

Split into two groups:

-Group 1 practices ascending ropes and reviews building anchors (group must be split into two due to Aviary capacity)

-Group 2 practices clipping into a rope as a team (considerations of, kiwi coils, etc)

**Field School Day 1 - Safe Travelling**

**Morning**

Hike up to glacier

Split into groups of 4 with instructor

Discussion on terrain choices

**Afternoon**

Practice self-arresting

Rope up

Practice group arresting (duck duck goose game)

Simul climbing practice (probe and place gear)

Go find a crevasse to look at!

**Evening**

Make dinner

Discussion of learnings, questions

**Field School Day 2 - Ropework and Rescue**

**Morning**

Rope up

Anchor building

Improvised belays - pit belays, belaying over cruxes

**Afternoon**

Transferring a load onto the anchor

3:1 hauling system (demonstration as large group)

2:1 hauling system (demonstration as large group)

Hike out

## G2 Curriculum

**Dry school (Tuesday)**

Sort out gear and carpooling

**Evening class session (Friday)**

Introductions, discussion on course

Discussion on leadership (what does it mean to coordinate a trip or take a leadership role?)

Tools for pre-trip planning and emergencies (what you need to think about when planning a route, tools you need to prepare for the event of an emergency)

**Day 1 session: Advanced ropework in Smoke Bluffs**

Hauling systems (set up)

Rappelling down to an injured climber

Escaping the belay (load transfer to anchor)

Camp at trailhead to a glacier if appropriate

**Day 2 session: Navigation/route-finding and anchor practice on a glacier**

Morning: hike to a glacier and build V-threads and snow bollards

Afternoon: discuss navigation techniques using map and compass

Debrief, hike down

## Appendix B – Accident Report

FALL INTO CREVASSE - SNOW BRIDGE COLLAPSED, CLIMBING UNROPED

Oregon, Mt. Jefferson, Whitewater Glacier

- *Accident Reports*
- Accident Year: 2013
- Publication Year: 2014

Our team—Craig Hanneman (64), Mark Morford (56), Bob Alexander (56), and Jim Walkley (40)—was traversing the Whitewater Glacier at about 1 p.m. on July 20, after successfully summiting via the Jefferson Park Glacier route. We were traveling unroped, and our helmets and crampons were stowed. Conditions on the glacier were such that we believed existing crevasses were for the most part open and obvious and could be easily avoided.

At around the 8,900-foot level, midway across the glacier, we encountered an area of tic-tac-toe crevasses. Hanneman, who had climbed the same route two weeks prior, and Morford were in the lead, and Walkley and Alexander were a short distance behind. Hanneman recognized that we probably had drifted too far down-glacier and needed to climb a little to get around this crevassed section. Alexander suggested roping up, and we were beginning to back out of the area to accomplish this when the snow under Hanneman gave way. He had been unknowingly standing on a partial bridge. A 10- by 25-foot section collapsed, and he fell approximately 30 feet into a tapering part of the crevasse. The bridge on which he was standing was probably five feet thick and stayed mostly intact. It wedged in the taper about 30 feet from the surface. Hanneman rode this bridge down. A large portion of the lip followed the main slab and fell on top of Hanneman, mostly burying him. Another large portion of the bridge, about 10 by 10 feet, remained hanging and threatened to fall on him.

The team was relieved to hear Hanneman's muffled calls for help. He was able to partially free one arm after about five minutes and clear a space in front of his face to breathe, but was otherwise unable to move. The rescue effort was dealt an immediate blow when we realized that our one 9mm rope was with Hanneman, in his pack, buried. A quick inventory of every runner, piece of cord and webolette on our harnesses allowed us to cobble together about 40 feet of line. Morford volunteered to go in, but before that could happen we needed to get to the far side of the crevasse. The near wall still had significant amounts of snow clinging to it. We couldn't risk knocking it loose and dropping it on Hanneman.

We did an end run of the crevasse field and then carefully navigated back to the opposite edge of the crack that held Hanneman. Morford tied into our makeshift rope and was lowered with a hip belay into the crevasse. The sides of the crevasse were vertical or overhanging and coated with rotten snow. It was not possible to get any purchase with crampons or tools in the crevasse walls. Thirty minutes had passed since the accident. Hanneman was clad in a T-shirt and was soaking wet, buried in snow, and getting very cold. Most of his body was buried below a block of ice. His head was contorted at an angle that suggested a neck injury. He was conscious but incoherent. It took another 30 minutes to dig him free, access his pack, add some layers, and send the climbing rope up.

