AUSTRALIAN ARMY

LAND WARFARE PROCEDURES - GENERAL

LWP-G 7-6-2

ADVENTUROUS TRAINING – ROPING

This publication supersedes Land Warfare Procedures - General 7-6-2, Adventurous Training – Roping, 2012.

SAFETY PUBLICATION

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2. It is certified that the amendments promulgated in the undermentioned amendment lists have been made in this publication.

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3. Changes have been made to this publication and a familiarisation with all of the content is highly recommended. Significant changes from the most recent rewrite are listed in the following table.

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4. All superseded Amendment Certificates should be retained at the rear of the publication for audit purposes.
SAFETY INFORMATION

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Aim

1. The aim of this publication is to present the techniques, procedures and technical information for use by any unit adventurous training leader in the performance of Defence adventurous training activities related to roping, canyoning, caving and climbing.

Level

2. This publication is for use by Defence unit adventurous training leaders that are roping, canyoning, caving, climbing or otherwise authorised.

Scope

3. This publication provides, principles and procedures sourced from endorsed publications. Further, some of the details contained within have been developed for this publication from current training practices. This publication describes the fundamentals of roping, canyoning, caving and climbing to support unit adventurous training leaders in executing adventurous training.

Associated Publications

4. This publication should be read in conjunction with other publications and documents, in particular:
   a. Adventurous Training Wing Equipment Operators Manual
   b. Army Training Instruction 5-3/10 Army Adventurous Training
Contents

x

c. Block Scale 19/07, Army Adventurous Training Regional Loan Pool Equipment
e. Defence Instruction (Army) Administrative 23-2, Management of Reportable Incidents
f. Defence Instructions (Army) Operational 68-1, Military Risk Management
g. Defence Learning Manual
h. Electrical and Mechanical Engineering Instructions – Miscellaneous Equipment M 028-1, Climbing, Rappelling and Caving Equipment
i. Land Warfare Doctrine 7-6, Adventurous Training
j. Land Warfare Procedures - General 1-2-5, Army First Aid
k. Land Warfare Procedures - General 7-6-1, Experiential Learning and Adventurous Training
l. Land Warfare Procedures - General 7-6-4, Adventurous Training – Whitewater Rafting and Kayaking

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Gender

7. This publication has been prepared with gender-neutral language.
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1. The principal source for Australian Defence Force abbreviations is the Australian Defence Glossary located at [http://adg.eas.defence.mil.au/adgms](http://adg.eas.defence.mil.au/adgms). Abbreviations contained within this publication are in accordance with the business rules, guidelines and conventions for the Australian Defence Glossary at the time of its release. The following abbreviations are used throughout this publication; however, commonly used terms have been presented in their abbreviated format throughout the publication and have not been included in this list.

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<td>adventurous training</td>
</tr>
<tr>
<td>ATLI</td>
<td>adventurous training leader instructor</td>
</tr>
<tr>
<td>CE</td>
<td>Conformité Européenne</td>
</tr>
<tr>
<td>FBH</td>
<td>full body harness</td>
</tr>
<tr>
<td>FF</td>
<td>flying fox</td>
</tr>
<tr>
<td>GI</td>
<td>glycemic index</td>
</tr>
<tr>
<td>GL</td>
<td>group leader</td>
</tr>
<tr>
<td>hex</td>
<td>hexentric</td>
</tr>
<tr>
<td>HRC</td>
<td>high ropes course</td>
</tr>
<tr>
<td>SLCD</td>
<td>spring-loaded camming device</td>
</tr>
<tr>
<td>UATL</td>
<td>unit adventurous training leader</td>
</tr>
<tr>
<td>UIAA</td>
<td>Union Internationale des Associations d’Alpinisme</td>
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2. The following abbreviations appear in tables and figures within the publication.

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<tr>
<td>Li-ion</td>
<td>lithium-ion</td>
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3. The following are common shortened forms or symbols for names of measurements used throughout this publication.

<table>
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<tr>
<td>kN</td>
<td>kilonewton</td>
</tr>
<tr>
<td>ppm</td>
<td>parts per million</td>
</tr>
<tr>
<td>t</td>
<td>tonne</td>
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</table>
4. The following are common shortened forms or symbols for names of chemicals and/or explosives used throughout this publication.

\[
\begin{align*}
\text{CO}_2 & \quad \text{carbon dioxide} \\
\text{O}_2 & \quad \text{oxygen}
\end{align*}
\]
CHAPTER 1

ROPING

WARNING

Using this publication for private use could result in serious injury or death for untrained personnel.

SECTION 1-1. INTRODUCTION TO ROPING

1.1 This chapter provides a broad introduction to all roping activities, including the purpose, requirements and general planning considerations. This publication describes the use of: abseiling, canyoning, caving and climbing for the purposes of adventurous training (AT) and general roping activities.

1.2 AT is a technique designed to assist commanders with developing resilience and prepare their soldiers for battle. Drawing on the theory of adventure-based learning, AT places participants in situations where there is fear and consequence, and facilitates transfer of the benefits of this experience to the workplace. A wide range of disciplines lend themselves to this purpose, and roping activities are some of the most commonly employed.

1.3 This publication is to be used with other publications relating to AT (see LWD 7-6, Adventurous Training, LWP-G 7-6-1, Experiential Learning and Adventurous Training and the Defence Learning Manual [Part 2, Chapter 6]), this publication provides guidance to unit adventurous training leaders (UATLs) and adventurous training leader instructors (ATLIs) and members of Army adventure associations.

1.4 This publication is the source of technical information required for the conduct of all roping activities such as, abseiling, canyoning, caving and climbing AT activities for the ADF. This
publication is written from a general AT perspective and in line with the outdoor industry Adventure Activity Standards (commonly known as AAS). All roping activities are to conform to the information contained herein, notwithstanding any specific manufacturer requirements for the use of specialist equipment. Together with publications relating to AT theory, technical disciplines and equipment, this publication provides guidance to the following:

a. COs
b. UATLs/ATLIs
c. members of Army adventure associations
d. others concerned with designing, planning and conducting roping AT activities.

1.5 Roping encompasses the processes to descend or ascend vertical and horizontal features utilising techniques, skills and specialist equipment.

Requirements

1.6 Like all AT activities, roping involves risk. A detailed risk assessment must be conducted prior to the activity, and a comprehensive risk management plan must be established in accordance with Army Standing Instruction – Military Risk Management. Safety instructions for all roping activities are provided in the relevant annexes of this chapter.

Adventurous Training Safety Brief

1.7 Before commencing any roping activity, all participants must be briefed on safety procedures. Failure to cover all the relevant points could result in disaster. Every activity and area will require a different brief. The information to be covered in a safety brief for a roping activity is detailed in the relevant appendices of this chapter. A safety brief card containing all information is provided as a source of reference and is to be used at all times while conducting AT activities.
General Planning Considerations

1.8 When planning a roping activity, the following points should be considered:

a. There is to be a minimum of two UATLs/ATLs per activity. The only exception to this rule is when a static single pitch activity is being conducted and the one UATL/ATLI can actively supervise both the top and the bottom of the pitch.

b. A roping and climbing qualified UATL can assist on a caving or canyoning activity. The Roping and Climbing UATL can act as the second person within the activity but cannot be counted as a qualified member in order to increase participant numbers (eg, a Caver plus a Roping and Climbing UATL can take six personnel on an activity whereas two Cavers can take 12).

c. Sufficient time and space must be allocated to conduct the activity, including front-loading and debriefing (see LWD 7-6, Adventurous Training).

d. The location and venue should be carefully selected, taking into account the experience, size, age and fitness of the group, as well as the season and weather.

e. The activity should be planned to create an experience that will develop the qualities specified by the CO.

f. Large groups will impact on the ability to facilitate the adventurous experience.
SECTION 1-2. HAZARDS AND MEDICAL CONSIDERATIONS ASSOCIATED WITH ROPE

General Safety Hazards and Methods of Prevention

During all roping activities there are a number of hazards that need to be addressed. The following is a short list of common hazards:

a. **Equipment that is Damaged or Poorly Maintained.** All safety equipment must be inspected by a UATL before, during, and after use.

b. **Knots and Obstructions.** Knots and obstructions in ropes can cause problems for novice ropers. Inspections during the activity will ensure that there are no issues with the ropes.

c. **Fear.** This is the emotional response to perceived and real imminent threats creating a surge of physical arousal necessary for flight or flight. The experience of fear and the ability to work through that fear is different for everyone.

d. **Anxiety.** This is anticipation of a possible threatening outcome. This is often associated with a tensing of the muscles and increased vigilance. The expectation of future peril promotes avoidant and cautious behaviours.

e. **Other Climbers.** Other abseilers or climbers using the same area could present a hazard through unsafe practices.

f. **Spectators.** Spectators are a concern when working at height. Areas should be allocated and all safety issues should be addressed.

g. **Adverse Weather Conditions.** Adverse weather conditions need to be looked at for all activities. Flooding is a concern for caving and canyoning. Lightning and high winds are a concern when working at height.
h. *Edges of Vertical Features and Drops.* Safety lines need to be set up at critical points when required.

i. *Falling Objects, Loose Debris and Rocks.* The area may have sections where there could be falling objects, loose debris and rocks:

1. If possible avoid the area of concern.

2. If personnel dislodge rocks or debris they are to shout ‘BELOW’ or ‘ROCK’ loudly, this warning is to be passed by each subsequent member if required. This point is to be covered in safety briefs.

3. On hearing the call ‘BELOW’ or ‘ROCK’ all personnel who are below the area of concern are to look straight ahead and move into the cliff or wall. Do not look up. When the rock hits the cliff it will often bounce out.

j. *Slippery Surfaces.* Slippery surfaces are a concern especially near edges.

k. *Sharp Edges.* Sharp edges are a concern where ropes are used. Ensure that ropes are protected where possible or ensure that participants are aware of the areas of concern when descending or ascending.

l. *Ledges.* Ledges need to be assessed for safety considerations and made safe by the use of safety-lines and/or ensure that participants are briefed on the procedures to be used.

m. *Trees/Scrub.* The trees or scrub in the area may not be safe to use as handholds or anchors. Ensure that participants test before committing full weight on the object.

n. *Water.* Rising water levels can be a concern depending on the activity. Also drinking the local water is a concern as the source is unknown.
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o. **Overhangs.** Overhangs are a concern when descending or ascending. Ensure that participants are briefed on passing overhangs.

p. **Snakes and Insects.** Snakes and poisonous insects are a concern as they hide on the cliff face in cracks or on ledges.

q. **Nesting Birds.** Nesting birds are to be avoided. Most parks will advise when areas are closed during nesting periods.

r. **Medical Hazards and Methods of Prevention.** A detailed list of medical hazards should be part of the safety brief.

s. **Harness Injury.** Suspension trauma, also known as harness hang syndrome. The most common cause is accidents in which the participants remains motionless suspended in a harness for long periods of time. Motionlessness may have several causes including fatigue, hypoglycemia, hypothermia or traumatic brain injury.

t. **Rope Burns and Abrasions.** Rope burns generally happen when a person has lost control during an abseil or on fast abseils.

u. **Gloves.** When belaying an abseiler with a bottom belay, gloves are to be removed so that the belayer has better control over their braking ability.

v. **Psychological Trauma.** Psychological trauma is the strong emotional or physical reaction following a traumatic event. These reactions should subside over a few days or weeks depending on the nature of the event, the available support, previous and current life stress, coping mechanisms and personality. More information on trauma can be found at the Australian Psychological Society website.1


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**LWP-G 7-6-2, Adventurous Training – Roping, 2018**

**Contents**
SECTION 1-3. THE FUNDAMENTALS OF ABSEILING

Introduction to Abseiling

1.10 This section provides a broad introduction to abseiling including a description of its nature and general planning considerations. Safety instructions for abseiling are detailed in Annex A.

1.11 Abseiling is a method used to descend vertical or near-vertical features, both natural and artificial, using ropes and descending devices. Abseiling activities range from the following:

a. Static Single Pitch. Static single-pitch abseiling is where repeated descents are made on one pitch or length of rope.

b. Single-pitch Expedition. Single-pitch expedition abseiling consists of a single-pitch abseil where the ropes are recovered from the base. This technique could be used for getting off a climb.

c. Multi-pitch Expedition. Multi-pitch expedition abseiling consists of a series of stages or ‘pitches’. The ropes are rigged so they can be recovered from the bottom of each pitch.

Purpose

1.12 Abseiling can be employed as an activity in isolation. It is an activity that has the capacity to accommodate a large number of participants with minimal training. It is also quick to set up, and can be conducted in a wide variety of areas. However, the AT benefits gained from abseiling are quickly diminished with repeated exposure to static single-pitch abseiling. Abseiling is therefore more effectively used as an element of more substantial activities such as canyoning, and caving. Multi-pitch and expeditionary abseiling activities also provide alternate options to static single-pitch abseiling.
Abseiling may be used for the following purposes:

- to introduce participants to AT
- as a foundation skill for more demanding and advanced activities
- as part of a multi-discipline activity, and/or
- as a demanding activity in its own right.

In particular, abseiling has the potential to develop and enhance physical courage, stress management techniques, self-confidence, and determination.

Planning Considerations for Abseiling

When planning an abseiling activity, the following points should be considered:

- Abseiling can be conducted in a variety of locations and venues (natural and artificial). The location and venue should be carefully selected, taking into account the experience, size, age and fitness of the group.
- Before conducting any multi-pitch or expedition-based activity, participants should complete a single-pitch abseil.

By varying the activity – through a variety of sites, heights and techniques – participant interest can be maintained for a longer period. Alternatively, a complex activity, involving abseiling and ascending techniques that are goal or expedition-based can more effectively develop the desired group and individual qualities.

SECTION 1-4. THE FUNDAMENTALS OF CANYONING

Introduction to Canyoning

This section provides a broad introduction to canyoning including a description of its nature and general planning considerations. Safety instructions for canyoning are detailed in Annex B.
1.18 A canyon is a narrow chasm with steep cliff walls, cut into the earth by running water. Canyoning is an activity of exploring these areas. Canyons can be either horizontal or vertical, and either wet or dry. Exploring canyons requires an assortment of skills, such as navigation, swimming and abseiling. Participants can expect to negotiate a range of obstacles while canyoning in Australia, including pools of water, waterfalls, cliffs, creek beds and subterranean waterways. Canyons are graded from Grade 1 to Grade 6, with Grade 1 being the simplest and Grade 6 being the most challenging to negotiate. Many canyons have a written guidebook. Information can be obtained from the internet, local parks and wildlife authorities, clubs and associations.

1.19 Canyoning activities can be conducted in a variety of areas. Canyoning has the potential to develop physical courage, self-confidence, teamwork, leadership, determination, and stress management skills.

1.20 Canyoning is a day or night activity that may be conducted with the following aims:
   a. to introduce participants to AT
   b. as a challenging AT activity on its own
   c. as part of a multi-disciplined activity, or
   d. as an expedition.

Canyoning Planning Considerations

1.21 When planning a canyoning activity, the following points should be considered:
   a. The location and venue should be carefully selected, taking into account the experience, size, age and fitness of the group, as well as the season and weather.
   b. Exploring different canyons helps maintain the participants’ interest in the activity.
   c. All waste products including rubbish, food scraps and human faeces should be carried out of the canyon in
strong plastic bags and disposed of appropriately (see Section 1-11).

d. The group leader (GL) is to give the pre-activity brief (see Appendix 1 to Annex B) to all participants of the group. This brief must be given before the safety brief.
e. Canyoning parties should leave a canyon as they found it. The group is to:
   (1) avoid leaving unnecessary slings
   (2) avoid establishing new abseil routes or footpads
   (3) keep to established waterways to avoid damaging sensitive creek banks and soft vegetation
   (4) avoid unnecessary camping in canyons.

SECTION 1-5. THE FUNDAMENTALS OF CAVING

Introduction to Caving

1.22 This section provides a broad introduction to caving including a description of its nature and general planning considerations. Safety instructions for caving are detailed in Annex C.

1.23 Caving is the exploration of natural underground passages and chambers, usually formed where water has dissolved away limestone, or other similarly soft rock. Caving involves elements of numerous other skills, and is often considered a combination of climbing, abseiling, hiking and, on occasion, swimming. The majority of caving involves walking along passages and climbing or scrambling up slopes and walls, and occasionally crawling and squeezing.

1.24 Caving is a dynamic activity that has the capacity to accommodate a large number of participants with minimal training.

1.25 Caving may be used for the following purposes:
   a. to introduce participants to AT
b. as a demanding activity in its own right, in particular, caving has the potential to:

(1) develop and enhance teamwork
(2) physical courage
(3) stress management
(4) self-confidence
(5) leadership and determination

c. as a foundation skill for more demanding and advanced activities
d. incorporated into a multi-disciplined activity.

Caving Planning Considerations

1.26 When planning a caving activity the following points should be considered:

a. The location and venue should be carefully selected taking into account the experience, size, age and fitness of the group.

b. By varying the activity, through a variety of caves involving different depths, forms, squeezes and techniques required, participant interest can be maintained for a longer period.

Cave Types

1.27 A cave is a naturally formed cavity within the Earth’s surface. Caves are separated into two broad classes – those that are formed by essentially chemical processes and those that are formed by mechanical processes. Within these two classes, caves are listed by the following major processes that lead to their formation:

a. caves formed mainly by chemical processes:

(1) solution caves
(2) lava caves
(3) ice caves

b. caves formed by mechanical processes:
   (1) tectonic caves
   (2) eolian caves
   (3) sea caves
   (4) talus caves
   (5) erosion caves
   (6) suffusional caves.

SECTION 1-6. CAVING ETHICS AND CONSERVATION

Conservation

1.28 When entering a cave for the first time, a person quickly realises that a cave is a unique environment. The effects of time and water are evident in ways that cannot be seen on the surface. It is likely that a person’s first several trips will be to caves that are heavily visited. Caves of this type are damaged by the effects of heavy traffic by people who often have little appreciation of the cave. The floors can be littered with rubbish, the walls covered with graffiti and the streams and pools may be black with pollution. All of these things should make the need for cave conservation obvious to anyone with sensitivity for and an appreciation of the natural environment.

1.29 Caves have unique scientific, adventurous, scenic and challenging facets. Carelessness and vandalism endanger these aspects and, once gone, they cannot be recovered. UATLs must accept the responsibility of both themselves and their group for protecting and enjoying the caves. The old adage ‘leave nothing but footprints, take nothing but photos, kill nothing but time’ applies.

1.30 Caving parties should leave a cave as they found it. The following basic rules should apply when caving:
   a. ensure the removal of all human waste
b. minimise marking of caves

c. do not disturb life forms such as bats

d. do not increase the number of disfiguring paths

e. do not collect souvenirs

f. remove all rubbish and food scraps

g. avoid unnecessary camping in caves

h. avoid destruction or disfiguration of cave decoration

i. do not smoke in caves.

