Introduction

Rope rescue needs to be done in a simple and efficient way with an acceptable level of safety and a minimum amount of gear. The response is firstly about the rescuers making sure they do not encounter any unnecessary risks and secondly about making the casualty’s bad day better.

The Rope Rescue & Rigging Field Guide provides easy to reference practical reminders on essential field techniques for training and responding to rope rescue incidents.

This Field Guide contains only overview information on technical rescue systems and is therefore not a complete reference. It is designed to be used by competent operators who have undertaken rope rescue training with a qualified instructor.

The Field Guide is aimed at rescuers working in the back country and remote areas as well as off road and industrial situations.
About the author

Grant has been professionally involved in rescue since the early 90s. Initially in ski patrol and then for 14 years in the Aoraki / Mt Cook Mountain Rescue Team.

He was one of the founders of the Search and Rescue Institute of New Zealand (SARINZ) and then employed as Rescue Programme Manager for 10 years (www.sarinz.com).

He currently owns and operates Over The Edge Rescue which specialises in custom publications, safety consulting, training and design (www.oterescue.co.nz).

He has expanded his skills and experience from the mountains to include expertise in the caving, canyoning and industrial environments. He loves to share his knowledge as a trainer and each year spreads the word all over the world.

Important information

Warning

Information contained in this field guide relates to working in areas of high operational risk. Attempting to use any procedures or equipment detailed in this guide without formal training and supervision may result in death or serious injury.

Disclaimer

Over The Edge Rescue and the author disclaims all responsibility and all liability for all expenses, losses, damages, injury and death you might incur as a result of the information being inaccurate or incomplete in any way, or for any other reason.
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5. Anchor System

Having a variety of ways to rig anchors is important as no two sites are the same. This section looks at a range of techniques to build effective anchors including Wrap 3 Pull 2s, multi-point anchors, snow anchors, ice anchors and ground anchors.

Definitions

Anchor system
An anchor system is a collection of items that secures a rope in the desired location for the load and purpose. These collection of items includes:

1. The **OBJECT** being rigged to such as snow, rock, earth, tree, vehicle or beam.
2. The **ATTACHMENT** to the object such as a snow stake, an ice screw, rock protection or a wrap 3 pull 2 with webbing.
3. The **RIGGING** to form the anchor by focusing or moving the focal point to a desired location such as a two point anchor.

Bombproof anchor point
An assessment that a single anchor point will hold the entire load with sufficient margin including the requirements of the main and/or belay. For example a large well secured rock or tree, a large vehicle, or a structural beam.

Marginal anchor point
An assessment that a single anchor point is not able to hold the entire load. Several marginal anchors will need to be joined together to form a suitable anchor with sufficient margin. For example a snow stake, rock protection, ice screw or handrail.

Focal point
Where the rigging from multiple anchors come together and a rigging plate and/or carabiners are attached.
5 A’s of anchors

When establishing anchors, consider the 5 A’s.

1. Above
For easy and efficient use rig all anchors ABOVE the ground or floor level. How much above will depend on the type of use and availability of anchors.

2. Adequate
The anchors have ADEQUATE strength for the job they are undertaking. This is a safety factor of 10:1 of the load that is being applied. Also adequately protected edges.

3. Angles
The ANGLES creating in the rigging are kept to an acceptable level considering the anchors they are attached to, the breaking strength of the rigging and load being applied.

4. Aligned
Rigging is ALIGNED to the direction the load is being applied. Consider how much a load moves during an operation especially for slope lowering.

5. Area
The focal point of your rigging is located in a good working AREA. Ideally this is a flat and open place to stand and use equipment. This may not be where the anchors are located.
Wrap three pull two anchors

A wrap three pull two (W3P2) is a surprisingly simple and effective way to rig an anchor. The W3P2 is ideal for single point bombproof anchors such as a rock or tree and can also be used on structural items such as a beam and vehicle chassis. Where you have a solid object to attach to this anchor is a good choice.