Alexander and Walkley set up a haul system in a cramped field surrounded by crevasses. At that point we were fortunate to flag down two other climbers. These two provided extra horsepower and much more assistance. The raise went quickly, but the lip presented us with a difficult problem. Even with an ice axe as edge protection, the rope dug deeply into the rotten snow of the freshly formed lip. Hanneman is not a small guy (6-feet-3-inches and 210 pounds), he had basically lost the ability to control his limbs, and was mostly delirious and in considerable pain. He could do little to assist us in getting him over the last few feet. A second drop loop and a lot of yanking on his arms and harness finally got him over the edge. Close to two hours had passed since the initial fall, and we had a severely hypothermic, injured friend.

Some us worked to get Hanneman out of wet clothes while the others extracted Morford. He too was a little cold after having spent an hour and a half in a wet crevasse. Now in dry layers, Hanneman was placed in two sleeping bags and zipped into a bivy sack. He continued to shiver uncontrollably, flail around, and didn't always seem to recognize us.

Despite having a clear view of most of central Oregon, we had been unable to get a cell signal to call or text for assistance. At this point, Kasey Crockett and Tony Chenier (the two other climbers) basically emptied their packs of anything we could use, noted the coordinates of our location, and headed for the Whitewater Trailhead to report the accident to authorities and a fifth member of our party who had elected not to climb. They completed this task by 5:20 p.m. Meanwhile, Morford and Walkley made a round trip to our camp on the North Ridge to collect additional gear for a bivy on the glacier.

Over the course of the evening, as he warmed up, Hanneman's mental state improved, but he was still in considerable discomfort and we worried about possible internal injuries. Our plan was to monitor him through the night and reassess our situation in the morning. We didn't anticipate any assistance until daylight. As darkness fell we all retreated into our bags and tried to stay warm. Hanneman was cocooned in three sleeping bags atop a down air mattress, and all of this was packaged in a bivy sack.

At 11 p.m. we were surprised to hear rotors and see the spotlight from an Oregon Army National Guard Blackhawk. We scrambled to put on our boots and secure our gear. Soon the flight medic was descending, followed by a litter. The helicopter withdrew while we packaged Hanneman, then returned to take him on a wild ride into the sky. The medic grabbed Hanneman's pack and clipped onto the cable a few minutes later. Once he was onboard, the Blackhawk turned away and it was suddenly quiet, except for the sound of one large collective exhale.