SECTION 1-7. THE FUNDAMENTALS OF CLIMBING

Introduction to Climbing

1.31 This section provides a broad introduction to climbing including a description of its nature and general planning considerations. Safety instructions for climbing are detailed in Annex D and Annex E.

1.32 Climbing is a method used to ascend vertical or near-vertical features, both natural and artificial. Ropes and protection secured to the rock are used for safety to protect climbers when they fall. Climbing activities range from simple single-pitch static activities to single- or multi-pitch expeditions in both top rope and lead climbing.

1.33 Top rope climbing activities are divided into static single-pitch top rope climbing activities, and multi-pitch top rope climbing expeditions.

1.34 Climbing can be employed as an independent activity. It is a challenging activity that has the capacity to accommodate a reasonable number of participants with minimal training. It is also quick to set up and can be conducted in a wide variety of areas. However, the AT benefits gained from static top rope climbing are quickly diminished with repeated exposure. Climbing is more effectively used as an element of a more complex AT activity.
1.35 Climbing may be used for the following purposes:
   a. to introduce participants to AT
   b. to prepare personnel for AT activities using single-pitch natural or artificial climbing surfaces
   c. as a demanding activity in its own right – climbing has the potential to develop and enhance physical courage, stress management, trust, self-confidence and determination
   d. as a foundation skill for more demanding and advanced activities such as lead climbing, multi-pitch expeditions, aid climbing, ice climbing and mountaineering.

Climbing Planning Considerations
1.36 When planning and training for a climbing activity, the following points should be considered:
   a. Climbing can be conducted in a variety of locations and venues, natural and artificial. The location and venue should be carefully selected, taking into account the experience, size, age and fitness of the group.
   b. The safety considerations for top rope climbing are described in Annex D.
   c. By varying the activity – through a variety of sites, heights, and techniques – participant interest can be maintained for a longer period. Alternatively, complex activities, involving climbing techniques that are goal or expedition-based can more effectively develop the desired group and individual qualities.

Requirements
1.37 Before conducting climbing activities, UATLs should ensure that a gradual progression of training has been conducted. When planning climbing activities the following points should be considered:
   a. The activity requirements will often dictate the time and place of the activity, the size of the group and the
techniques required to achieve the exercise outcomes. Sufficient time and space must be allocated to conduct the activity.

b. Reconnaissance and detailed planning, incorporating formal risk assessment, are required for all climbing activities.

SECTION 1-8. LEAD CLIMBING SAFETY

1.38 This section details specific safety instructions for the conduct of lead climbing activities. It should be read in conjunction with Section 1-7. Lead climbing activities involve the ascent of a vertical feature, either natural or artificial, using climbing techniques. Unlike top rope climbing, where the participant is belayed and supported from above by a safety rope, the leader in a pair participating in lead climbing is protected from striking the ground from below. This can cause a significant increase in forces placed on climbers and their equipment in the event of a fall; therefore, lead climbing requires specific considerations. The lead climbing safety brief format is contained in Annex E.

Definitions

1.39 Definitions pertinent to lead climbing activities discussed in this chapter are as follows:

a. Single-pitch Climbing. Single-pitch climbing is where the top of the climb can be reached using a single rope-length.

b. Multi-pitch Climbing. Multi-pitch climbing is where the top of the climb cannot be reached using a single rope-length, and there is a need to re-use the rope to conduct further climbing ascents to reach the top.

c. Static Lead Climbing Activities. Static lead climbing activities are those where participants are instructed in the techniques required to lead a climb by the GL. Static lead climbing activities are single pitch and the participants actually lead the climbs. Static lead climbs
should not be conducted on climbs greater than half the rope-length in height, unless the second is an experienced lead climber (ie, a qualified UATL) and can perform a leader rescue.

d. Expedition Lead Climbing Activities. Expedition lead climbing activities are those where the GL leads the climb and guides participants to the top. Expedition lead climbing can be conducted as both single-pitch and multi-pitch climbing.

Specific Activity Requirements

1.40 Wet rock becomes slippery and increases the chance of the climber falling. Lead climbing is not to be commenced on wet rock.

Pre-activity Requirements

1.41 All personnel participating in multi-pitch climbing activities must be able to abseil and have demonstrated an ability to climb during either top rope or single-pitch lead climbs. They are to be assessed by the OIC as having sufficient knowledge and skill to perform the planned activity.

SECTION 1-9. COMMUNICATIONS

Whistle, Light and Hand Signals

1.42 During the conduct of roping activities, communications between participants can be difficult. This can be due to distance, weather, wind, or other noise such as that caused by waterfalls, rapids and so on. In addition, communications between party members can be difficult when separated or lost. As a result, non-verbal communication methods may be required. Therefore, whistles are to be carried by all participants. If directional aid is required, the emergency signal and reply are to be repeated. In the dark, the whistle blasts can be supplemented by torch flashes.
1.43 General whistle signals for all roping activities are as follows:
   a. Single long whistle blast – Stop! Make yourself safe and look this way.
   b. Repeated whistle blasts – situation requiring immediate or urgent assistance or response required.

1.44 General hand signals for all roping activities are as follows:
   a. One hand continuously waving above head of participant – distress, need urgent assistance.
   b. Fist clenched and positioned on top of head – I am OK/are you OK.
   c. Two arms extended horizontally to the ground – Stop! Do not proceed.

SECTION 1-10. FOOD AND WATER

1.45 Food and water must be carried on every trip, regardless of the duration. There should be enough food for each member in the group and enough to cover any emergency. Water is best stored in a collapsible water container, as this will take up less room when empty. However, always use a robust water container that is able to handle adverse conditions. Remember that avoiding dehydration is an important consideration on all activities. In addition, each person must carry enough food to last until resupply and as a minimum, some form of emergency ration such as a chocolate bar.

1.46 Food should have some form of wrapping to prevent it from being handled with dirty hands and care is to be taken to remove all food waste. Before consuming food be sure to disinfect the hands with sanitiser.
1.47 To ensure continued environmental conservation, participants should attempt to relieve themselves prior to arriving at an area that has no facilities.

1.48 Where required each person should carry a wide mouthed bottle to urinate in. Ensure that it is large enough to hold all urine excreted during the activity (750 mL bottle would be the minimum recommended). Females should carry a funnel or equivalent, to assist in this process.

1.49 For faeces, groups should carry strong plastic bags or ‘wag bags’ and a few sheets of toilet paper in a waterproof bag. Faeces should be carried out for disposal to ensure minimum environmental impact.

Annexes:

A. Safety Instructions for Adventurous Training Abseiling Activities
B. Safety Instructions for Adventurous Training Canyoning Activities
C. Safety Instructions for Adventurous Training Caving Activities
D. Safety Instructions for Adventurous Training Top Rope Climbing Activities
E. Safety Instructions for Adventurous Training Lead Climbing Activities
ANNEX A TO CHAPTER 1

SAFETY INSTRUCTIONS FOR ADVENTUROUS TRAINING ABSEILING ACTIVITIES

1. This annex details specific safety instructions for the conduct of abseiling activities, including ascending.

Group Leader/Participant Supervision Ratio

2. Ratios are to be determined by a risk appreciation process, with the following factors taken into consideration:
   a. level of difficulty of the activity and skills required
   b. anticipated environmental conditions, remoteness, difficulty and duration of the activity
   c. leader experience and knowledge of the area
   d. the identified capabilities of participants (ie, experience, competence)
   e. land managers or relevant authorities may suggest ratios that differ from those recommended; if these suggest a ratio with fewer participants per leader or per activity, they will be regarded as the overriding requirements.

3. Paragraph 4 to paragraph 10 indicate the general ratios that are considered acceptable during a defence activity.

Single-pitch Static Abseiling

4. One UATL/ATLI or equivalent is permitted to supervise two ropes during any single-pitch static abseiling activity.

5. The distance between the ropes must be such that the GL can control them at all times, both visually and using verbal communications.
Single-pitch Expedition

6. A UATL/ATLI or equivalent is permitted to supervise two ropes during any single-pitch expedition abseiling activity.

7. The distance between the ropes must be such that the GL can control them at all times, both visually and using verbal communications.

Multi-pitch Expedition

8. One UATL/ATLI can lead up to six personnel during a multi-pitch expedition activity.

9. Ratios should be set by a qualified person with detailed knowledge of the activity, location, equipment and the group.

10. Personnel with abseiling qualifications and skills are deemed competent to assist with the conduct of the abseiling and ascending component only of a top rope climbing, caving or canyoning activity.

Limitations

11. Abseiling is only to be conducted using techniques that require the participant to have their own hand on the descent rope at all times throughout the descent. Hands-free abseiling is not to be taught or practised during the conduct of AT abseiling. Hands-free abseiling may only be conducted when practising the duties of the brake person, or when lowering an injured abseiler during an emergency. When practising brake person duties, the abseiler is to be held in a stationary position throughout the demonstration unless attached to a secondary top belay. Specialist training including emergency brake descents may only conducted by the AT Wing.

Pre-activity Requirements

12. All personnel participating in multi-pitch expedition activities must have completed single-pitch abseiling training. They are to be assessed by the OIC as having sufficient knowledge or skill in abseiling to perform the planned activity.
General Safety Precautions

13. The following general precautions must be observed when conducting abseiling AT activities:

a. Static ropes only are to be used for abseiling activities (with the exception of accessing or returning from a climbing activity).

b. An approved Union Internationale des Associations d’Alpinisme (UIAA) helmet is to be worn at all times when abseiling, belaying, or when closer than 5 m to the base of the cliff.

c. The GL must check all harnesses once fitted.

d. Safety measures are to be taken when approaching cliff edges. When a cliff edge is stable, no person is permitted to be closer than 2 m without safety measures; however, this distance may need to be increased depending on cliff stability.

e. All abseiling is to be done in a controlled manner so as to place minimum impact on anchors and equipment, and for general safety.

f. All abseilers are to receive a safety check prior to commencing their descent.

g. During initial training, and until deemed competent by the OIC, all personnel abseiling are to have their descents controlled using a top belay system, or a brake person (a member positioned at the bottom of each rope in use who is trained to arrest a falling abseiler).

h. During initial roping training (or training involving beginners), a brake person is to be employed during periods of instruction.

i. Belayers are not to remove their hands from the rope at any time that the rope is active.

j. Dispatchers are to be attached to a safety line, regardless of their distance from the cliff edge. The
safety line should allow the dispatcher to reach the edge to view the abseiler during their descent.

k. All pockets are to be done up and all loose clothing is to be tucked away so as to not interfere with the descent device. Rings and jewellery are to be removed.

l. The OIC must ensure that a casevac plan is formulated and that all members are briefed on the plan on arrival in the training area. The evacuation plan is to include the means of evacuation both off the cliff or mountain and to a medical treatment facility.

m. Only locking karabiners (maillons are also acceptable) are to be used to connect a descent device to a harness.

n. All descent lines must be checked to confirm that the running end of the rope is on the ground; or where no such confirmation can be obtained, a knot large enough to block the descent device is to be tied at least 1 m from the end of that descent line.

o. During all abseiling activities a rescue rope the length of the abseiling pitch is to be positioned at the top of the descent in order to effect a rescue. For multi-pitch abseiling activities, a spare set of ropes are required in case the original ropes become stuck. These spare ropes may act as the rescue rope.

p. Effective safety communications must be established between the top/base of site for all roping activities before the training activity commences, and maintained for the duration of those activities.

q. Training activities are to cease immediately upon a loss of communications between top/base of site.

r. When groups are operating independently, the GL is to assume the responsibilities of the OIC, for their group.

s. A safety brief in accordance with Appendix 1 is to be given before any abseiling or ascending activity commences.
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Safety Precautions for Abseiling Anchors

14. The following precautions are to be observed when constructing or dismantling abseiling anchors:

a. For static abseiling activities where multiple descents are made, an anchor system consisting of two anchor points is to be used.

b. During single-pitch and multi-pitch expedition-type activities where only a single descent by each participant is made, anchors consisting of two fixed anchor points or a fail-safe natural anchor point is to be used. Where possible this should be backed up for all descents except the last person.

c. All karabiners used in the anchor must be a single locking or two-opposed and reversed clip gate karabiners.

d. All anchors and anchor systems must be checked by the OIC prior to the commencement of any roping activity.

e. The OIC of the activity or safety officers must check the anchor system periodically throughout the activity.

f. Prior to dismantling an anchor system, the OIC/GL must ensure that no person is dependent on that system. Where possible, the descent rope should be retrieved prior to dismantling the system.

g. Where an anchor system uses artificial protection, two pieces of protection form an anchor point.

Safety Precautions for Ascending a Rope

15. The following precautions are to be observed when ascending a rope using the single rope technique:

a. Two points of contact must be maintained with the rope at all times when ascending. This can be two ascenders or one ascender and a clip-in with the rope. Both points of contact must be attached to the harness.
b. The GL or a competent assistant must check that the ascenders are correctly attached to the harness and to the rope before the participant commences their ascent.

c. When using a single ascender or when conducting a changeover, personnel must maintain two points of contact (eg, clipping into the rope or rebelay).

Safety Precautions for Equipment

16. The following precautions are to apply to the inspection, transport and storage of abseiling equipment:

a. The OIC or GL of each group is to supervise the daily inspection of all equipment before, during and after use.

b. All safety equipment used is to be of an approved standard for use in accordance with the Adventurous Training Wing Equipment Operators Manual or of an accepted civilian standard.

c. The OIC of the activity must ensure that all abseiling equipment is stored, transported and used correctly.

d. The GL of each group is to assist the OIC and conduct regular inspections of the equipment for which they are responsible.

e. All associated abseiling stores are to be used for the activity only, and are to be stored separately from general stores in a shaded, well-aired area away from fuel, chemicals or any other substance likely to cause them damage.

f. Any equipment found unserviceable or considered unsafe by a UATL or equivalent, or where the slightest doubt exists, is to be tagged and immediately withdrawn from use. Tagged equipment is to be returned for disposal action.
Individual Equipment Requirements

17. The minimum individual equipment that must be carried by a participant is as follows:
   a. an approved UIAA helmet
   b. an approved harness or tape seat
   c. two locking karabiners
   d. a descending device
   e. gloves
   f. whistle.

Group Leader Equipment Requirements

18. The additional equipment required by a GL conducting an abseiling activity is as follows:
   a. four locking karabiners
   b. three accessory cords
   c. a knife
   d. 3 m tubular tape.

Group Rescue Equipment Requirements

19. The minimum group equipment required for an abseiling activity is as follows:
   a. rescue rope (suitable for the longest pitch to be abseiled)
   b. spare set of ropes (multi-pitch activities)
   c. spare locking karabiners
   d. rescue pulley.

Appendix:

1. Safety Brief – Abseiling
APPENDIX 1 TO ANNEX A TO CHAPTER 1

SAFETY BRIEF – ABSEILING

1. Appointments:
   a. activity commander
   b. OIC
   c. UATL(s)/GL(s)
   d. medic
   e. driver (safety vehicle).

2. Locations:
   a. safety vehicle
   b. keys for safety vehicle
   c. OIC/medic
   d. medical kit
   e. safety case with emergency phone numbers.

3. Communications:
   a. primary communications
   b. secondary communications
   c. frequencies and phone numbers
   d. unlock codes and PIN numbers.

4. Location information:
   a. current location
   b. nearest hospital
   c. route to hospital
   d. all maps and hospital numbers are located
   e. weather forecast
5. **Actions-on:**
   a. lost/separated
   b. casualty
   c. hearing the distress signal
   d. no communications
   e. broken or dropped equipment
   f. what is to occur in adverse weather.

6. **Equipment:**
   a. continue to check equipment
   b. do not remove your equipment until advised to do so by a UATL
   c. if your equipment is removed ensure that it is rechecked by a UATL
   d. do not drop any equipment (explain)
   e. no smoking while wearing or near equipment
   f. do not leave equipment lying around
   g. tuck away all loose clothing and hair and remove rings and watches
   h. do not stand on ropes.

7. **Abseiling/Ascending:**
   a. helmets to be worn at all times within 5 m of the base of the cliff
   b. proceed no closer than 2 m from the edge without a safety line
   c. do not touch any anchor system or ropes unless directed to do so by the OIC
1A1-3

d. anchor systems are to be dismantled only on the order of the OIC

e. explain routes up and down

f. do not run

g. do not throw anything

h. anything dislodged or seen falling shout ‘BELOW’

i. on hearing ‘BELOW’ move in towards the pitch face, do not look up

j. use clear abseiling calls

k. pay attention to leaders at all times

l. report any injuries to leaders.
ANNEX B TO CHAPTER 1

SAFETY INSTRUCTIONS FOR ADVENTUROUS TRAINING CANYONING ACTIVITIES

1. This annex details specific safety instructions for the conduct of canyoning activities.

Group Leader/Participant Supervision Ratio

2. Ratios are to be determined by a risk appreciation process, with the following factors taken into consideration:
   a. level of difficulty of the activity and skills required
   b. anticipated environmental conditions, remoteness, difficulty and duration of the activity
   c. leader experience and knowledge of the area
   d. the identified capabilities of participants (ie, experience, competence)
   e. land managers or relevant authorities may suggest ratios that differ from those recommended; if these suggest a ratio with fewer participants per leader or per activity, they will be regarded as the overriding requirements.

3. Paragraph 4 and paragraph 5 indicate the general ratios that are considered acceptable during a defence activity.

Horizontal Canyoning

4. One UATL/ATLI can lead up to six personnel on activities involving horizontal canyoning.

Vertical Canyoning

5. One UATL/ATLI can lead up to six participants when conducting a canyoning activity requiring abseiling techniques within the canyon.
6. Ratios should be set by a qualified person with detailed knowledge of the activity, location, equipment and the group.

Pre-activity Requirements

7. All personnel participating in canyoning requiring abseiling techniques must have completed single-pitch abseil ground training. They are to be assessed by the OIC as having sufficient knowledge or experience in abseiling to perform the planned activity. In addition, all personnel participating in canyoning activities involving swimming, needs to have a canyon specific swim test conducted by the OIC. This may be conducted wearing the equipment to be used and be of a distance relevant to the canyon to be conducted.

Specific Activity Requirements

8. Specific Weather Requirements. As canyons are formed by water, they are prone to flooding when it rains in the catchment area; flooded canyons are extremely hazardous. Where canyons are prone to flooding, an accurate weather forecast is to be obtained prior to an activity commencing. Where there has been heavy rain in the catchment area, or heavy rain and thunderstorms are forecast within the catchment areas, the activity is not to proceed.

9. Specific Medical Requirements. Personnel participating in canyon activities involving swimming sections are to receive first aid training in treating a drowning, and receive practice in CPR. In addition to carrying a first aid kit, participants are to carry appropriate equipment to treat hypothermia.