1
2
3
4

Rigging a W3P2
Multi-point anchors

The aim of multi-point anchor rigging is usually to join two or more marginal anchor points to create a system to hold the intended load. One anchor point by itself would not be enough so a second or third is added.

A multipoint anchor could be used to position the focal point in the right working area. The anchors may actually be bombproof but are not located in the right place to make the rescue operation easy.

Note: Short anchor legs do not need to be front tied & tensioned.

Rigging a 2-point anchor
Rigging a 3-point anchor

1

2

3

Rigging a 3-point anchor
Find the centre

Applications:
Suitable for rigging snow and ground anchors on sloping terrain.

Rigging an adjustable 2-point anchor
Fixed and floating-focused anchors

The aim of fixed and floating-focused anchor rigging is to bring anchors forward to a better working area. Rigging where you want to operate, not where the anchors are located.

Definitions

Focused anchor
A focused anchor in the right place to operate the rescue system but does not have the structural strength to support the load. The main purpose is to provide enough support for tensioning of the back-tie and often to keep the rigging off the ground.

Back-tie
Used for anchor strengthening and/or moving the focal point to a more suitable location. A back-tie is a tensioning system between two anchor points using multiple strands to reduce stretch over a longer distance for example a 3:1CD non-working pulley system (11mm rope, Prusik and carabiners) or a jigger (pre-made pulley system). Additionally the back-tie pre-loads the rigging/anchors and allows an opportunity to sort out any design issues before use.

Front-tie
Used for positioning the rigging plate but usually not for tensioning. A front-tie is an adjustable system often between a rigging plate and a front-tie anchor. For example a doubled 8mm cord or a single 11mm rope and a Prusik.

Front-tie anchor
A front-tie anchor is able to provide enough support for tensioning of the floating-focused anchor. This anchor will not take any load of the rescue system during the operation.
Back-tie method with rope

Application: Suitable for bringing an anchor forward over a long distance to a better working area.
Rigging a fixed-focused anchor

Interlocked W3P2
Rigging a floating focused anchor

Note: Tie off all back-ties and front-ties once tensioned.

Back-ties used for tensioning the anchor system

Front-ties used for positioning the anchor system

Rigging a floating focused anchor
Snow anchors

This snow anchor system setup is for fixed locations (e.g. crevasse rescue) or slope lowering where the load moves from side to side.

Mark the anchor

1. Mark the direction of load and focal point.
2. The snow stakes are spaced about 2 stakes apart minimum or one cable length (around 1.2m).
3. Allow for the extension of snow stake cables and rigging cord/webbing to give an anchor angle of around 60°.

Place the stakes

1. Point the stakes towards the focal point.
2. Place the stake using the most suitable placement type for the snow condition.
3. For the upright mid clip in soft snow work in pairs with one person pulling the cable and the other booting in the stake.
4. If the snow is soft and easily holds together (makes snow balls) backfill trenches and stamp down in front of the anchor.
5. In harder snow use a snow saw to cut a slot to locate cables.
6. If driving in, for upright top clip in hard snow, use lots of small hits.

Rig the multi-point anchor

1. 3 point fixed anchor: tie 10m’s of 8mm cord into a sling.
2. 2 point fixed anchor: tie a 4m’s of 25mm webbing into a sling for a (or a sewn sling 1.7m end to end).
3. 2 point adjusting anchor: tie a 3m’s of 25mm webbing into a sling (or a sewn sling 1.2m end to end).
### Snow anchor selection