**Analysis**

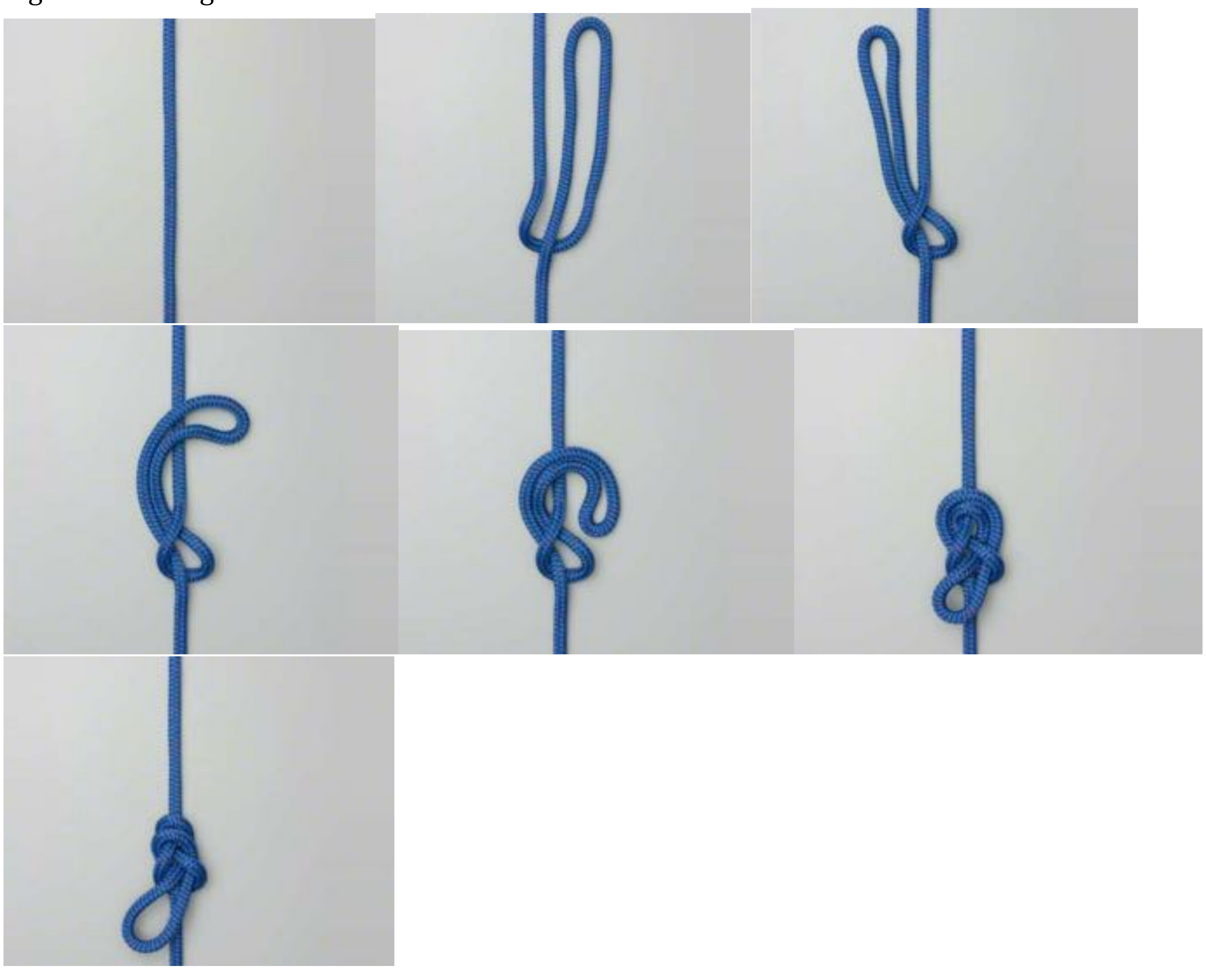
We should have been roped up when we stepped onto the glacier. There was no reason not to be. The rope had been used appropriately up to this point. However, we were nearing the end of what had been a straightforward climb and thinking that all of the difficulties were behind us. We just let our guard down. A rope may not have prevented the accident, but it likely would have minimized the injuries and would certainly have expedited the extraction.

We are all grateful for the selfless assistance provided by Kasey Crockett and Tony Chenier, and to the Oregon Army National Guard for their swift response and willingness to conduct a night operation. Our thanks also go out to SAR officials from Linn, Marion, Jefferson, and Deschutes counties for making the right things happen. Finally, our appreciation to the mountain rescue organizations and ground teams that began to mobilize on our behalf. (Source: members of the climbing party.)

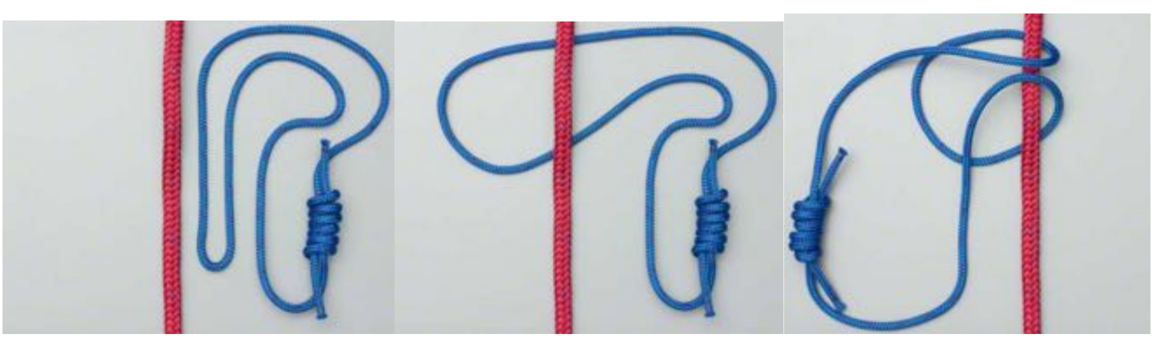
Source:American Alpine Club Publications
http://publications.americanalpineclub.org/articles/13201213061/Fall-into-Crevasse-Snow-Bridge-Collapsed-Climbing-Unroped