General Safety Precautions

10. When conducting a canyoning activity the following general safety precautions must be observed:

   a. A minimum group size of four personnel is required.
   b. An approved UIAA helmet must be worn at all times while in the canyon and in areas deemed appropriate by the OIC/GL.
c. No person is to jump into waterholes if the depth is unknown.

d. Canyon packs are not to be worn when jumping into water.

e. Navigation equipment including a map and compass are to be carried by each group.

f. Details of the canyon, estimated time of return and the route taken must be left with a competent authority.

g. The OIC/GL is to know the procedures used by the local civilian rescue emergency authorities capable of responding to an emergency involving both horizontal and vertical canyon rescue techniques.

h. Knowledge of the canyon should be obtained before the activity commences, in particular, known hazards and entry and exits points.

i. Where travelling in a canyon requires participants to move over rock greater than 2 m above the canyon floor using climbing techniques, or where the consequences of a fall could prove serious, the participant is to be belayed or protected.

j. When the canyon requires lead-climbing techniques, an appropriately qualified lead climber must be included in the canyoning party.

k. Personnel are to wear or carry appropriate equipment and clothing to protect them from the cold. The OIC/GL must conduct regular checks to ensure that participants have the appropriate clothing.

l. All spare equipment is to be carried in a pack. All packs are to be waterproofed and checked for positive buoyancy. Packs may be used to assist swimmers.

m. Identified weak swimmers should be provided with rated floatation device.
n. All personnel must carry a light source, which has been waterproofed.

o. A safety brief, in accordance with Appendix 1 is to be given before the canyoning activity commences.

Safety Precautions for Vertical Canyoning Activities

11. When conducting a canyoning activity involving abseiling techniques, the safety requirements detailed in Annex A must be applied. In addition, the following safety precautions must be observed:

   a. The OIC/GL must inspect all anchor points before use.
   b. When in fast water near a drop, members are to be attached to a safety line.
   c. A rescue rope or spare rope(s) must be carried.
   d. When descending by rope into unknown depth, a knot large enough to block the descent device is to be tied at least 1 m from the end of that descent line.

General Equipment Safety Precautions

12. The following precautions apply to inspection, transport and storage of canyoning equipment:

   a. The OIC or GL of each group must supervise the daily inspection of all equipment before, during and after use.
   b. During the conduct of the activity the GL of each group must assist the OIC, and conduct regular inspections of the equipment for which they are responsible.
   c. All associated canyoning and abseiling stores must be used for the activity only, and are to be stored separately from general stores in a shaded, well-aired area away from fuel, chemicals or any other substance likely to cause them damage.
Individual Equipment Requirement

13. The following is the minimum individual equipment to be carried on a canyoning activity:
   a. a UIAA-approved helmet
   b. a whistle
   c. warm dry clothing (waterproofed) suitable to spend the night in the canyon
   d. suitable footwear
   e. protective clothing as appropriate to the canyon environment (wet suits are recommended for cold conditions)
   f. thermal underwear is recommended for cold canyons (eg, woollen, polypropylene, chlorofibre)
   g. high energy food
   h. a headlamp.

14. For canyoning activities that involve abseiling the requirements detailed in Annex A must be adhered to.

Group Equipment Requirement

15. The following is the minimum group equipment required for each group of participants:
   a. navigation equipment including a map and compass
   b. abseil and rescue equipment (as detailed in Annex A)
   c. a handline or rescue rope for assisting swimmers
   d. a first aid kit
   e. a survival bag or bivvy bag
   f. emergency rations (additional to those to be consumed during activity)
   g. matches or lighter (to be waterproof).
Appendix:

1. Safety Brief – Canyoning
APPENDIX 1 TO ANNEX B TO CHAPTER 1

SAFETY BRIEF – CANYONING

1. Appointments:
   a. activity commander
   b. OIC
   c. UATL(s)/GL(s)
   d. medic
   e. driver (safety vehicle).

2. Locations:
   a. safety vehicle
   b. keys for safety vehicle
   c. OIC/medic
   d. medical kit
   e. safety case with emergency phone numbers.

3. Communications:
   a. primary communications
   b. secondary communications
   c. frequencies and phone numbers
   d. unlock codes and PIN numbers.

4. Location information:
   a. current location
   b. nearest hospital
   c. route to hospital
   d. all maps and hospital numbers are located
   e. weather forecast
5. **Actions-on:**
   a. lost/separated
   b. casualty
   c. hearing the distress signal
   d. no communications
   e. broken or dropped equipment
   f. what is to occur in adverse weather.

6. **Equipment:**
   a. continue to check equipment
   b. do not remove your equipment until advised to do so by a UATL
   c. if your equipment is removed ensure that it is rechecked by a UATL
   d. do not drop any equipment (explain)
   e. no smoking while wearing or near equipment
   f. do not leave equipment lying around
   g. tuck away all loose clothing and hair and remove rings and watches
   h. do not stand on ropes.

7. **Canyoning specific:**
   a. helmets to be worn at all times
   b. do not stray off on your own
   c. watch movement near cliff edges
   d. do not touch any anchor system or ropes unless directed to by the OIC
   e. do not run
f. do not throw anything
g. anything dislodged or seen falling shout ‘BELOW’
h. on hearing ‘BELOW’, move in towards the pitch face, do not look up
i. use correct abseiling calls
j. pay attention to leaders at all times
k. report any injuries to leaders
l. dangers of stagnant water
m. dangers of swift water.

8. Pre-activity brief – canyoning:
   a. canyon name
   b. location – general and specific
   c. canyon grade
   d. expected water levels
   e. expected temperatures
   f. canyon floor composition
   g. abseil points and heights
   h. canyon vegetation
   i. walk in/out routes
   j. nearest roads/condition of roads
   k. entry/exit points (markers/cairns)
   l. admin and waiting area
   m. weather (sunrise, sunset, cloud, forecast, temperatures)
   n. effects of weather on activity
   o. grouping (buddy allocation, additional groups).
9. Admin and log:
   a. transport and drivers
   b. equipment to remain in vehicles
   c. drop-off and pick-up plan
   d. location of vehicles
   e. location of keys
   f. rations:
      (1) daily
      (2) emergency
   g. water:
      (1) quantity
      (2) purification
   h. waste disposal:
      (1) rubbish
      (2) human.

10. Checks during activity:
    a. rope wear (move wear points)
    b. anchor systems
    c. personal equipment.

11. Equipment for activity:
    a. individual:
       (1) harness
       (2) helmets
       (3) karabiners
       (4) descender
       (5) rope
(6) gloves  
(7) safety equipment (whistles)  
(8) foul weather clothing  
(9) thermals  
(10) protective clothing (cag, wet suit)  
(11) dry bags  
(12) dry warm clothing.  

b. group:  
(1) map, compass, GPS  
(2) handline/throw bag  
(3) medical equipment  
(4) bivvy bag  
(5) emergency rations  
(6) matches or lighter  
(7) headlamps or torches  
(8) spare warm clothing.
ANNEX C TO CHAPTER 1

SAFETY INSTRUCTIONS FOR ADVENTUROUS TRAINING CAVING ACTIVITIES

1. This annex details the specific safety instructions for the conduct of caving activities, including ascending and descending.

Group Leader/Participant Supervision Ratio

2. Ratios are to be determined by a risk appreciation process, with the following factors taken into consideration:
   a. level of difficulty of the activity and skills required
   b. anticipated environmental conditions, remoteness, difficulty and duration of the activity
   c. leader experience and knowledge of the area
   d. the identified capabilities of participants (ie, experience, competence)
   e. land managers or relevant authorities may suggest ratios that differ from those recommended; if these suggest a ratio with fewer participants per leader or per activity, they will be regarded as the overriding requirements.

3. Paragraph 4 and paragraph 5 indicate the general ratios that are considered acceptable during a defence activity.

Horizontal Caving

4. One UATL/ATLI can lead up to six personnel on activities involving horizontal caving.

Vertical Caving

5. One UATL/ATLI can lead up to six participants when conducting a caving activity involving vertical caving.
techniques, where abseiling and ascending are required within the cave.

6. Ratios should be set by a qualified person with detailed knowledge of the activity, location, equipment and the group.

Pre-activity Requirements

7. All personnel participating in a caving activity involving vertical caving techniques must have completed training in the relevant techniques required to undertake the planned activity. They are to be assessed by the OIC as having sufficient knowledge or experience in abseiling to perform the planned activity.

Specific Activity Requirements

8. Specific Weather Requirements. Some caves are affected by flooding. Where caves are prone to flooding, an accurate weather forecast is to be obtained prior to an activity commencing. Where there has been heavy rain in the catchment area, or heavy rain and thunderstorms are forecast within the catchment areas, the activity is not to proceed.

Water Caves

9. All personnel participating in caving activities involving swimming must participate in a cave-specific swim test conducted by the OIC. This may be conducted wearing the equipment to be used and be of a distance relevant to the cave where the activity is to be conducted.

10. Specific Hazards and Medical Requirements. The following additional hazards are to be investigated before entering caves:

a. Foul Air. Foul air can be described as containing greater than 0.5 per cent CO₂ and/or lower than 18 per cent O₂ by volume. As a comparison, normal air contains approximately 0.03 per cent CO₂ and 21 per cent O₂ by
volume. The effects of foul air can be accumulative and repeated exposure needs to be carefully managed.

(1) The presence of foul air may cause the following symptoms:
   (a) laboured breathing
   (b) increased pulse rate
   (c) headache
   (d) nausea
   (e) a hot clammy feeling.

(2) Foul air can be detected by conducting a naked flame test with a cigarette lighter. The flame of the lighter will be diminished in the presence of foul air.

b. Disease Caused by Histoplasmosis. Histoplasmosis is a lung disease caused by inhaling the spore of a fungus that lives in bat guano. If untreated Histoplasmosis may cause death. Two to three weeks after exposure, the following symptoms may appear:
   (1) fever and night sweating
   (2) pain around lungs
   (3) shortness of breath
   (4) dry coughing.

11. Personnel who are displaying the listed symptoms after a caving activity are to seek medical advice.

General Safety Precautions for Horizontal Caving Activities

12. When conducting a caving activity the following general safety precautions must be observed:
   a. A minimum group size of four personnel is required.
   b. Cavers must wear UIAA-approved helmets at all times while in the cave.
c. For complex caves navigation equipment including a map and compass must be carried by each group.
d. Details of the activity, estimated time of return and the route taken must be left with a competent authority.
e. The OIC/GL is to know the procedures used by the local civilian cave rescue emergency authorities capable of responding to an emergency requiring both horizontal and vertical cave rescue techniques.
f. Knowledge of the cave should be obtained before the activity commences, in particular dangerous areas, known hazards, and alternate exits.
g. Where travelling in a cave requires participants to move over rock using climbing techniques, greater than 2 m above the cave floor, or where the consequences of a fall could prove serious, the participant is to be belayed or protected.
h. When the cave requires lead-climbing techniques, an appropriately qualified lead climber is to be included in the caving party.
i. The potential dangers posed by unstable rock or collapse are always to be considered. The GL is to take all reasonable steps to avoid known areas where this hazard exists.
j. The GL is to work to the known level of ability of their participants, particularly when in caves with vertical sections, tight squeezes or difficult navigation, and appropriate to their experience and training.
k. Participants are to have a minimum of two light sources when in a cave. Where appropriate, these light sources are to have spare batteries and bulbs and must be on their person not in a bag.

Safety Precautions for Vertical Caving Activities

13. When conducting a caving activity involving vertical caving techniques, where abseiling and ascending are required either
at the entry or exit, or within the cave, the safety requirements detailed in paragraph 8 are to be applied. In addition, the following safety precautions are to be observed:

a. Each caving ladder is to be secured to a minimum of a fail-safe anchor point.

b. When descending by rope into unknown depth, a knot large enough to block the descent device is to be tied at least 1 m from the end of that descent line.

c. The descending and ascending rope should be secured to two independent fail-safe anchor points (where possible).

d. When ascending using caving ladders, personnel must be either top belayed or self-belayed in accordance with Chapter 13.

e. The OIC/GL must inspect all anchor points and the security of the ladder prior to an activity and, where appropriate, inspect them for security during an activity.

General Equipment Safety Precautions

14. The following precautions apply to the inspection, transport and storage of caving equipment:

a. The OIC or GL of each group must supervise the daily inspection of all equipment before, during and after use.

b. All safety equipment used is to be used in accordance with manufacturers’ specifications.

c. The OIC of the activity must ensure that all caving equipment is stored, transported and used correctly.

d. The GL of each group must assist the OIC, and conduct regular inspections of the equipment for which they are responsible, during the conduct of the activity.

e. All associated caving and abseiling stores are to be used for the activity only, and are to be stored separately from general stores in a shaded, well-aired area away from
fuel, chemicals or any other substance likely to cause
them damage.

f. Any equipment found unserviceable or considered
unsafe by a UATL or equivalent, or where the slightest
doubt exists, is to be tagged and immediately withdrawn
from use. Tagged equipment is to be returned for
disposal action.

Individual Equipment Requirements

15. The following is the minimum individual equipment required to
be carried by a participant:
   a. a UIAA-approved helmet
   b. two independent light sources (with spare batteries and
      bulbs as required)
   c. protective clothing (overalls are recommended)
   d. emergency rations
   e. a container for human waste
   f. a whistle.

16. For caving activities that involve ascending and descending by
ropes or ladders the requirements in Annex A must to be
adhered to.

Group Rescue Equipment Requirement

17. The following is the minimum group equipment required for a
caving activity:
   a. navigation equipment including a map and compass as
      required
   b. rescue ropes (vertical caves only)
   c. a first aid kit
   d. a survival blanket.

18. See Appendix 1 for the caving safety brief.
Appendix:

1. Safety Brief – Caving
1. **Appointments:**
   a. activity commander
   b. OIC
   c. UATL(s)/GL(s)
   d. medic
   e. driver (safety vehicle).

2. **Locations:**
   a. safety vehicle
   b. keys for safety vehicle
   c. OIC/medic
   d. medical kit
   e. safety case with emergency phone numbers.

3. **Communications:**
   a. primary communications
   b. secondary communications
   c. frequencies and phone numbers
   d. unlock codes and PIN numbers.

4. **Location information:**
   a. current location
   b. nearest hospital
   c. route to hospital
   d. all maps and hospital numbers are located
   e. weather forecast
5. **Actions-on:**
   a. lost/separated
   b. casualty
   c. hearing the distress signal
   d. no communications
   e. broken or dropped equipment
   f. what is to occur in adverse weather.

6. **Equipment:**
   a. continue to check equipment
   b. do not remove your equipment until advised to do so by a UATL
   c. if your equipment is removed, ensure that it is rechecked by a UATL
   d. do not drop any equipment (explain)
   e. no smoking while wearing or near equipment
   f. do not leave equipment lying around
   g. tuck away all loose clothing and hair and remove rings and watches
   h. do not stand on ropes.

7. **Abseiling/Ascending:**
   a. helmets to be worn at all times within 5 m of the base of the cliff
   b. proceed no closer than 2 m from the edge without a safety line
   c. do not touch any anchor system or ropes unless directed to do so by the OIC
d. anchor systems are to be dismantled only on the order of the OIC

e. explain routes up and down

f. do not run

g. do not throw anything

h. anything dislodged or seen falling shout ‘BELOW’

i. on hearing ‘BELOW’ move in towards the pitch face, do not look up

j. use clear abseiling calls

k. pay attention to leaders at all times

l. report any injuries to leaders.

8. Caving specific:

a. route to and from caves

b. dangers of bat guano

c. foul air/CO₂

d. light discipline

e. eating in the cave

f. all human waste is to be removed from the cave

g. avoid marking of cave

h. do not disturb life forms

i. do not souvenir

j. all rubbish is to be removed.
ANNEX D TO CHAPTER 1

SAFETY INSTRUCTIONS FOR ADVENTUROUS TRAINING TOP ROPE CLIMBING ACTIVITIES

1. This annex details specific safety instructions for the conduct of top rope climbing activities.

2. This annex does not cover safety instructions for climbing activities conducted on climbing walls. These are contained in Chapter 22.

Group Leader/Participant Supervision Ratio

3. Ratios are to be determined by a risk appreciation process, with the following factors taken into consideration:
   a. level of difficulty of the activity and skills required
   b. anticipated environmental conditions, remoteness, difficulty and duration of the activity
   c. leader experience and knowledge of the area
   d. the identified capabilities of participants (ie, experience, competence)
   e. land managers or relevant authorities may suggest ratios that differ from those recommended; if these suggest a ratio with fewer participants per leader or per activity, they will be regarded as the overriding requirements.

4. Paragraph 5 to paragraph 8 indicate the general ratios that are considered acceptable during a defence activity.

Single-pitch Top Rope Climbing

5. One UATL/ATLI is to supervise up to two active ropes during a top rope climbing activity.
6. The distance between the ropes must be such that the GL can control them at all times, both visually and using verbal communications.

Multi-pitch Top Rope Climbing

7. One UATL/ATLI or equivalent can supervise one ledge.

8. Ratios should be set by a qualified person with detailed knowledge of the activity, location, equipment and the group.

Specific Activity Requirements

9. Wet rock becomes slippery and increases a climber's chances of falling. Top rope climbing may be conducted on wet rock in light rain only.

General Safety Precautions

10. The following general safety precautions must be observed when conducting AT top rope climbing activities:
   a. The climbing rope should be a single or double rope.
   b. Personnel belaying a climber from below are to be secured to the ground by an anchor point.
   c. Personnel belaying a climber from above must be secured to the rock by a belay point to prevent them from being dislodged in the event that the climber falls.
   d. Climbers, belayers and personnel within 5 m (or a distance nominated by the GL) must wear helmets.
   e. The OIC/GL must inspect all belay points prior to their use and, where appropriate, inspect them for wear and security during the activity.
   f. Belayers must have a hand acting as a brake on the rope at all times that the rope is active.
   g. When novices are belaying, a second belayer is to be used as a backup belayer. One person is to belay the climber and the other is to have hold of the rope so that a fall can be arrested if the belayer fails to apply the brake. Participants are to be assessed by the OIC as
having sufficient ability and skill before they can belay a climber without assistance.

h. The OIC/GL must ensure that other personnel do not interfere with the belayer or walk below a climber.

i. All personnel are to be tied into the harness using a rethreaded figure-eight knot (clipping in using a single locking karabiner is not acceptable).

j. A safety brief must be given before the activity commences.

Safety Precautions for Top Rope Climbing Anchors

11. The following precautions must be observed when constructing or dismantling top rope climbing anchors:

a. For top rope climbing activities, an anchor system consisting of two independent anchor points must be used.

b. At the culminating point of the anchor system two locking karabiners must be used.

c. All other karabiners used in the anchor system should be a single locking or two opposed and reversed clip gate karabiners.

d. The OIC or GL must inspect all anchor systems prior to their use, and where appropriate inspect them for wear and security at regular intervals during the activity.

e. Prior to dismantling an anchor system, the GL must ensure that no person is dependent on that system. The climbing rope is to be retrieved prior to dismantling the anchor.

f. Where an anchor system uses artificial protection, two pieces of protection form one anchor point. Only passive protection may be used.
Contents

Safety Precautions for Bouldering

12. The following precautions are to be observed when bouldering on rock faces or artificial walls:
   a. Personnel are not to climb more than 2 m above the ground. The height is measured from the ground to a person’s feet.
   b. A person bouldering is to have another person standing behind them ready to steady the climber in the event of a fall when bouldering on an overhang or when above uneven ground.