<table>
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<tr>
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<th>Strong snow</th>
<th>Very strong snow</th>
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<td>Dry or wet snow that cannot compress</td>
<td>Strong enough or can compress</td>
<td>Cannot compress but can cut a slot</td>
<td>Cannot have a slot cut</td>
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<td>Hardness definition</td>
<td>You can push a gloved finger into the snow pushing as hard as is bearable</td>
<td>You cannot push a gloved finger into the snow but can push a snow stake in by hand</td>
<td>You have to hammer a stake into the snow An ice axe pick can be pushed in</td>
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<td>Large object Horizontal mid-clip Upright mid-clip</td>
<td>Horizontal mid-clip Upright mid-clip Upright top-clip</td>
<td>Upright mid-clip Upright top-clip Upright top-clip</td>
<td>Upright top-clip</td>
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<td>Likely strength range for a standard size stake (60cm)</td>
<td>4-7kN for the bottom half of the pencil range 0.4-4kN for the 1f range</td>
<td>7-10kN as a mid-clip low end snow strength &gt;10kN as a mid-clip upper end snow strength</td>
<td>&gt;10kN as a mid-clip 5-7kN as a top-clip</td>
<td>&gt;10kN as a mid-clip 7-10kN as a top-clip</td>
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Snow anchor types

Large objects – weak snow

Upright mid clip – weak and strong snow
Horizontal mid clip (T slot) – weak and strong snow

Upright mid clip – very strong snow
Side view

Top view

Upright top clip – very and extremely strong snow
Multiple snow anchors

Two stakes, mid clip with fixed rigging
Three stakes, mid clip with fixed rigging
Snow lowering

Two stakes, mid clip with adjustable rigging

1.5m

0.6m

60°
Ice anchors

Ice screws$^{2,3,4}$

- Use longer screws for greater strength.
- Use multiple ice screw placements for rescue anchors.
- As a guideline 22cm long ice screws in most conditions with good ice should hold at least 10kN.
- Strength can be highly variable due to the quality of the ice.
- Clear away any loose material on top, such as rotten ice and snow.
- Place the ice screw:
  - Perpendicular to the surface for most conditions and ice types.
  - Angled forward in cold conditions with solid, dense ice may produce stronger anchors.
Multiple ice screw rigging

2-screw placement

3-screw placement
**V-thread**

- Using holes further apart will be stronger.
- Use multiple V-thread placements for rescue anchors.
- As a guideline the V-thread in cold conditions in solid, dense ice should hold at least 10kN.
- Strength can be highly variable due to the quality of the ice.

**Forming the V-thread anchor**
Ground anchors

This ground anchor system setup is for slope lowering where the load can move from side to side.

Mark the anchor
1. Mark the expected direction of load.
2. The pickets are spaced about 1 picket apart (approx 1m).
3. The focal point is the crossing point 1 picket from each anchor. This gives an anchor angle of around 60°.

Drive in the pickets
1. Point the pickets towards the focal point with the fin with holes pointing forward.
2. Lean the picket back 10° from perpendicular to the slope.
3. Drive in up to 1m or until the anchor is firm.
4. When driving in use lots of small hits.

Rig the W3P2s
1. To set up rig a 1.5m length of 25mm webbing on to a picket with a W3P2. When you take the sling off it will have 2 built-in twists and be pre-tied for the next use.
2. When rigging the pre-tied sling start by placing it over the picket with the knot at the back.
3. Wrap two more times and pull two.

Rig the 2-point anchor
1. Tie a 4-5m length of 25mm webbing into a sling.
2. Clip into both anchors and pull down to find the centre.
3. Tie overhand’s either side of the centre.
4. Clip the loops created in between the overhand’s.
Picket anchor strengths

1. Pickets work best in firm homogenous material such as soil or scree.

2. In firm ground, anchor strength is mostly dependant on the bending strength of the metal being used therefore use quality pickets.

3. As a guideline a quality picket in firm ground should fail at a minimum of 10kN.

Picket anchor

The fin with holes pointing forward

Load

1m

10°
Two pickets, with adjustable rigging

**Note:** Tie a W3P2 on top of each picket. Line up the front fin of the picket with the focal point.

Two pickets, with adjustable rigging