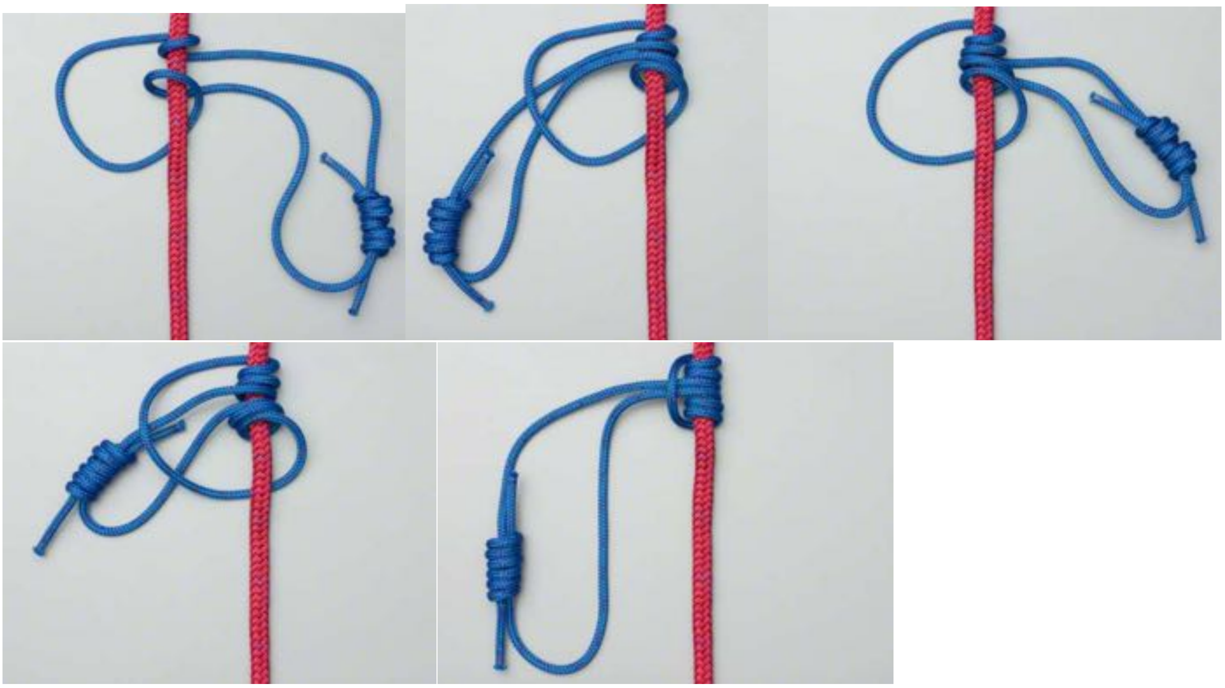
# Appendix C - Important Knots

Figure 8 on a Bight

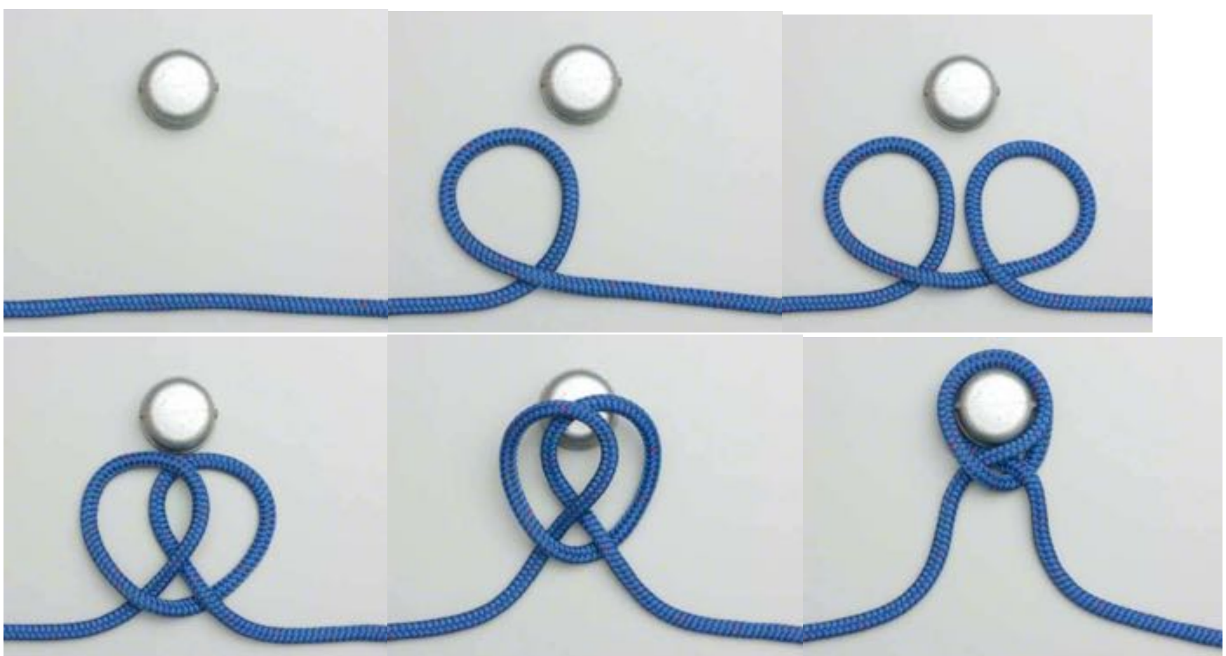


Prusik Hitch





Clove Hitch



Munter Hitch

Munter Mule

**The following knots are also good to know:**

- Alpine Butterfly
- Overhand to tie two lines together
- Double Fisherman's
- Chain Hinnet

Source (and to learn more): Animated Knots by Grog https://www.animatedknots.com/index.php

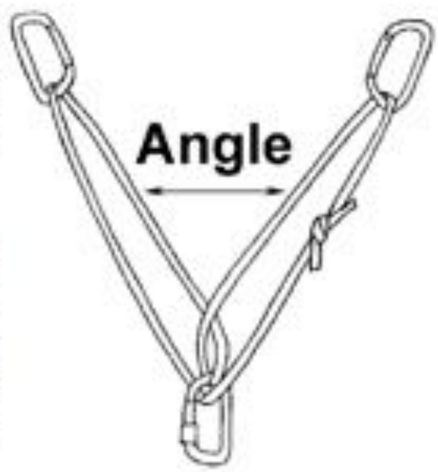
# Appendix D - EARNEST Anchors

## EARNEST

**E**qual tension
**A**ngles appropriate
**R**edundant
**N**on – **E**xtending
**S**trong
**T**imely

***Equal tension*** implies that in a multi-point anchor the load is shared relatively equally between the pieces within the anchor. This can be one of the most elusive of the considerations to actually achieve.

***Appropriate angles*** refers to the angles that the outside legs of a sling should make. Generally the angles should always be kept well below 60 degrees in a two piece anchor and absolutely less than 90 degrees in a three or more point anchor. Less is better. ***Strive for 25***.




***Redundant*** means that only in special circumstances would you use a single point anchor. The less you like the strength of the individual pieces in an anchor the more pieces there should be. I once made an anchor with five ice screws and both of my ice tools and still felt scared. We decided to retreat right after that!

***Non-extending*** means that if one of the points in your anchor should fail you should not have a situation where the entire anchor shifts a great distance with possible loss of the belay as the belayer may be pulled out of position or over an edge.

***Strong*** means that ***each primary placement in an anchor should be good or bombproof unto itself***. Avoid being satisfied with a multi-point anchor where each point is weak by itself. This can lead to catastrophic failures when all the pieces "*zipper*" or cascade out.

***Timely*** means that you should strive for safe simple anchor constructions that don't waste time. Wasted time in setting up belays can leave you out overnight or still trying to scratch your way to the summit as the afternoon thunderstorms start rolling in. Practice rigging is the best way to get fast! Be efficient and you will enhance your safety.

The EARNEST mnemonic does not include the consideration that some anchors must be multi-directional. So although EARNEST gets you a long way in assessing your anchors, there is more you should think about each time you clip in.

Source: Rescue Dynamics, Anchors in EARNEST
http://www.rescuedynamics.ca/articles/pdfs/EarnestAnchors3.pdf