Safety Precautions for Equipment

13. The following precautions must be applied to the inspection, transport and storage of equipment:
   a. The OIC or GL of each group must supervise the daily inspection of all equipment before, during and after use.
   b. All safety equipment used is in accordance with manufacturers’ specifications.
   c. The OIC of the activity must ensure that all top rope climbing equipment is stored, transported and used correctly.
   d. The GL of each group must assist the OIC and undertake regular inspections of all equipment during the conduct of the activity.
   e. All associated climbing stores are to be used for the activity only, and are to be stored separately from general stores in a shaded, well-aired area away from fuel, chemicals or any other substance likely to cause them damage.
   f. Any equipment found unserviceable or considered unsafe by a UATL or equivalent, or where the slightest doubt exists, it must be tagged and immediately withdrawn from use.
Equipment Requirements

14. The minimum equipment to be used by a climbing party conducting a top rope climbing activity is as follows:
   a. a UIAA-approved helmet per person
   b. one whistle per person
   c. an approved harness for each climber and belayer
   d. an approved belay device and locking karabiners for each top rope system
   e. dynamic or static rope for the climbing rope.

Group Rescue Equipment Requirement

15. The group rescue equipment required for a top rope climbing activity is as follows:
   a. rescue rope
   b. spare locking karabiners
   c. a pulley
   d. a first aid kit.

16. See Appendix 1 for the climbing safety brief.

Appendix:

1. Safety Brief – Climbing
APPENDIX 1 TO ANNEX D TO CHAPTER 1

SAFETY BRIEF – CLIMBING

1. Appointments:
   a. activity commander
   b. OIC
   c. medic
   d. UATL(s)/GL(s)
   e. driver for safety vehicle.

2. Locations:
   a. safety vehicles
   b. keys for the safety vehicle
   c. OIC/medic
   d. first aid kit
   e. safety case with Emergency phone numbers.

3. Communications:
   a. primary communications
   b. secondary communications
   c. frequencies and telephone numbers
   d. the unlock codes and pin numbers.

4. Location information:
   a. current location
   b. the nearest hospital
   c. the route to the hospital
   d. all maps and hospital numbers are located
   e. weather forecast
5. Actions-on:
   a. lost/separated
   b. casualty
   c. hearing distress signal
   d. no communications
   e. broken or dropped equipment
   f. what is to occur in advised weather.

6. Equipment:
   a. continue to check equipment
   b. do not remove equipment until instructed to do so by a UATL
   c. if equipment is removed, once refitted it is to be checked by a UATL
   d. do not drop any equipment (explain)
   e. no smoking while wearing equipment or near equipment
   f. do not leave equipment lying around
   g. tuck away loose clothing/hair
   h. remove or place tape around rings and watches
   i. do not stand on ropes.

7. Climbing procedure:
   a. helmets to be worn at all times within 5 m of the base of the cliff
   b. proceed no closer than 2 m to the edge without a safety line
   c. do not touch any anchor systems or ropes unless directed by the OIC
d. anchor systems are to be dismantled only on the order of the OIC

e. explain the route up and down

f. do not run

g. do not throw anything

h. if anything is dislodged or seen falling, shout ‘BELOW’

i. On hearing ‘BELOW’, move in towards the pitch face, do not look up

j. use clear climbing calls

k. pay attention to leaders at all times

l. report any injuries to leaders.

8. When bouldering, no participant is to climb above 2 m from the ground, and participants are to use bouldering mats or a spotter.
ANNEX E TO CHAPTER 1
SAFETY INSTRUCTIONS FOR
ADVENTUROUS TRAINING LEAD CLIMBING
ACTIVITIES

1. This annex details specific safety instructions for the conduct of
lead climbing activities.

Group Leader/Participant Supervision Ratio

2. Ratios are to be determined by a risk appreciation process, with
the following factors taken into consideration:
   a. level of difficulty of the activity and skills required
   b. anticipated environmental conditions, remoteness,
difficulty and duration of the activity
   c. leader experience and knowledge of the area
   d. the identified capabilities of participants (ie, experience,
competence)
   e. land managers or relevant authorities may suggest
ratios that differ from those recommended; if these
suggest a ratio with fewer participants per leader or per
activity, they will be regarded as the overriding
requirements.

Single-pitch Lead Climbing

3. One UATL/ATLI can supervise one rope.

Multi-pitch Lead Climbing

4. One UATL/ATLI is required per active belay stance.

General Safety Precautions

5. When conducting a lead climbing activity involving abseiling
and ascending, the safety requirements detailed in Annex A
must be applied. In addition, the following general precautions must be observed when conducting lead climbing AT activities:

a. A minimum group size of four personnel is required.

b. Knowledge of the climb must be obtained before the climb is commenced; in particular the grade, route up and down, and alternate exits.

c. During multi-pitch climbs, a guidebook or details of the climb are to be carried by each climbing party.

d. During multi-pitch climbs, each group is to carry the appropriate equipment to conduct an abseiling retreat from the climb.

e. The OIC/GL is to know the procedures used by the local civilian rescue emergency authorities capable of responding to an emergency requiring vertical rescue techniques.

f. The potential dangers posed by loose or unstable rock are always to be considered. GL must take all reasonable steps to avoid known areas where this hazard exists.

g. GL must work to the known level of ability of their participants, particularly during multi-pitch climbs.

h. Single or double dynamic climbing ropes are only to be used for lead climbing activities.

i. A UIAA-approved helmet is to be worn at all times when lead climbing, belaying or when closer than 5 m to the base of the cliff or as determined by the GL.

j. Whenever a harness is fitted, it must be checked by a GL.

k. All novice climbers must receive a safety check prior to and during their ascent.

l. All personnel are to be tied into the harness using a rethreaded figure-eight knot.
m. When lead climbing, protection is to be used when more than 2 m above the ground and at appropriate intervals to prevent the climber from striking the ground in the event of a fall.

n. The first piece of protection should be placed for an upward and outwards pull from a falling climber. This is to prevent other subsequent protection from being dislodged (zipper effect).

o. When at the top of the climb, personnel must be secured by rope to a belay or anchor point if closer than 2 m to the edge of a cliff. During a multi-pitch climb, all personnel are to be secured to the rock face unless they are more than 2 m from the cliff edge and walking off the climb.

p. A safety brief must be given before any lead climbing activity commences (see Appendix 1).

General Precautions for Belay

6. The following precautions must be observed when constructing, dismantling and/or conducting a climbing belay:

a. At all times when belaying a lead climber, the person belaying is to be secured to the rock or ground by a belay point to prevent them from being dislodged in the event a climber falls.

b. Where personnel are belaying a lead climber from below, they must be secured to the ground by a belay point positioned for an upward pull.

c. Where personnel are belaying a second or subsequent climber from above, they must be secured using a belay point consisting of a minimum of two pieces of protection sharing an equal load and positioned for a downward pull.

d. During multi-pitch climbing, personnel who are belaying must be secured to the rock using a belay point
consisting of a minimum of two pieces of protection for a downwards pull, sharing an equal load.

e. If subsequent pitches are required, one piece of protection for an upwards pull must be placed.

f. Where possible, the OIC/GL must inspect all belay systems prior to their use, and where appropriate, inspect them for wear and security during their use.

g. All belays are to be constructed in such a way that the belayer can safely escape from the system. Where the belay position is at height, belayers must remain on a safety line when escaping from the system, in order to prevent a fall.

h. Belayers must have a hand acting as a brake on the rope at all times that the rope is active.

General Equipment Safety Precautions

7. The following precautions apply to the inspection, transport and storage of lead climbing equipment:

a. The OIC/GL of each group must supervise the daily inspection of all equipment before, during and after use.

b. All safety equipment used is in accordance with manufacturers' specifications.

c. The OIC of the activity must ensure that all lead climbing equipment is stored, transported and used correctly.

d. The GL of each group must assist the OIC, and conduct regular inspections of all equipment during the conduct of the activity.

e. All associated climbing stores are to be used for the activity only, and are to be stored separately from general stores in a shaded and well-aired area away from fuel, chemicals or any other substance likely to cause them damage.

f. Any equipment found unserviceable or considered unsafe by a UATL or equivalent, or where the slightest...
doubt exists, is to be condemned, tagged and immediately withdrawn from use. Condemned equipment is to be returned for disposal action.

Equipment Requirements

8. The minimum equipment required by each person participating in a lead climbing activity is as follows:
   a. a UIAA-approved safety helmet
   b. a whistle
   c. an approved harness
   d. an approved belay device and a locking karabiner
   e. two 2 m accessory cords.

Group Equipment Requirement

9. The group equipment required for a lead climbing activity is as follows:
   a. dynamic climbing rope (per pair)
   b. appropriate climbing hardware for the planned climb (per party)
   c. pulleys.

Appendix:

1. Safety Brief – Lead Climbing
APPENDIX 1 TO ANNEX E TO CHAPTER 1

SAFETY BRIEF – LEAD CLIMBING

1. Appointments:
   a. activity commander
   b. OIC
   c. medic
   d. UATL(s)/GL(s)
   e. driver (safety vehicle).

2. Locations:
   a. safety vehicle
   b. keys for the safety vehicle
   c. OIC/medic
   d. medical kit
   e. safety case with emergency phone numbers
   f. SAR plan.

3. Communications:
   a. primary communications
   b. secondary communications
   c. frequencies and telephone numbers
   d. unlock codes and pin numbers.

4. Location information:
   a. current location
   b. nearest hospital
   c. route to the hospital
   d. all maps and hospital numbers are located.
5. Actions-on:
   a. lost/separated
   b. casualty
   c. no communications
   d. hearing distress signal
   e. broken or dropped equipment
   f. what is to occur in advise weather.

6. Equipment:
   a. continue to check equipment
   b. do not remove equipment until instructed to do so by a UATL
   c. if equipment is removed, once refitted it is to be rechecked by a UATL
   d. do not drop any equipment (explain)
   e. no smoking while wearing equipment or near equipment
   f. do not leave equipment lying around
   g. tuck away loose clothing/hair
   h. remove or place tape around rings and watches.

7. Climbing procedure:
   a. helmets to be worn at all times within 5 m of the base of the cliff
   b. move no closer than 2 m to the edge without a safety line
   c. do not touch any anchor systems or ropes unless directed by the OIC
   d. anchor systems are to be dismantled only on order by the OIC
   e. do not run
   f. do not throw anything
1E1-3

- if anything is dislodged or seen falling shout 'BELOW'
- on hearing 'BELOW', move in towards the pitch face, do not look up
- use clear climbing calls
- explain routes up and down
- pay attention to leaders at all times
- report any injuries to leaders.
CHAPTER 2  
EQUIPMENT

SECTION 2-1. EQUIPMENT USED FOR ADVENTUROUS TRAINING ROPING

2.1 The purpose of this chapter is to outline the identification, care, maintenance and inspection requirements for AT roping equipment.

2.2 While there are many standards of compliance for the manufacture of roping equipment (including Australian standards), the most relevant are the international standards of the UIAA\(^1\). Australian standards for AT roping equipment are usually based on Conformité Européenne\(^2\) (CE) standards but may have additional requirements above this standard. Only equipment that meets the CE or UIAA standards should be used for AT roping activities.

2.3 One of the styles of testing that the UIAA and CE use is 3-Sigma. This is a statistical quality control method to rate ultimate product strength. The test is conducted on a sample from a batch of equipment and uses standard deviation to confirm that 99.87 per cent of equipment will be above the standard. Another style is to test each piece of equipment individually.

2.4 **Entitlements for Adventurous Training Roping Equipment.**

As roping equipment is attractive by nature, its availability is regulated via **Block Scale 19/07, Army Adventurous Training Regional Loan Pool Equipment.** This block scale essentially outlines the distribution and entitlements of equipment throughout the Army. This scale has scope for constant

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1. This is usually translated as the International Mountaineering and Climbing Organisation or ‘Union International Association of Alpinists’ in English.
2. This translates to ‘European Conformity’ in English.
Contents

SECTION 2-2. ROPE

2.5 Maintenance and user inspection of all roping equipment is to be in accordance with Technical Regulation of ADF Materiel Manual – Land (commonly known as TRAMM-L) and Electrical and Mechanical Engineering Instructions (commonly known as EMEIs). Other sources of reference available on the maintenance, storage and inspection of AT roping equipment include manufacturers’ handbooks and guidelines.

2.6 Rope is the most important part of any activity involving abseiling and climbing. There is a clear distinction between rope designed for abseiling and rope designed for climbing. Climbing ropes have a lower abrasion resistance and a high-energy absorption capacity when compared to abseiling ropes. Abseiling ropes offer higher abrasion resistance and a lower ability to absorb energy. In simple terms: climbing ropes stretch and are said to be ‘dynamic’; abseiling ropes do not stretch as much and are said to be ‘static’.

Rope History

2.7 During its infancy, climbing ropes were made of natural fibres (such as manila, hemp and sisal) and were used to protect climbers. However, these ropes were not reliable for holding severe falls, and had little stretch. The development of nylon ropes by the DuPont Company during WWII changed roping activities forever. Suddenly, climbers were offered lightweight lines capable of bearing more than 2 t. The nylon ropes also had the remarkable quality of elasticity. Rather than bringing a fallen climber to an abrupt, jolting stop, the nylon ropes stretched to dissipate much of the force of the fall. The first nylon ropes were of ‘laid’ or ‘twisted’ construction. Similar to braided hair, these ropes were composed of many thin nylon filaments bunched into three or four major strands which were then woven together to form the rope. The early nylon ropes were years ahead of natural fibre ropes, but they were stiff to
handle and created substantial friction when run through the points of protection used by climbers. Also, they stretched too much when climbers ascended the rope.

2.8 In 1951, the Edelrid Company introduced kernmantle ropes and soon all twisted nylon ropes were replaced by kernmantle ropes, designed specifically for climbing. Today's kernmantle ropes are composed of a core (kern) of braided or parallel nylon filaments encased in a smooth, woven sheath (mantle) of nylon. Kernmantle rope maintains the advantages of nylon but improves upon the problems associated with twisted ropes such as stiffness, friction and excessive elasticity. Kernmantle ropes are now the only climbing ropes used and are the only ropes approved by the UIAA for climbing and abseiling activities.

Requirements

2.9 There are two distinct activities requiring rope:
   a. climbing or belaying
   b. ascending/descending fixed lines.

2.10 These activities demand entirely different characteristics of a rope.

2.11 Climbing or Belaying. For the climber, the greatest characteristic a rope can possess is that of arresting a falling climber, as gently as possible. This calls for a very strong and elastic rope. For this reason, activities involving lead climbing and top rope climbing should use dynamic ropes. Belaying a person to prevent a fall on cliff sites or ledges can also be done on dynamic ropes.

2.12 Ascending/Descending. For ascending and descending (including caving and canyoning), rescue, haulage and casevac, strong non-elastic ropes are most suitable. Activities such as these should use static ropes.

Strength

2.13 The most often used measure of strength of nylon ropes and accessory cords is static breaking strength. This is measured
in kilonewtons. A newton is the unit of force that acts for 1 second on a mass of 1 kg that gives it a velocity of 1 m per second. That is: 1 kN approximately equals 100 kg (as gravity equals approximately 10 m/s each second). For example, an accessory cord with a breaking strain of 5 kN can hold a static load of 500 kg or a load of 50 kg in a 1 second fall.

Static Rope

2.14 Static ropes have low stretch, high strength and a high abrasion resistance. Static ropes have the following characteristics:

a. **Stretch.** A static rope stretches approximately 2 per cent under a constant 80 kg load.

b. **Strength.** The tensile strength or static strength has been measured under laboratory conditions. The strength of ropes varies with diameter and manufacturer. CE and UIAA standards define static ropes as follows:

   (1) **Type A Ropes.** Type A ropes are designed for rescue, rope access, work positioning, or as a working or security line for work at height. Type A ropes are greater than 9.5 mm in diameter, and must have a minimum static breaking strain of 22 kN. Typical 11 mm static ropes have a static breaking strain of 30 kN.

   (2) **Type B Ropes.** Type B ropes are ropes of lesser diameter and strength than Type A ropes, demanding greater precautions and attention to security during use. Type B ropes are 9.5 mm or less in diameter, and must have a minimum static breaking strain of 18 kN. Typical 9 mm static ropes have a static breaking strain of 20 kN.

Dynamic Rope

2.15 Dynamic ropes incorporate good elongation with strength and elasticity to allow the rope to absorb energy during a fall. They also have flexibility, softness, ease of knotting, resistance to kinking and resistance to abrasion.
2.16 Dynamic ropes have the following characteristics:
   a. *Stretch.* A dynamic rope stretches approximately 6 to 8 per cent under an 80 kg load.
   b. *Strength.* The tensile strength of a dynamic rope varies with diameter and manufacture. A guideline for breaking strains is:
      (1) 11 mm – approximately 2400 kg
      (2) 9 mm – approximately 1800 kg.

2.17 Dynamic climbing ropes are also divided into the following three types by their use:
   a. *Single Rope.* Single ropes are generally from 9.4 to 11 mm in diameter, and are suitable for top rope climbing and leading. Single climbing ropes may also be used with double-rope and twin-rope techniques.
   b. *Double Ropes.* Double ropes are generally from 8 to 9 mm in diameter, and are suitable for lead climbing with the double-rope or twin-rope technique.
   c. *Twin Ropes.* Twin ropes are generally from 7 to 9 mm in diameter, and are suitable for lead climbing with the twin-rope technique only. Twin ropes must never be used for the double-rope technique.

2.18 Dynamic climbing ropes are marked according to their type. The UIAA standard markings for dynamic climbing ropes are shown in Figure 2–1.

![Figure 2–1: International Standard Markings for Dynamic Climbing Ropes](image-url)
Due to lower abrasion resistance dynamic ropes are not normally used for specific abseiling activities.

Rope Characteristics

Both static and dynamic kernmantle ropes have the following characteristics:

- they are light and supple
- they absorb little water
- they do not rot or suffer from mildew
- they are affected by acids, alkalis, oxidising agents, UV light, POL and bleaching compounds
- they have a low melting point of between 200 to 230 °C.

Construction. Kernmantle ropes are constructed using continuous nylon fibres. The rope consists of a core (kern) and sheath (mantle). The core provides 75 per cent of a rope’s strength. They are characterised as follows:

- Core. The core is the inner part of the rope, which consists of nylon filaments. This is the main load-bearing section of the rope. The core provides the dynamic properties of a rope. The manufacturing process used to create the core determines the elongation of the rope.

- Sheath. The sheath contributes 25 per cent of the rope’s strength. The sheath is braided around the core, protecting it against abrasion. The construction of the sheath makes it easier to grip the rope. The sheath on a dynamic rope has a loose weave, compared to the sheath of a static rope, which has a much tighter weave. The construction of a kernmantle rope is shown in Figure 2–2.
Modern dynamic kernmantle rope has a coloured mantle. One reason for this is to allow the rope to be easily distinguished on ice or snow. This helps to prevent damage to the rope by crampons. In addition, the coloured mantle helps distinguish ropes when climbing on double ropes. The coloured mantle also exerts a certain control function. If the rope is severely damaged, the now-visible white kern is a distinct warning. Dynamic climbing ropes have a multicoloured pattern running along their length that also indicates the year of manufacture. UIAA standards dictate that static ropes must be of one main colour, which must consist of 80 per cent of the visible mantle. They may have additional spiral threads in a maximum of two
different colours along the length of the rope. This control ensures that dynamic ropes and static ropes are easy to differentiate.

2.23 **Uses.** Kernmantle ropes come in various diameters and lengths. The diameter of the rope and its characteristics will determine the best use for that rope. Some common uses for rope types include:

a. 6 mm static – catcher’s loops
b. 7 mm static – catcher’s loops, runners and slings
c. 9 mm static – top belaying, abseiling when doubled, and haul lines
d. 11 mm static – abseiling, haul lines and rescue
e. 9 mm dynamic – climbing when doubled; mountaineering
f. 10.5 mm dynamic – lead climbing and mountaineering
g. 11 mm dynamic – top rope climbing.

2.24 **Accessory Cord.** Kernmantle static ropes of 8 mm or less are referred to as accessory cord. Static accessory cord has many uses, such as ascending, rescue and the construction of catcher’s loops, slings and runners. Care and maintenance is the same as for rope. Accessory cord is subject to *British Standard European Norm 564:2014, Mountaineering equipment – Accessory cord – Safety requirements and test methods*, and *UIAA 102, Accessory Cord, 2013*.

**Care and Maintenance of Rope**

2.25 Ropes are weakened by normal wear and tear or contact with elements such as chemicals, POL, heat and UV light. Constant care and inspection of ropes is essential to avoid injury or loss of life. Rope and cord damage occurs in the following ways:

a. **External Wear.** This is caused by friction when the rope comes into contact with other objects in various ways. It is usually identified by a furry sheath. Descending devices can leave the sheath with a blackened
appearance from the wear of the descender. This causes stiffening of the rope. External wear can be over the length of a rope, or localised to a specific wear point. Fuzziness on the surface of a rope occurs as individual fibres of the sheath are broken. When the ratio of broken to unbroken fibres reaches 50 per cent of the sheath strands, the rope should be retired. This does not take into account other trauma that may have occurred to the rope. The method of inspection for areas of sheath damage is to try to part the sheath with your fingernails. If the sheath can be parted to expose any part of the rope’s core, that section of the rope should be cut off or the rope should be retired.

b. **Cuts.** Cuts are caused by sharp-edged objects coming into contact with the rope. This damage will be more severe should the rope be under load. This may cause internal as well as external damage.

c. **Overloading.** A severe shock load to the rope causes overloading. Permanent stretching may result from a shock load so that reserves of extension in an emergency are reduced. A static rope is to be discarded after a severe shock loading if an OIC, UATL, or ATLI determines that the core of the rope has been damaged. This can be measured if the original length of the rope is known. The stretch should not exceed 5 per cent for nylon rope over the piece that was overloaded. This is measured after the rope has been rested for 24 hours.

d. **Chemical Action.** Chemical action can occur in many forms and all types of rope are susceptible to it. Chemical action may be recognised by local weakening and the softening of surface fibres, enabling them to be plucked easily, or rubbed as powder in serious cases. Any rope that is suspected of coming into contact with POL, acids or any contaminant is to be discarded.

e. **Heat.** Heat will severely damage ropes. Ropes, accessory cords and tapes should never be stored near any source of direct heat. Ropes are never to be dried by
2.26 **Sunlight.** Over a period of time, UV rays have a damaging effect on rope. Ropes are not to be stored or left in the sun longer than is necessary. While bright colours fade more quickly, UV damage is consistent for all nylon ropes, cords, and tape, regardless of colour. The time of exposure, rather than the colour fade, is the determining factor.

2.27 **Internal Wear and Inspecting for Damage.** Damage to the core of the rope is of the greatest significance to the rope user. Harm to the core consists of filament or yarn breakage and slight retraction. If enough strands rupture, a localised reduction of the diameter of the rope results. This can be felt or seen while handling ropes. Inspections of ropes by qualified personnel should be done before, during and after roping activities. This is done by running the rope through your fingers, looking and feeling for abnormalities. Placing the rope under tension can assist in checking suspected areas. This will separate any broken strands and emphasise any deformities.

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**WARNING**

If there is clearly a noticeable difference in the diameter of the rope, it is to be red tagged and immediately withdrawn from use. What appears to be core damage may be limited to the mantle, however, when in doubt, it is to be tagged. It is the damage that cannot be seen that makes a rope unsafe potentially causing serious injury to personnel, or death.

2.28 **Washing of Ropes.** Dirty or muddy rope should be washed in cold water with rope wash, rope cleaner (available from rope manufacturers), or pure mild soap flakes. Emphasis should be placed on the water and cleaning agent being allowed to pass through the core rather than having a clean sheath. The rope must be rinsed completely of cleaning agent. The rope should then be dried in a cool, shaded area away from direct heat or sunlight.
2.29 A rope can be daisy chained (also known as chain braiding) prior to washing. This will assist in handling the rope when cleaning it using a washing machine or tub. Hand washing in a tub is the safest method of cleaning a rope. If a washing machine is used, consideration should be given to placing the rope into a pillowcase if it is not braided. Another method that may be used to clean ropes is a rope brush. This item encases the rope and has bristles that scrub the rope.

2.30 **Drying Ropes.** To dry ropes ensure that they are hung in a well-ventilated area away from direct sunlight (where possible) and free from knots and kinks. Ropes should not be dried in a daisy chain.

2.31 **Rope Register.** Ropes should be regularly inspected to ensure that the rope is still serviceable. A rope register should be maintained at each AT equipment store detailing all relevant details for each rope, covering the date of purchase, age, length, dates used and duration of use. UATLs are to inspect ropes on issue and return and where they assess a rope has been damaged due to abrasion, shock loads and/or falls the rope is subjected to they are to be marked for destruction and returned into their unit Q Store for disposal, not returned to the store. An example rope register is shown in Annex A.

2.32 **Serviceability of Rope.** Rope is to be red tagged if any of the following apply:

a. when there is any doubt as to the residual strength of the rope

b. where there are signs of deterioration caused by contact with direct heat, chemicals or other harmful agents including excessive UV light exposure

c. where severe shock loading has inflicted damage to internal filaments

d. when the mantle is badly worn through abrasion (strands have 50 per cent wear or can be parted to expose the core)
When the rope reaches its retirement age (manufacturer’s specifications), and/or if the history of the rope is unknown or it does not have a current rope register.

2.33 Storage of Ropes. Ropes are to be stored with the following considerations:

a. Ropes are to be stored in a cool, dry, well-aired place away from direct sunlight or any source of heat.

b. Ropes are not to be stored directly on the floor or on the ground.

c. Ropes are not to be stored near chemicals or other agents that may damage rope.

d. Ropes are not to be stored under tension.

e. Ropes that are wet are to be hung to dry in a well-ventilated position away from direct heat.

f. Ropes and accessory cords are to be coiled and stored in accordance with Chapter 4.

2.34 Transport. Ropes should preferably be transported in trunks to prevent them from being crushed under other objects and away from any chemicals that may be present in vehicles. Ropes may also be transported in rope bags, either improvised or special-purpose rope bags. If these are unavailable, rope should be placed on top of all other equipment.

SECTION 2-3. TAPES AND WEBBING

2.35 Nylon tape (or webbing) can be used for anchors, harness construction, or other general tasks. The most common size in use is 25 mm, with a static breaking strain of 1800 kg. Nylon tape is subject to British Standard European Norm 565:2017, Mountaineering Equipment – Tape – Safety requirements and test methods, and UIAA 103, Tape. Nylon tape is susceptible to the same damage as rope. It has a lower abrasion resistance.
than static rope and should always be padded when used on sharp or rough surfaces.

2.36 Characteristics of Nylon Tape. Two types of nylon tape are available: flat webbing and tubular tape. Nylon tubular tape is used primarily for slings and improvised harnesses, while flat webbing is used in the construction of commercially produced harnesses. It is produced in 10 to 50 mm widths. Nylon slings can be produced sewn or cut and knotted.

Other Materials

2.37 Tape manufactured from Dyneema® and Spectra® fibres are available. The advantage this offers over traditional nylon is durability, a low-weight, high-cut resistance, extreme strength and low water absorption. These qualities make it extremely advantageous in alpine climbing. Dyneema and Spectra tapes must be kept out of contact with hot descending devices.

2.38 Dyneema and Spectra slings are only to be used when still in the original sewn state produced by the manufacturer.

Slings

2.39 A sling is a continuous loop of generally 10 to 25 mm wide nylon webbing, Spectra or Dyneema, and is of a tubular design. Most slings are pre-stitched but nylon slings can be constructed with a tape knot. Slings are used on many tasks from extending protection on a climb to being used as an anchor or a belay point.

Quickdraws

2.40 A quickdraw is a combination of two clip gate karabiners joined by a sewn sling or loop sling of 25 mm nylon tube tape (see Figure 2–3). Quickdraws are used to extend the rope away from placed protection.

2.41 Quickdraws usually consist of a straight gate clip gate karabiner (used for clipping into the protection), a variable length of looped or sewn sling and a bent gate clip gate karabiner (used for clipping the rope into the karabiner). Two straight gate clip gate karabiners are also suitable, but two bent
gate clip gate karabiners are not. Most climbers use quickdraws made with commercially available sewn slings of various lengths, as these often have more rigidity and are easier to use.

Figure 2–3: Quickdraw

Nylon Tape Care, Maintenance, Storage and Washing

2.42 As both tape and rope are made of similar materials and substances, identical procedures and precautions for the care and handling also apply to tape.
WARNING

When the tape is first removed from the roll; any joins in the tape are to be identified. While such joins are contrary to UIAA guidelines, they do occur. These joins are usually held with white tape or a pin. These joins are not to remain within a length of tape as they will separate under load causing serious injury to personnel, or death.

2.43 Nylon tape, as with rope, should be regularly inspected to ensure that it is safe for use. Inspecting the condition of the tape will allow the user to assess its serviceability. The following factors are to be taken into consideration when inspecting any type of tape:

a. age of tape (exposure to elements, water, and UV rays)

b. stitching

c. buckles (on tape harnesses)

d. visual signs of damage, similar to the requirements for rope inspection

e. heat damage, stiffness or evidence of wear points, and/or

f. any visual signs of deterioration (such as chemical, POL or rodent damage).

2.44 Of special note, the stitching in sewn items must be inspected for continuity, and for any loose threads that may have developed in the material. If the tape is part of a sling, the tape must be replaced if it has been subjected to an impact force such as that experienced during a lead climber fall.

SECTION 2-4. HARNESSSES

General Commercial Harnesses

2.45 Commercial sit harnesses are those that are manufactured specifically for roping activities. The harness is constructed
from nylon, sewn together and must have a rupture strength greater than 1800 kg. Emphasis should not only be on strength, but also comfort as it is the job of the harness to evenly distribute force over the body to prevent injury.

Canyon-specific Harness

2.46 The rear of a canyon-specific harness is reinforced with non-absorbent materials to protect wetsuits and the rear harness straps from damage (see Figure 2–4). These harnesses are effective but are not mandatory for canyoning as normal climbing harnesses can perform the same function.

Caving-specific Harness

2.47 Additional requirements for a caving-specific harnesses are as follows:

a. A harness must be comfortable, as it may be necessary to sit in it for a long time when ascending long pitches.
b. It must be lightweight and not made with lots of bulky, water-absorbing padding.

c. It should fit neatly, even tightly, without restricting leg movement. Any slack in the harness will ultimately have an adverse effect on ascending efficiency. Figure 2–5 shows an example of a cave-specific harness.

![Cave-specific Harness](image)

**Figure 2–5: Cave-specific Harness**

2.48 If a cave-specific harness is to be used, a maillon rapide (see paragraph 2.75) must be used to hold the seat together. The use of a 10 mm diameter maillon in a delta or half-round shape is recommended with a cave harness.

**Tape Harness**

2.49 A tape harness consists of 5 m of 50 mm flat tape with a buckle sewn onto one end. It can be used as a harness through a procedure that will thread the tape around the body. While not
as comfortable for long periods as a commercial sit harness, it is light and inexpensive and can be adjusted to fit a person of almost any size.

A Chest Harness

2.50 A chest harness is required for the fitting of a chest ascender and in some rescue situations. This system is useful when abseiling with heavy loads. It provides the user with an altered centre of gravity due to the raised suspension point. This reduces the risk of the user inverting during descent.

2.51 Chest harnesses are not always life support equipment. They do not need to be heavy or overly strong. Ropers often make their own chest harnesses from 25 mm tube tape, even though commercial models are available.

2.52 The chest harness used depends on the system being used and may only be required to lift a chest ascender or support some of the weight when wearing a backpack. In the event that the body needs to be upright and tightly against the rope, a strong harness with wide, strong tape may be required to support the weight. Figure 2–6 shows an example of a commercial chest harness.
Harness Care and Maintenance

2.53 Harnesses are made from nylon and are susceptible to damage in the same way as rope. Care and maintenance is the same as for rope, accessory cord and tape. The most common damage to a harness is melting to the waist strap and leg loop. Generally this occurs on the brake-hand side from poor abseiling technique, where an abseiler allows the rope to rub across the harness. Severe melting requires the harness to be condemned. If the stitching begins to break it can be repaired by a qualified rigger or the manufacturer who will guarantee their work. Otherwise, the harness must be condemned. For further information on care and maintenance of the harness, the user should refer to the manufacturer’s recommendations.

2.54 Gear loops can be replaced, if necessary, with small-diameter accessory cord and plastic tubing placed over the cord. The
harness is to be condemned if the buckle has excessive corrosion, wear or cracks, or there is any distortion.

2.55 Further information on harnesses is contained in Chapter 3.

Safety Lines

2.56 All types of safety lines are recommended to only be used while below the anchor point.

Roping Safety Line

2.57 A person scaling traverse lines, ladders and fixed lines is to be equipped with a means of bypassing anchors and runners safely. This is achieved using a safety line. The safety line is made up of a 3 to 3.5 m length of dynamic, single rope as described in paragraph 2.15, with one figure eight on a bight tied close to the centre and two barrel knots on the ends to attach to locking karabiners, as shown in Figure 2–7.

2.58 The barrel knot needs to be constantly supervised as it can untie when not under load. Figure eight on the bight knots can be used as an alternative to the barrel knot. A safety line must be replaced every two years regardless of its usage history or if a Fall Factor 2 occurs. Fall factors are discussed further in Chapter 18.
A cowstail is used in a caving environment. It is technically a safety line; however, the different construction and replacement requirements allow this to be attached while still above the anchor. A cowstail is constructed with the intent that it can be used above an anchor point. A cowstail must be replaced every two years regardless of its usage history or if a Fall Factor 2 occurs (see Chapter 18). When the elbow is placed against the stomach the short length should measure from the elbow to the wrist so that the karabiner sits in the palm of the hand. The long length is measured from the elbow to the tips of the fingers so that the karabiner is just past the hand. For convenience, cowstail karabiners should be fitted with a bar clip.
or rubber bands to keep them orientated correctly for quick action. There are also commercial types of cowstails that can be used. Figure 2–8 shows an example of a cowtail karabiner.

![Cowstail](image)

**Figure 2–8: Cowstail**

**Personal Anchor System**

**2.60** The personal anchor system (see Figure 2–9) is made up of multiple sewn slings looped together. It is a versatile personal safety system and can be used as a single attachment or equalised across multiple anchors. Each chain link is independent and rated to full strength, so attaching anywhere along the chain or through multiple loops results in a secure connection.
Daisy Chains

2.61 The daisy chain (see Figure 2–10) is a single closed loop of webbing with small loops made by bar-tacking either side of the webbing together at intervals along the length, one side of the webbing being offset to form the loops. Daisy chains have an ultimate strength rating of 22 kN, which depends on the stitching joining the ends of the webbing.

2.62 The danger involved with using a daisy chain is that the intermediate bar-tacks will start failing at about 2 kN. A serious risk associated with daisy chains is clipping a karabiner into two loops either side by side or an end loop and a loop further up. Failure of the stitching will cause the karabiner to break free. A daisy chain is not recommended to be used as safety-line.
SECTION 2-5. ROPING HARDWARE

2.63 It should be noted: This publication refers to an item of equipment and a knot of the same name. To enhance reader clarity the descending device (equipment) will be referred to as a figure 8 (numeral) and the knot will be referred to as a figure eight (word in full).

Descenders

2.64 A descender is a device that, when attached to a rope, assists the user in controlling their rate of descent by providing friction. Descenders are generally made from high-strength alloy or extruded aluminium. These materials help dissipate the temperature increase caused by the friction of the rope on the device.

2.65 Figure 8 Descender. The figure 8 is a commonly used descent device. It allows swift descending over short distances. One
The disadvantage of these descenders is the twisting effect they have on rope. A descent with a figure 8 will generally add a twist in the rope every 4 m descended. The figure 8 descender is available in a wide size range with some minor variations to the shape. A figure 8 descender is shown in Figure 2–11.

Figure 2–11: Figure 8 Descender

**In-line Descenders**

2.66 **Racks.** Racks are variable friction devices and are effective on many sizes of rope. Their versatility allows them to be used in many conditions with varying loads and rope types.

2.67 There are two main types of racks: the closed rack and the open-ended rack. Both racks work on the same principle and have varying numbers of bars to choose from, with the following differences:

a. **Closed Rack.** A closed rack is made from a U-shaped piece of stainless steel with a nut threaded onto the end
of each arm. The bottom of the ‘U’ is the attachment point. A closed rack usually has five bars, with the first, third and fifth bars fixed. Figure 2–12 shows an example of a closed rack.

b. Open-ended Rack. The standard rack comprises an open-ended U-shaped piece of 10 mm stainless steel rod with an attachment eye bent into one end of the ‘U’. The bars are threaded onto the ‘U’ by means of a hole drilled into one end of the bar. An angle slot is cut into the other end of the bar, allowing it to close on the frame like a gate. The angle slot is cut so that slight pressure is required to open the gates. This prevents the bars from
flapping around when not in use. Figure 2–13 shows an example of an open-ended rack.

Figure 2–13: Open-ended Rack

Belay Devices

2.68 Belay devices are mechanical friction brake devices used to control a rope when belaying. Their main purpose is to allow the rope to be locked off with minimal effort to arrest a climber’s fall. Multiple kinds of belay devices exist; additionally they can be used as descenders for controlled descent on a rope.

2.69 Belay devices are available in both passive and active designs. Passive belay devices rely on the belayer’s brake-hand and a karabiner to lock off the rope. Belay plates and belay tubes are
examples of passive belay devices. The following is a description of passive devices:

a. A belay plate consists of a flat but thick disc, usually of aluminium alloy, through which there are two slots that accept climbing ropes up to 11 mm. The most common belay plate available is the Sticht plate, names after its designer Fritz Sticht. Sticht plates are available with springs attached, which prevent the accidental locking of the rope while belaying.

b. A belay tube is similar to a belay plate, although it is much deeper. This depth makes a belay tube much less prone to accidental locking than belay plates. The amount of friction generated by a belay tube varies by manufacturer and depends on factors such as the length and depth of the rope slots, the radius of curves and the design of the devices. Most belay tubes are manufactured to include a wire catcher’s cord to prevent migration up the rope when belaying. Some newer belay tubes such as guides give you greater flexibility to use in many different situations.

c. Some belay tubes can be used in ‘guide mode’ which automatically stops the rope from moving through the device – or catches the climber. This is best done when belaying directly off an anchor point. A guide mode device is identified by its additional, full-strength, clip-in point. This method is only used when belaying from above.

d. If a belay device is lost or damaged, a Münter hitch on a karabiner can be used as an improvised passive belay device. Belay plates and tubes are shown in Figure 2–14.
2.70 Active belay devices have a built-in mechanism that locks off the rope without the help of any other pieces of equipment. Active belay devices use an offset cam to lock off the rope, automatically catching a falling climber, much like a seat belt in a car locks off to hold a passenger securely. These types of devices are not hands-free belay devices, and constant vigilance is required by the belayer. The Petzel® GRIGRI® is an example of an active belay device and is shown in Figure 2–15.

2.71 For more information on the use and employment of belay devices see Chapter 16.
Karabiners

2.72 Karabiners are widely used in roping activities such as climbing, caving, canyoning, rope rescue and industrial rope work. They are typically made from steel or alloy.

2.73 Karabiners come in four characteristic shapes:
   a. **Oval.** Symmetric shape (even in distribution). Most basic with smooth regular curves are gentle on equipment and allow easy repositioning of loads.
   b. **D Shape.** Asymmetric shape (uneven in distribution) transfers the majority of their load onto the spine, the karabiner’s strongest axis.

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LWP-G 7-6-2, Adventurous Training – Roping, 2018
c. **Offset-D Shape.** Variant of a D with a greater asymmetry, allowing for a wider gate opening.

d. **Pear/Halbmastwurfsicherung.** These are specialised oversized offset-Ds used in belaying. The Halbmastwurfsicherung (commonly known as HMS), German for half clove hitch belay, otherwise known as a Münter hitch, is specifically designed for belaying with the Münter hitch.

2.74 There are three main categories of karabiners, they are non-locking, manual locking, and auto-locking. The major difference between the three are as follows:

a. Non-locking (clip gate) karabiners have a sprung swinging gate that accepts a rope, webbing sling, or other hardware. Care must be taken when using wire gate karabiners with bolt plates that the karabiner and plates used are compatible. The three common gate types are:

1. **Straight Gate.** This is the most utilitarian and hence the most common gate.

2. **Bent Gate.** Curved gates are designed to make clipping a rope into the karabiner easier. The gate strength remains on a par with straight-gate karabiners.

3. **Wire Gate.** This is the lightest type, with the strength roughly equal to the others, allowing more to be carried for a given weight. Wire gates are less prone to icing up than solid gates, an advantage in Alpine mountaineering and ice climbing. The reduced mass makes their wire gate less likely to vibrate open during a fall. **Figure 2–16** shows examples of clip gate karabiners.
b. Locking karabiners have the same general shape as non-locking karabiners but have an additional mechanism securing the gate. These mechanisms may be either manual locking or auto-locking. The major difference between the two are as follows:

(1) **Manual Locking.** Screwgate karabiners have a threaded sleeve over the gate which must be engaged and disengaged manually. They have fewer moving parts than spring-loaded mechanisms, are less prone to malfunctioning due to contamination or component fatigue, and are easier to employ one-handed. They, however, require more total effort and are more time-consuming. An example of a screwgate karabiner is shown in Figure 2–17.
(2) **Auto-locking.** Auto-lock karabiners have a mechanism that closes and locks the karabiner. They offer the advantage of re-engaging without additional user input. Being automatic, they are prone to fatigue and susceptible to environmental factors such as dirt, ice, or other contamination. An example of an auto-locking karabiner is shown in Figure 2–18. There are many different types of auto-locking karabiners that can be used in different applications. Care should be taken when using auto-locking karabiners. The following are some examples of auto-locking karabiners:

(a) **Tri-lock.** Triple-locking karabiners open by pulling back on the sleeve, rotating the sleeve, and then pressing to open.

(b) **Bi-lock.** Bi-lock karabiners auto-lock with two motions to unlock.

(c) **Double Gate.** Double gate is a pear-shaped karabiner, with double straight gates for a twin gate system operation.

(d) **Magneto Lock.** Magneto lock uses two magnetic arms in the gate and a steel insert in the karabiner's key-lock nose to create an ultra-secure, self-clearing and redundant locking mechanism that can be easily used with either hand. It also has a body shape that traps the belay loop to eliminate cross-loading.
Karabiners are an integral part of equipment used in roping activities. Only those that have a UIAA or CE certification are to be used. Karabiner strength is measured in three ways:

a. along the major axis with the gate closed
b. along the major axis with the gate open
c. across the karabiner's axis.

Additionally there are also omni-karabiners which allow for load to be applied to all three axes. The parts of a karabiner are shown in Figure 2–19.

Figure 2–18: Twist Karabiner
Figure 2–19: Parts of a Karabiner

CAUTION
Only locking karabiners are to be used when connecting a descent device to a harness for an AT abseiling activity. When using an auto-locking karabiner, a tri-lock is the minimum to be used.

2.77 Karabiner Uses. The following points are to observed when using karabiners:

a. A locking karabiners minimum rating is to be 22 kN.

b. Steel locking karabiners are preferred for use in anchors.
2.78 **Maillon Rapide.** A maillon rapide, also known as a quick link, is a metal link, similar to a karabiner. Maillons have a threaded sleeve which tightens over a thread, as opposed to a hinged gate like a karabiner, making them stronger, but more difficult to use. Like karabiners, maillons are available in a range of shapes and thicknesses (ie, strengths), and often offer greater versatility over most karabiners as their different shapes and lack of hinged gates allow them to be used in multi-directional load situations. Figure 2–20 shows an example of a maillon rapide.

![Maillon Rapide](image.png)

**Figure 2–20: Maillon Rapide D-shaped Metal Link**

2.79 Maillon rapide or quick links are also used in canyons or on multi-pitch abseil points as a link from the anchor for the descent rope to run through. This is to assist in the recovery of the ropes at the completion of the abseil and to stop wear and tear on the chains or slings.

2.80 Maillon rapide must be CE certified and rated to a minimum of 20 kN.

**Ascenders**

2.81 An ascender is a mechanical rope clamp that allows the user to ascend a rope by means of a pivoting cam that clamps against
the rope. This enables the rope to pass-through during an upward movement, but bites into and grips on the rope when weighted. Usually, an ascender requires three movements to extract the rope and has a safety catch to prevent this from happening unintentionally.

2.82 There are two types of mechanical ascenders; one has teeth on the cam that bites into and grips on the sheath of the rope. These types of ascenders are good for muddy or icy ropes. The teeth will cause damage to the rope sheath with prolonged use. The other type has a smooth cam that is designed to squeeze onto the core of the rope, these cause less damage to the rope however can slip when used on muddy or icy ropes. Examples of ascenders are shown in Figure 2–21.

![Figure 2–21: Petzl ASCENSION Left- and Right-handled Ascenders](image)

2.83 A chest ascender is normally attached to the harness by a karabiner. It is also attached to a chest harness which is used to maintain the orientation of the chest ascender. The chest
The harness is not load bearing. Figure 2–22 shows an example of a Petzl CROLL chest ascender.

**Figure 2–22: Petzl CROLL Chest Ascender**

2.84 The Petzl TIBLOC is an ultra-lightweight ascender that can be used as a friction-knot replacement (rope grab) in self-rescue situations. The Petzl TIBLOC is a chrome-plated steel clamp with angled teeth that securely grips the rope. It requires a 10 to 12 mm karabiner to provide the cam action. It can be used as an auto-block in a hauling system. Figure 2–23 shows a Petzl TIBLOC ascender.
A Petzl Shunt is an ascender that grips onto the rope core. When the Shunt is unweighted and operated, the rope passes through during an upward or downward movement. When the lever is released and weighted it clamps onto the rope. A Shunt may be used to ascend or descend on single or double ropes. The Shunt also allows the user to use it as a mechanical self-belay device during a descent. Figure 2–24 shows a Petzl SHUNT.
The Petzl Microcender also clamps the core of the rope. It completely encloses the rope and is a great alternative for ascending or hauling in emergency rescue situations. The cam is forgiving and will slip rather than damage or shear the rope. Figure 2–25 shows a Petzl Microcender.
A pulley is designed to reduce friction and provide the rope a protective environment when being redirected. A good pulley should be small, strong and light. The two types of pulley that may be used in a rescue scenario are: fixed or swivel cheek. The swivel cheek pulley is typically stronger than the fixed cheek pulley. The pulley and axle should be made of a high-strength non-corrosive material. The parts of a pulley are shown in Figure 2–26.
Figure 2–26: Parts of a Pulley

2.88 The use of pulleys is beneficial in any raising operation. They reduce the amount of friction created by ropes bending around a small circumference and help maintain the theoretical mechanical advantage generated by the use of pulley systems. Figure 2–27 shows an example of a pulley.
2.89 Pulleys are available with varying sizes, capacities and features. Some of the basic pulleys consist simply of a plastic wheel, which can be fitted onto a rated karabiner.

2.90 The MICRO TRAXION is an ultra-light, ultra-compact progress-capture (auto-block) pulley. The cam can be locked in the open position so the device can be used as a simple pulley. Figure 2–28 shows an example of MICRO TRAXION.
Wire Ladders

2.91 Wire ladders, typically used in caves, are largely used for short pitches. The rungs of the ladders are aluminium, cold welded to galvanised cable at 30 cm, or 1 ft, intervals. Each rung can hold a 500 kg load. The ladders come with a 2.5 m wire trace. The most common lengths are 10 m (30 ft), or 15 m (50 ft), and can be clipped together to make longer ladders. The ends are fitted with C clips for easy joining (rated to 650 kg). An example of a wire ladder and a wire trace are shown in Figure 2–29.
Figure 2–29: Wire Ladder and Trace
Passive Protection

2.92 There are variations on essentially the same design, a tapered aluminium rectangle on one end slung with a factory installed steel wire. Climbing nuts are usually made from aluminium alloy; a material that is both extremely strong and soft. It is important that the material have some give to ensure that the nut ‘bites’ into the rock when loaded. Modern machining techniques have transformed the original straight-sided nuts into curved and double-sided units. Very often climbing nuts are constructed with a transverse taper (when seen from the top, the piece narrows from face to face) to offer a wider range of placement options. Figure 2–30 shows an example of a set of nuts/stoppers.

![Figure 2–30: Nuts/Stoppers](image)

2.93 Hexcentrics (or hexes) are six-sided semi-barrel shaped units with tapered edges similar in shape and curvature to modern...
nuts. Although well suited for wide cracks and bottlenecks, hexes were designed for parallel-sided cracks because of their ability to ‘cam’ into the rock when loaded. Figure 2–31 shows an example of a set of wire hexes.

Figure 2–31: Wire Hexes

Active Protection

2.94 Active Protection consists of spring-loaded camming devices (SLCDs) (also commonly referred to as cams), and active hex nut placements. This type of gear is active because as force is applied to the device, it applies more force to the rock, creating more friction. In other words, the harder you pull, the tighter it holds. Active protection is incredibly versatile. It can be placed in vertical, horizontal or diagonal cracks, and some pockets.
Active protection is particularly useful because a single piece will fit a range of crack widths.

2.95 Cams consist of a shaft or handle, an axle, a trigger, and three or four lobes. The trigger is pulled and the lobes rotate, giving the cam a lower profile. After inserting the cam into a crack, the trigger is released and the head expands until it makes contact with the rock. Some cams have two axles, such as Black Diamond C-4s, while most others have one axle. The extra axle gives you a slightly larger range in each cam. Figure 2–32 shows an example of a double-axle SLCD.

Figure 2–32: Double-axle Spring-loaded Camming Device
Bolts

2.96 In rock climbing, a bolt is a permanent anchor fixed into a hole drilled in the hard surface as a form of protection. Most bolts are either self-anchoring expansion bolts or fixed in place with liquid resin. Detailed information on bolts is contained in Chapter 6.

2.97 A carrot bolt is normally a 10 mm machine bolt, with a slight taper to the end. Often the head is ground smaller to make fitting a key hole bolt plate easier. Bolt plates are generally carried by the user and recovered after the activity. Figure 2–33 shows an example of bolt plates.

Figure 2–33: Bolt Plates

Piton

2.98 A piton, also called a pin or peg, is a metal spike (usually steel) that is driven into a crack or seam in the rock with a hammer, and which acts as an anchor to protect the climber against the consequences of a fall. Pitons are equipped with an eye hole or a ring to which a karabiner is attached; the karabiner can then be directly or indirectly attached to a climbing rope. Pitons were the original form of protection. Figure 2–34 shows an example of a piton.
Rigging Plates

2.99 Rigging plates easily assist in organising the work station to equalise loads and create multi-anchor systems. They can assist in rescues when rigging stretchers and for setting up Tyrolean traverses.

2.100 The minimum size of the holes in rigging plates is 19 mm in order to allow the locking sleeves of most karabiners to pass through. Made of aluminium with excellent strength-to-weight ratio of a minimum breaking strength of 36 kN. Figure 2–35 shows an example of rigging plates.
Hardware Care and Maintenance

2.101 Hardware needs to be handled with care. If hardware has been dropped onto a hard surface it is to be inspected for damage, and is to be free of burrs or sharp points, which could damage the rope. If these or any other flaws are discovered during inspection, the item must be removed from service and condemned.

2.102 All alloy hardware must not be used if it has 10 per cent or greater surface wear. A rack must be retired if any bars have 20 per cent wear.

2.103 When hardware is exposed to dust and dirt, or in the event of the action not functioning properly, it should be washed with mild soapy water and brushed to remove any dirt from the moving parts. With heavy dirt, kerosene may be used for the washing process then rinsed off in clean water. After washing, rinse in methylated spirits and allow to air dry.

**CAUTION**

To avoid damage to equipment, ensure that nylon components are not exposed to methylated spirits and kerosene.

2.104 After drying, moving parts should be very lightly lubricated with a silicone-based spray or equivalent to prevent corrosion. Any excess lubricant should be removed.

2.105 If any part of the hardware action does not operate as it should, the item must be removed from use and condemned.

2.106 After use, SLCDs may be washed in mild soapy water, rinsed and dried. Dirt needs to be removed from the teeth on the cam with mild soapy water. The cam is spring-loaded, so inspection and light lubrication is required. If the cam mechanism fails to operate correctly or if any defects or cracking appear in the cams or body of the SLCD, it is to be removed from service and condemned. If an SLCD is dropped from a height of 2 m or more onto a hard surface, it is to be inspected, and if visual
2-52

inspection reveals damage it is to be removed from use and condemned.

SECTION 2-6. HELMETS

2.107 A helmet is essential to provide protection to the head from rockfall and collision. Most helmets are made from high-strength plastic, carbon fibre or a mixture of similar composite materials. Helmets should be adjustable for a variety of head sizes and have a comfortable head lining.

2.108 Helmets must be inspected prior to use to ensure that the shell is not fractured. If a helmet receives a hard knock or rockfall, it is to be removed from use and condemned. Fractures may have occurred that are not visible to the naked eye. Any webbing used in the helmet is to be inspected for frays and damage, including the chinstrap and buckle. Only helmets with CE or UIAA certification are to be used for roping activities. An example of a helmet is shown in Figure 2–36.
The primary function of a helmet is to protect the head from falling rocks, blows from a tumbling fall or blows to the head. The other function is to support a lamp, freeing the person’s hands to assist in movement in low light conditions. Figure 2–37 shows an example of a helmet with a fitted headlamp.
The following are special features to consider when choosing a helmet. The helmet should:

a. be UIAA- or CE-approved
b. be lightweight and not lined with water-absorbing padding
c. be small and not ride high, or it will be a nuisance in tight passages
d. sit securely on the head, be comfortable and, in addition to rear fastening straps, have jugular straps that do not block side vision
e. fit lamps so that mounting screws, nuts or rivets do not project into its interior.

Some helmets have lamp mountings on the front; however, most new helmets have front and rear mounting straps for a headlamp.
Helmet Care and Maintenance

2.112 Helmets also need to be regularly maintained for safety and to prolong their serviceability. A helmet may be washed with mild soapy water to remove any grit or perspiration from the chinstrap and lining, and then thoroughly dried. Petroleum-based products are not to be used to clean the shell of the helmet as this will break down the material used in its construction. For further information on care and maintenance of helmets, the user should refer to the manufacturer’s recommendations.

2.113 Helmet life is in accordance with the manufacturer's specifications; however, this will be affected if the helmet becomes damaged or worn in any way.

SECTION 2-7. HEADLAMPS

2.114 The two main types of lighting used are the dry cell electric lamp and the LED lamp.

Basic Headlamps

2.115 Dry Cell Electric Headlamp. The most common dry cell headlamp comes with a fully adjustable elastic headstrap. Some are weatherproof and are easily attached to most helmets. These headlamps will take a number of AA or AAA batteries. They come in standard bulbs or LEDs. They are ideal for novice cavers who are involved in short caving trips. They can also be used as a backup emergency light. Figure 2–38 shows an example of a head torch. Table 2–1 sets out torch characteristics.
2.116 Light Emitting Diodes. Major advances in this area in recent years have seen this type of lighting become the market leader in cave lighting. The advantages of an LED over an incandescent bulb are as follows:

a. LEDs do not use a filament as an incandescent bulb does.

Table 2-1: Torch Characteristics

<table>
<thead>
<tr>
<th>Battery Type</th>
<th>Bulb Type</th>
<th>Beam Distance (Average)</th>
<th>Battery Life (Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Cell Alkaline</td>
<td>Standard</td>
<td>30 m</td>
<td>8 hours</td>
</tr>
<tr>
<td>AA (1.5 V) or AAA (1.5 V)</td>
<td>Halogen</td>
<td>100 m</td>
<td>4 hours</td>
</tr>
<tr>
<td></td>
<td>LED</td>
<td>60 m</td>
<td>55 to 120 hours</td>
</tr>
<tr>
<td>Dry Cell Li-ion 18650 (3.7 V)</td>
<td>LED</td>
<td>150 m</td>
<td>8 to 250 hours</td>
</tr>
</tbody>
</table>
b. They consume a lot less electricity and the globe lasts a lot longer.

c. The flexibility of LED technology allows for different shapes and colours.

d. They are as durable, if not more so, last a lot longer, and are in some cases a lot brighter. There are more advances in this field each year.

e. Their light-to-weight ratio is unsurpassed.

2.117 The disadvantages of an LED over an incandescent bulb are as follows:

a. more expensive

b. not user replaceable

c. change colour (from pure white to blue tinge) due to age and temperature

d. significantly degraded by overheating and voltage supply

e. cheap LEDs produce a poor quality light that is perceived differently than sunlight or incandescent light.

2.118 Electric Headlamps. Electric lights are convenient to use. Most cast a strong beam, which is useful for spotting up and down pitches.

2.119 The disadvantages of electric headlamps are:

a. a poor light-to-weight ratio and the need to recharge or replace used cells, especially on long trips

b. rechargeable cells need mains power, a car battery or a solar cell to recharge them, while those which use dry cells can be expensive in the long term.

2.120 However, LED headlamps are the ideal choice for all unit activities run by UATLs.
Additional Light Sources

2.121 A minimum of two light sources are required while caving. The choice of light source can be influenced by the type of cave being explored (eg, wet or dry cave). The most common additional light source carried by cavers is a standard torch. A caver must be able to safely exit the cave using the backup light source. The light sources need to be independent of each other.

Torches

2.122 The most common secondary light carried by cavers is the torch. Most cavers prefer the smaller Maglite® style torch or a similar variety. They are waterproof, small and light, and produce a bright beam. By using alkaline or lithium batteries and carrying extra batteries and bulbs, a more than sufficient margin of safety can be achieved.

2.123 The emergency light should be checked for serviceability prior to each activity. It must be carried on the person, not within the pack. It is suggested that a retaining line be attached to the torch so that the light cannot be separated from the body.

Candles

2.124 Until recently the most common third source of light was the candle. One drawback of standard candles is that they tend to drip wax in the cave, which goes against the cave conservation message, ‘Leave nothing but footprints’.

2.125 The open flame of a candle is not a useful source of light while climbing and crawling through a cave. It is best reserved for the times when a group intends to remain in one location for a while.

Chemical Lights

2.126 The light output of a chemical light stick (Cyalume) during its first hour of operation is comparable to an AA cell torch, but the light is diffused in all directions. There are several advantages and disadvantages to using chemical light sticks as a backup light source. One advantage is that, although the intensity of
the light gradually diminishes over a period of time, the human eye is particularly sensitive to the yellow-green colour of the chemical stick. Also, whereas a candle or torch of similar size will no longer be useful after about 3 hours, the chemical light will continue to glow for up to 24 hours, depending on the type used. Light sticks will also work when they are submerged and, unlike an open flame light source, they do not burn oxygen, an important consideration if caught in a bad air section of a cave or when involved in tight crawling situations. Finally, unlike most other light sources, which may be damaged if dropped or bashed around, if a light stick is damaged, all it will do is start working.

2.127 This final advantage may also be a disadvantage in that the chemical light stick may be accidentally activated, although this may be prevented if the light stick is stored in a container. Light sticks should not be subjected to heat, as this tends to reduce their efficiency. Another disadvantage is the low-level and diffused light produced, which makes light sticks only suitable for lighting up a caver’s immediate surroundings. Finally, these sticks also tend to deteriorate with time and have a shelf life of about two years.

SECTION 2-8. CLOTHING

Canyon Clothing

2.128 The clothing requirement for canyoning depends on the weather and the type of canyon being explored. The clothing that is used must provide protection to the participants from temperature extremes, water, sand and abrasions. Some considerations for participants when selecting clothing include:

a. The clothing has to be rugged, as it will be subjected to hard wear and constant contact with rocks.

b. The clothing must be warm enough for protection from a cold, wet and sometimes windy environment.

2.129 Cags. Cags (see Figure 2–39) are lightweight tops which are available in dry or semi-dry variants. They are a windproof
outer shell and do not provide any insulation. They are a suitable outer layer for cold windy canyons.

Figure 2–39: Cag

2.130 Footwear. It is inevitable that canyoning footwear will get wet, so waterproof footwear is not the best option. Footwear that drains quickly is the preferred option. For the best traction on wet rocks, choose footwear with a soft sole and a close tread pattern (see Figure 2–40). Harder soles will have less grip when negotiating obstacles. Wetsuit booties are not suitable for canyoning as they do not provide adequate protection to the feet.
Protective Clothing

2.131 Gloves. Gloves can be worn while abseiling, caving, canyoning and climbing. They provide protection from sharp rocks or rope burn as well as keeping the hands clean and warm. Different types of gloves suit different activities. Abseiling gloves need to be made of a sturdy hard wearing material preferably with extra covering over the palm. Gloves for caving are optional and are mainly to protect hands from the mud and guano in the cave. Loose-fitting gloves give a false grip and tend to slip when a caver tries to move or climb within a cave. If worn, they should be made of cloth that is heavily impregnated with plastic, and should be well fitted. Gloves in the canyon environment can be useful to keep hands warmer and therefore more dextrous for knot tying. Gloves that are used for climbing can be home made from tape or purchased.
‘Hand Jammies’. This kind of glove only offers protection to the back of the hand for climbing cracks and jamming sequences.

2.132 Thermal Underwear. Thermal underwear (commonly known as thermals) are used to preserve body heat and to draw water and perspiration away from the skin. There are many different types of thermals available, ranging from natural fibres to synthetic fibres. Figure 2–41 shows thermals that are made from synthetic fibre.

WARNING

Cotton thermals are not to be worn as they reverse the normal effect of thermals and cool the body when wet which may lead to hypothermia.

Figure 2–41: Synthetic Fibre Thermal Underwear
Caving Clothing

2.133 Caving clothing varies with the type and location of the cave system. Protection from cold, water, mud, sand and rock is needed to varying degrees in most caves. The selection of caving apparel will depend on the nature of the cave and personal preference. A few basic considerations need to be applied, as follows:

a. The clothing has to be rugged, as it will be subjected to hard wear and constant contact with the hard rock.

b. The clothing must be warm enough for protection from the cold and absorbent enough to soak up perspiration in 100 per cent humidity.

c. The clothing must also be loose enough to permit the body to contort to any shape while crawling, slithering through holes, and other typical manoeuvres. At the same time, clothing should be fitted to allow the caver to use ascending and descending devices on ropes.

Outer Layer

2.134 For the outer layer of clothing, many cavers prefer overalls, although there are several different types of outfits that can be used, as detailed in the following paragraphs. Their use will be determined by the conditions within the cave. Figure 2–42 shows an example of a cave suit.
Figure 2–42: Cave Suit
Overalls

2.135 Overalls are used because the one-piece suit eliminates the gap between trousers and top when crawling. Overalls are made from rugged materials, often containing a fairly high percentage of synthetic fibre. This gives the fabric a greater resistance to abrasion and tearing than that of pure cotton fabrics.

2.136 Most overalls come with several pockets and a double front zipper or press-studs which can be undone from the bottom or the top. The zipper variety is preferable, as the press-studs can dig into the caver’s chest when crawling through a squeeze. Constant crawling through squeezes can also cause the area around the press-studs to wear. The pockets are only useful when they have zippers which prevent objects from falling out. The storage of large items in pockets other than maps should be avoided, as they cause discomfort and can make it impossible to crawl through a tight squeeze.

Wetsuits

2.137 Wetsuits are excellent for wet environments in which one is constantly in and out of water or swimming. They offer an all-over padded skin, buoyancy for deep water and a streamlined profile for smaller passages. However, there are some disadvantages, they restrict limb movement considerably, adding to fatigue and making climbing difficult. A wetsuit is uncomfortable in a dry environment, as it seals in sweat, keeping the wearer constantly warm and thereby increasing the risk of overheating. The efficiency and amount of insulation that a wetsuit provides is small, so it is necessary to stay active in order to keep warm. If forced to stop for some time, it is easy to become dangerously cold.

2.138 A ‘spring suit’ made of soft neoprene, with thinner patches behind the knees and elbows to increase flexibility, is the better alternative to a diver’s wetsuit. This design accommodates all movements and allows a wearer to reach both hands above the head. A suit that is a slightly loose fit will give better freedom of movement and allow a caver to wear thermals for cold
conditions. Remember to wear some form of protective outer clothing to protect the suit from damage.

Footwear

2.139 Good footing is important in caves. The height of boots is an individual preference; however, good, reasonably light, lined hiking boots or gumboots are also acceptable. Gumboots are ideal as they offer suitable protection. Flat, soft-soled shoes similar to Volleys are suitable; though physical training styled runners are not, as they are very slippery and provide no ankle support.

SECTION 2-9. ADDITIONAL EQUIPMENT

2.140 A UATL running an activity must carry extra, individual equipment to facilitate the activity and to assist in the event of an emergency.

2.141 Some examples of additional equipment are listed in this section. While the list presented here contains many useful items, it is by no means exhaustive and a UATL should determine the extra equipment requirements based on the abilities and experience of the group, the size of the group, and the environment.

2.142 Spare Hardware. The UATL should always carry spare hardware, such as karabiners, a descending device and maillons.

2.143 Knife. A small knife or multi-tool can be handy for emergency repairs to equipment. This does not replace the rope rescue knife.

2.144 Whistle. A whistle must always be carried with each individual UATL and participant. The whistle needs to be loud and resistant to damage. A plastic whistle without a pea is the preferred type. This will prevent the whistle from being overblown, frozen closed, jammed, or frozen to the lips. Ensure that the whistle is easy to access.
2.145 **Rope Protection.** There are many kinds of rope protection on the market. Two types of rope protection that can be used are wrap around and flat protectors. Wrap-around protection can be made from various materials including strips of tough canvas, nylon, PVC, vinyl or polyester, fastened into a cylinder with velcro and secured with cord, or purpose made polyurethane protection which uses friction to be held in place.

2.146 Flat types of edge protection can include carpet, PVC, rubber, or another type of suitable material (rope bags, etc.). These types of protection are used to protect the rope by being laid over the suspicious area and secured with cord. It is suggested that if rubber is used care is taken as it can become very slippery.

2.147 **Edge Roller.** An edge roller is a type of protection that works well on the edge of man-made structures. It generally is constructed with an aluminium roller(s) and comes in a variety of breaking strains from not rated at all to rated at more than 60 kN. Edge rollers can be joined together to extend the area of protection and are able to be secured to the surface. They can also accept multiple ropes and are ideal for hauling operations.

2.148 **Basic First Aid Kit.** A small basic first aid kit should be carried to cover minor emergencies.

2.149 **Survival Blanket.** Personnel must not embark on a caving activity without a survival blanket. There are robust re-useable models or single-use items which lose their silvery coating in a year or less (although this has little effect on their efficiency). The blanket can be carried in a pack or pocket.

2.150 **Spare Tape and Cord.** It is important to carry some spare tubular tape and 5 to 7 mm cord for emergencies.

2.151 **Pencil and Paper.** A pencil and paper will serve many purposes. It will allow a UATL to record a patient’s vital signs, to be provided to medical staff upon their arrival. This will assist the staff in their assessment of the patient. A pencil and paper will also allow the UATL to record or map any additional information about the activity that is not covered in the
guidebooks. This information can then be stored in a personal library or passed on to other UATLs.

Canyon Packs

2.152 Canyoning packs are used by participants to carry the equipment required for the canyoning activity. A good canyoning pack has the following features (see Figure 2–43):

a. they are made of heavy, PVC-coated polyester fabric or canvas type material, which wears well, and is waterproof or non-absorbent with holes for drainage

b. they have two shoulder straps

c. they have a maximum diameter of 30 cm (any greater and the pack may impede progress when moving through constricted parts of a canyon), large canyon packs need to be oval or rectangular, with a short axis of 30 cm or less to make them practical

d. seams are protected or reinforced against wear, especially those around the base

e. they have handles on the side or top so that they can be carried like a suitcase or dragged through pools

f. they have a lid flap to keep the contents in.
Dry Bags

2.153 Dry bags are used to keep equipment dry. They are filled and sealed before being packed into the canyoning pack. They are normally made of rubberised material and are not very resistant to abrasion. They are available in a variety of colours and sizes (see Figure 2–44). An alternate to dry bags can be heavy duty garbage bags that have had the air expelled and secured, or large mouthed water bottles.

Figure 2–43: Suitable Canyoning Pack
Throw Bags

2.154 Throw bags are used to quickly deploy a safety line to a swimmer in trouble. They are made from highly visible and durable materials. They have internal flotation and a floating rescue rope which keeps the rescue bag on top of the water (see Figure 2–45).
Flotation Devices

2.155 These can be very useful in activities where there are long swims or if there is a weak swimmer within the group.

2.156 Life jackets, as used in white water exercises, may be used during roping activities where swims are expected. This is the
preferred device for weak swimmers, as it can be secured to their body and cannot be accidentally released should the swimmer become distressed. A life jacket is an approved piece of safety equipment for an aquatic environment.

2.157 Inflatable mattresses can be used for long sections of deep water. Rubberised canvas is preferred, as plastic will puncture easily. Participants can either lie on or straddle the mattress in a sitting position. Another option is a small inner tube, which can be carried throughout the activity and pumped up using a bike pump at the site. Inflatable mattresses and inner tubes are swimming aids only and should not be used in lieu of approved safety equipment, as they can be released if the swimmer becomes distressed.

2.158 Packs are also used as a type of flotation device. A pack that has been made buoyant using dry bags placed inside can be used for short swims. If the pack has a waist strap, this can help the swimmer with extra buoyancy and stop the pack from rising and pushing the swimmer's head under. Participants can swim backwards with a pack underneath them to help keep their heads out of the water.

**WARNING**

Exposure to cold water increases the risks of cramps or hypothermia. Using a wetsuit or a flotation device is strongly recommended to minimise this risk, even for strong swimmers.

Cave Packs

2.159 The style of cave pack chosen will depend on supply, the individual's requirements and the caving trip to be undertaken. A good cave pack has the following features:

a. made of heavy PVC-coated polyester fabric which wears well and is water-resistant

b. two durable shoulder straps which lie flat against the pack to reduce the likelihood of snagging when dragged
a maximum diameter of 30 cm, oval shaped packs can be larger as they fit through cave passages with greater ease

seams protected or reinforced against wear, especially those around the base

a handle on the side or top to allow the pack be carried like a suitcase or dragged through squeezes

a permanently attached haul cord which can be used to drag and suspend the pack just below the feet.

2.160 Examples of commercially available caving packs can be seen in Figure 2–46.
SECTION 2-10. CLIMBING ACCESSORIES

Friction Boots

2.161 Friction boots (see Figure 2–47) are an aid to climbing that help the climber maintain contact with the rock surface by providing friction in much the same way as a car tyre. Personal preference, the climber’s skill level and the types of surfaces to be climbed are all factors to consider in selecting a pair of...
friction boots from the many types available. For novice climbers, a good all-round boot should be selected.

Figure 2–47: Friction Boots

2.162 **Fitting.** Friction boots must fit firmly, but not so tightly that the wearer feels pain or cannot walk properly. Ideally, friction boots will fit so that air gaps inside the boots are minimised and the foot fills all available space without being crushed. The boots should fit firmly before laces are tightened, as the function of the laces (or velcro straps) is only to take up any existing slack. Different brands and models of boots will fit differently, and climbers should try on as many different boots as possible to select the pair that has the best fit. Friction boot selection should also consider the form of climbing to be undertaken and the duration for which the boots are to be worn. Friction boots can be worn tighter when climbing on an artificial wall in a
climbing gymnasium, rather than on an all-day multi-pitch climbing route.

2.163 Care and Maintenance. Friction boots should be maintained in a clean and dry state in order to prolong their usable life. After use, damp boots should be dried in a warm place, but out of direct sunlight and away from direct heat, as excessive heat will cause the glue bonding the sole of the boot to soften. Boots must be stored in a dry and well-ventilated area. If friction boots have a distinctly foul odour, they may be dusted with bicarbonate of soda. Conventional foot powders and deodorisers must not be used, as they may soften the glue bonding the sole of the boot. After heavy use, boots should be washed by hand with mild soapy warm water and the sole cleaned, removing dirt and ensuring that the rubber is maintained to its full gripping capability.

2.164 After extensive use, the rubber will wear down or come away from the leather uppers. Resoling kits can be purchased to extend the life of the boot, although repairs conducted by professional friction boot repair agencies are recommended.

Nut Key

2.165 A nut key or chockstone extractor (see Figure 2–48) is a very simple tool used to remove chocks wedged fast in rocks. There are no particular care and maintenance considerations for nut keys.
Climbers use gymnasts' chalk (magnesium carbonate) to assist in maintaining sweat-free hands and a good grip on the rock. Chalk is widely available as a powder, as blocks that can be crushed in the hands or as chalk balls. While chalk is not a hazardous substance, due to its fine particle nature, care should be taken not to inhale or consume chalk powder. Chalk is usually carried in chalk bags, which are worn around a climber’s waist and come in different sizes (see Figure 2–49).
Annex:
A. Dynamic and Static Rope Register
### ANNEX A TO CHAPTER 2

**DYNAMIC AND STATIC ROPE REGISTER**

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CHAPTER 3

HARNESS FITTING (COMMERCIAL AND IMPROVISED)

3.1 More than any other item used in a roping activity, harnesses present the widest variety of design and style. Harnesses are worn primarily to distribute the forces of ascending, descending and falling to a large percentage of the body. This chapter describes various types of harnesses and the correct fitting and considerations for use of those harnesses. In general, harnesses are available in two basic designs or configurations, as follows:

a. sit harnesses
b. improvised harnesses.

Sit Harness

3.2 A sit harness is a commercially available harness that consists of a waist belt and leg loops. These may be separate pieces that are joined by a belay or abseiling loop through the crutch strap or may be incorporated into the harness as a single piece. Features that may be included in a sit harness are:

a. adjustable leg loops
b. a belay or abseiling loop
c. gear loops
d. padding in the waist belt and leg loops.

3.3 An example of a sit harness is shown in Figure 3–1.
3.4 All harness buckles are to be connected or threaded in accordance with the manufacturer’s specifications. Where applicable all buckles on a harness must be back-threaded to prevent the nylon webbing slipping through the buckle. A minimum of an 80 mm tail is to be left after the buckle on the waist belt of the harness has been fully tied and back-threaded, as shown in Figure 3–2.
Sit Harness Fitting

**WARNING**

Care is to be taken when fitting a harness, as an incorrectly fitted harness places the wearer at risk of serious injury to personnel, or death.

3.5 The sit harness must be fitted correctly to distribute weight evenly and prevent the restriction of circulation. When a sit harness is used for the first time, all buckles and straps should be loosened for ease of fitting and adjustment. Some sit harnesses have the buckles back-threaded and then covered with nylon guards to prevent them coming undone. This type of buckle still requires checking when fitting a harness. The waist belt should be fitted first, followed by the leg loops, then the leg loop rear elastic straps. When removing the harness, the buckles only need loosening enough to allow the harness to be slipped off, saving time when refitting.

3.6 When attaching a karabiner to the harness for abseiling or belaying activities, the karabiner must be passed through the belay loop as per the manufacturer’s specifications. Locking karabiners must be used for attaching a descent device to a participants harness. For best practice the belay loop needs to sit within the wide end of the karabiner and the spine of the karabiner on the wearer’s master side. **Figure 3–3** shows the
correct orientation of the karabiner attached to a sit harness. For safety lines a second karabiner must attached to the belay loop below the descent device.

Figure 3–3: Sit Harness with Karabiners

Improvised Harnesses

3.7 Diaper Harness. An improvised harness can be made from 25 mm tubular tape. This harness is not recommended for general use, particularly because if suspended for long periods of time in the harness, the tape tends to restrict blood circulation. It is, however, very useful in an emergency.

3.8 Diaper Harness Fitting. The diaper harness is fitted as follows:

a. With a 3 to 5 m length of 25 mm tubular nylon tape, tie the ends together with a tape knot. Place a foot in the loop and adjust the tape knot so that the length of the loop is from under the foot to the bottom of the sternum.

b. Place the loop formed behind the back with the knot uppermost and central in the small of the back, allowing the lower tape to drop below the line of the crutch, as shown in Figure 3–4(1).
c. Place the hands through the tape and form a bight at each hip. Grasp the lower tape from in front and between the legs with both hands, as shown in Figure 3–4(2).

d. Maintaining the grip on the lower loop of the tape, pull it up and through the bights at each hip so that a loop is formed around each leg, as shown in Figure 3–4(3).

e. Attach a locking karabiner through the two bights formed at each hand, as shown in Figure 3–4(4). For best practice the harness straps need to sit within the wide end of the karabiner with the spine of the karabiner on the wearer's master side.

3.9 Chest Harness. A chest harness is required when fitting a chest ascender and may be used in certain rescue situations. This system may also be used to assist in keeping the body upright when abseiling with heavy loads.

3.10 Chest Harness Fitting. The chest harness is fitted as follows:

a. With a 3 to 5 m length of 25 mm tubular nylon tape, fold in half and measure so that the doubled length will just
pass around the chest. Once measured correctly tie the ends together with a tape knot, as shown in Figure 3–5(1).

b. Place the chest harness over the head and left shoulder, ensuring that the tape knot is in the small of the back.

c. With no twists in the tape, grasp the upper tape with the left hand and the lower tape with the right hand. Pull the lower tape under the upper tape, as shown in Figure 3–5(2).

d. Without releasing the tape with either hand, lift the lower tape over the right shoulder and head.

e. To check if it was done correctly, the tape cross-over point on the chest must be interlocked and form a diamond shape when pulled apart, as shown in Figure 3–5(3). The karabiner will be connected to this culminating point.
3.11 **Full Body Harness.** The full body harness (FBH) is a system which is particularly advantageous when abseiling with heavy loads. The FBH provides the user with an altered centre of gravity because of the raised suspension point, thereby eliminating the chance of the abseiler inverting during descent.

3.12 The FBH incorporates two separate harness systems that are connected together, consisting of a harness for the chest and a
harness for the waist. The harness can be constructed from tubular tape of the following minimum sizes:

a. chest harness – 10 mm wide tubular nylon tape
b. waist harness – 25 mm wide tubular nylon tape.

3.13 **Full Body Harness Waist Harness Fitting.** The FBH waist harness is fitted as for a diaper harness (see paragraph 3.7 and Figure 3–4 [Step 1 to Step 3]), with the exception that the two bights at the waist are longer, as follows:

a. With a 3 to 5 m length of 25 mm tubular nylon tape, measure the length by placing a foot in the centre and measuring the tape from foot to eyes. At this point tie the ends together with a tape knot.

b. Place the loop formed behind the back with the knot uppermost and central in the small of the back, allowing the lower tape to drop below the line of the crutch, as shown in Figure 3–4(1).

c. Place the hands through the tape and form a bight at each hip. Grasp the lower tape from in front and between the legs with both hands, as shown in Figure 3–4(2).

d. Maintaining the grip on the lower loop of the tape, pull it up and through the bights at each hip so that a loop is formed around each leg, as shown in Figure 3–4(3).

3.14 **Full Body Harness Chest Harness Fitting.** The FBH chest harness is fitted as a standard improvised chest harness, with the exception that the chest harness is passed through the two bights on the waist harness to begin, as shown in Figure 3–6(1) and as follows:

a. Place the chest harness over the head and left shoulder, ensuring that the tape knot is in the small of the back, as shown in Figure 3–6(2).

b. With no twists in the tape, thread the tape through the two bights created from the waist harness. It is now important to create the normal twist that would occur when setting up the chest harness.
c. Without releasing the tape with either hand, lift the lower tape over the right shoulder and head, as shown in Figure 3–6(3).

Figure 3–6: Full Body Harness Chest Harness Fitting

3.15 The waist and chest harness are adjusted so that the karabiner suspension point is in an approximate line with the nipples. The FBH should be firm but not uncomfortable. When adjusted, the knots should be at the user’s back.
3.16 A karabiner is attached to the FBH as follows:

a. Hold the karabiner in the right hand (not shown in Figure 3–7) and hook the two loops from the tape seat harness from the right to the left (see Figure 3–7(1). Reverse this step for left-handed people.

b. Continue turning the karabiner so that the two tapes coming over the shoulder are connected. Allow the karabiner gate to close and continue turning the karabiner until the narrow end is closest to the body (see Figure 3–7[2]).

c. Rotate the karabiner until the gate is on the non-master side and, if applicable, the small end of the karabiner is to be at the top (see Figure 3–7[3]).

d. Force the karabiner through the two tapes that extend over the shoulders immediately below where they cross on the chest (see Figure 3–7[4]).

e. The karabiner should now be held securely, with the spine of the karabiner on the side of the master hand and the wide end of the karabiner closest to the body, as shown in Figure 3–7(5).
Figure 3–7: Karabiner Attachment
3.17 Combination Full Body Harness. An FBH may be constructed using an improvised chest harness and commercial sit harness. The system is simple to construct using available equipment and has a number of practical applications and uses in various situations. This harness may be used for rescue situations when a patient requires an FBH and is already fitted in a sit harness. A combination FBH may also be used when heavy loads are being carried by the abseiler, as the harness alters the abseiler’s centre of gravity due to the raised suspension point which reduces the risk of the abseiler inverting during descent.

3.18 Combination Full Body Harness Fitting. The FBH alters the abseiler’s centre of gravity due to the raised suspension point, which reduces the risk of the abseiler inverting during descent. The combination FBH is fitted as follows:

a. Fit a commercial sit harness and adjust as required.

b. Attach a locking karabiner to the harness via the belay loop.

c. Fit a chest harness, and adjust as required.

d. Using a small accessory cord tied together with a double fisherman's knot, clip it into the karabiner on the sit harness. Push the accessory cord through the culminating point of the chest harness, then clip back into the karabiner on the sit harness and tighten the locking karabiner.

e. Place a locking karabiner through the accessory cord and the culminating point on the chest harness, orientated such that the gate is uppermost and the widest part of the karabiner is closest to the body. Connect the descending device to this karabiner, as shown in Figure 3–8.
Figure 3–8: Combination Full Body Harness Fitting
CHAPTER 4
ROPE CRAFT

SECTION 4-1. EMPLOYMENT OF ROPE

4.1 Rope craft is the term given to techniques used to manage the lifelines used in roping activities. This chapter covers all relevant aspects of rope craft including the characteristics and use of knots and hitches, and the coiling and throwing of ropes.

4.2 The following are terms relating to rope craft which are relevant to this chapter:

a. Bight. A bight of a rope is a simple bend of rope in which the rope does not cross itself.

b. Loop. A loop is a simple bend in the rope in which the rope crosses itself.

c. Standing End. The standing end is the end secured to a point.

d. Running End. The running end is the free end of the rope that is not secured to a point.

e. Knot. A knot is the intertwining or tangling of parts of one or more ropes, tapes, or cords in order to fasten them together.

f. Hitch. There are three types of hitches – fixed (eg, clove hitch), friction (eg, Garda hitch) and sliding (eg, Münter hitch). A hitch is the passing of the end of a rope, tape, or cord around its standing part which is then fastened with a loop or bight to provide a temporary stoppage.

g. Tail. The part of the standing end of the rope not in the loop or bight formed when tying a knot.

4.3 The sections of a rope are shown in Figure 4–1.
4.4 All knots, once tied, require some dressing off so that the knot sits the way it is designed to. All tails of the ends of the knot are to be no shorter than 100 mm when tied in rope and tape, and 50 mm when tied in accessory cord. When there are two tails to a knot (such as a double fisherman’s knot) the tails are to be of equal length so that a quick visual inspection can be made to ensure that the knot has not slipped at all.

4.5 **Characteristics of a Knot.** A good knot has the following characteristics:

a. easy to tie and untie
b. easy to check
c. secure – remains tight after tying
d. strength – rope weakening is a minimum

e. has versatility (can be used in a variety of situations)

f. does not tension on itself.

4.6 The following are knots commonly used in roping activities when using nylon ropes or tapes:

a. **Figure Eight on the Bight.** The figure eight on the bight is a very efficient and strong knot because it forms a loop in the rope, which will not draw tight. The knot is strong because the rope does not have sharp bends. The figure eight on the bight is shown in Figure 4–2, Step 1 to Step 4. When both ends of a figure eight on the bight are to be tensioned, the angle between the two ropes must not exceed 60°. Angles greater than 60° split the knot to a point where it begins to tension upon itself causing a weakening of the knot, as shown in Figure 4–3.

![Figure 4–2: Figure Eight on the Bight](image-url)
Figure 4–3: Splitting the Knot

b. *Rethreaded Figure-eight Knot.* The rethreaded figure-eight knot is used to tie onto and around objects such as harnesses and trees, as shown in Figure 4–4, Step 1 to Step 8.
c. **Double Figure-eight Knot.** Also known as bunny ears, the double figure-eight knot is tied to equalise the load on two anchors, each clipped to the ‘ear’. This knot is considered to be strong and secure, and it is fairly easy to adjust the size of the ‘ears’ or loops by moving rope from one of the loops to the other as shown in Figure 4–5, Step 1 to Step 9.

Figure 4–4: Rethreaded Figure-eight Knot
Figure 4–5: Double Figure-eight Knot
d. **Directional Figure-eight Knot (Inline Figure Eight).** A directional figure-eight knot is a knot that can be made on the bight. The directional figure eight should be tied depending on which way the loop will be loaded as shown in Figure 4–6, Step 1 to Step 5. The loop must only be loaded in the correct direction or the knot may fail.

![Figure 4–6: Directional Figure-eight Knot](image)

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e. **Figure-nine Knot.** This knot resembles the figure-eight knot. It creates a strong loop which is reasonably easy to untie. It is tied similarly to a figure eight but with an extra
half turn before finishing. While the knot uses more rope and is bulkier than the figure eight, it avoids sharp bends and therefore retains about 70 per cent of its strength and can be easier to untie after loading. A figure-nine knot is shown in Figure 4–7, Step 1 to Step 6.

Figure 4–7: Figure-nine Knot
f. **Flat Rethread Figure Eight.** This knot is used for joining two ropes of equal diameter. Although suitable, it is bulkier than other options for rope recovery. The flat rethread figure eight is shown in Figure 4–8, Step 1 to Step 4.
Figure 4–8: Flat Rethread Figure-eight Knot
g. *Double Fisherman’s Knot.* This knot is used for joining ends of rope or cord. It is an effective way of joining rope of equal and unequal diameters. The knot is very secure and is difficult to untie once it has been loaded. Additionally it is used when making a Prusik loop and tying rope slings, as shown in Figure 4–9, Step 1 to Step 4.

![Double Fisherman’s Knot](image)

Figure 4–9: Double Fisherman’s Knot

h. *Reef Knot/Square Knot.* The reef or square knot has various applications. It is often used to finish off a coiled rope. A reef knot alone is generally unsuitable for joining two nylon ropes as the knot may slip under tension. The reef knot can come undone when not under load. A reef knot is shown in Figure 4–10, Step 1 to Step 3.
Figure 4–10: Reef Knot

i. *Square Double Fisherman’s Knot.* The square double fisherman’s knot can be used to join two ropes for means of descent. The advantage of this knot is that when wet it does not cinch tight. The disadvantage is that it is bulky and can catch and jam in cracks. A square double fisherman’s knot is shown in Figure 4–11.
j. **Alpine Butterfly.** This knot is versatile due to its ability to be loaded three-ways. It can be used to form a loop mid-rope or to isolate a worn or damaged section of rope. An alpine butterfly knot is shown in Figure 4–12, Step 1 to Step 4.
Figure 4–12: Alpine Butterfly Knot

k. **Tape Knot.** Also known as the water knot, it is used for tying two ends of nylon webbing together and is very useful for joining tape slings. This knot can loosen with movement. It must be set firmly and rechecked often. The tape knot is shown in Figure 4–13, Step 1 to Step 5.
Mariner Knot. The mariner knot can be easily released under tension and is therefore useful in self-rescue situations. This knot will work loose when not under a constant load and for this reason must be under constant surveillance. The mariner knot is shown in Figure 4–14.
Figure 4–14: Mariner Knot

m. **Overhand Knot.** Also known as the thumb knot. The overhand knot is most often used to secure loose rope ends after another knot has been tied. If in the centre of a rope it will reduce the strength by half. The knot can roll and the tighter the knot the weaker the knot becomes. An overhand knot is shown in **Figure 4–15**, Step 1 and Step 2.
n. *Flat Overhand Knot.* This knot is an effective method of joining two ropes of equal diameter for the purpose of rope recovery. Flat overhand knots are also an acceptable way of joining ropes for descent. Because of its asymmetrical profile, the knot tends to rotate away from the rock. The flat side lies against the rock, which makes the knot pull smoothly across edges. Pull the knot tight, it must be appropriately dressed and have a minimum tail length of 1 m. A flat overhand knot is shown in Figure 4–16.
Figure 4–16: Flat Overhand Knot

o. Friction Knots. The following are friction knots. Friction knots work best with 5 to 7 mm accessory cord, generally at least 4 mm smaller than the diameter of the rope that the accessory cord is being attached to and tied in a loop (catcher’s loop):

1. Classic Prusik Knot. The classic Prusik knot can be used as a rope grab. The knot will slide freely up or down a rope, but will grip solidly when weighted using friction, biting onto the core of the rope. The knot also has many uses in ascent and rescue techniques. This knot should normally be wrapped twice around the rope, but a third wrap may be made for heavier loads or if the rope is
wet, muddy, or icy. A classic Prusik knot is shown in Figure 4–17, Step 1 to Step 3.

Figure 4–17: Classic Prusik Knot

(2) **Klemheist.** Like the Prusik knot, this knot may be used to grab a rope. The Klemheist works well with accessory cord but can also be used with 15
to 25 mm nylon tape. After being unweighted, the Klemheist releases and slides up the rope more easily than the Prusik knot. A Klemheist knot is shown in Figure 4–18, Step 1 and Step 2.

Figure 4–18: Klemheist Knot

(3) French Prusik. Like the Klemheist, the French Prusik also works well with accessory cord as well as 15 to 25 mm nylon tape. It must have a minimum of three wraps around the rope. An advantage is that it is easy to retrieve, a disadvantage is that it must be continually maintained during use. It may be used in some rescues and as a self-belay. The French Prusik is shown in Figure 4–19.
(4) *Bachmann.* The Bachmann involves the use of a karabiner and is a sliding friction knot, similar to the Prusik knot. The knot is useful in pulley systems used for hoisting. The karabiner is to be orientated such that it opens at the top. The Bachmann is shown in Figure 4–20, Step 1 to Step 4.

Figure 4–19: French Prusik Knot
Figure 4–20: Bachmann Knot

4.7 Safety Points. The following safety points apply to knots:
   a. Knots must always be neat.
b. Tails must be 100 mm or greater for rope and tape, and 50 mm for accessory cord.

c. Tails should be the same length for easy inspection for slippage.

d. Knots must be loaded in the intended direction of pull.

e. The angle of the two ropes of a figure eight on the bight with tension on both knot tails, must not exceed 60°.

f. Knots must be inspected regularly for damage or wear.

g. If using the flat overhand knot tails must be at least 1 m long.

4.8 Tying a knot or a hitch in a rope will reduce the strength of that part of the rope due to the sharp bends that the rope makes while forming the knot. Table 4–1 summarises the relative strength of a kernmantle rope once a knot has been tied.

Table 4–1: Relative Strengths of Knots for Single Kernmantle Rope

<table>
<thead>
<tr>
<th>Knot</th>
<th>Per cent</th>
<th>Knot</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without knot</td>
<td>100</td>
<td>Double fisherman’s knot</td>
<td>65 to 70</td>
</tr>
<tr>
<td>Bowline</td>
<td>70 to 75</td>
<td>Tape knot</td>
<td>60 to 70</td>
</tr>
<tr>
<td>Figure eight</td>
<td>75 to 80</td>
<td>Clove hitch</td>
<td>60 to 65</td>
</tr>
<tr>
<td>Fisherman’s</td>
<td>60 to 65</td>
<td>Thumb knot</td>
<td>60 to 65</td>
</tr>
</tbody>
</table>

SECTION 4-3. HITCHES

4.9 Hitches. The following are hitches used in roping activities:

a. Round Turn and Two Half Hitches. The round turn and two half hitches can be untied under tension and is therefore useful in self-rescue situations. Because
hitches may work loose when not under tension, this hitch needs to be under constant supervision therefore it must not be used in anchor systems or wherever it cannot be constantly checked. The hitches must be tensioned against the round turn so that they remain taut. This hitch is shown in Figure 4–21, Step 1 to Step 4.

![Figure 4–21: Round Turn and Two Half Hitches](image)

b. **Clove Hitch.** A clove hitch is used to fix a rope to an object. The clove hitch cannot be released when it is under tension. A clove hitch is shown in Figure 4–22, Step 1 to Step 4 and Step 1 to Step 3. Because this hitch
can slip it is only to be used in closed systems. This is where both tails of the hitch are attached or tensioned, thereby preventing either tail from completely slipping through the hitch. A closed system is shown in Figure 4–23.

Figure 4–22: Clove Hitch
c. *Girth Hitch*. The girth hitch is a useful hitch for attaching an accessory cord or sling to a karabiner to lock it in position. It is not recommended to use a girth hitch to join two slings together as this hitch will dramatically weaken the slings, instead join them with a karabiner. The girth hitch is shown in Figure 4–24.
d. **Münter Hitch.** The Münter (or Italian hitch) hitch is a useful hitch in roping. Unlike the clove hitch, the Münter hitch is designed to slip. In an emergency the Münter hitch can be used to belay a climber, or abseil. The Münter hitch is shown in Figure 4–25.
4.10 For carrying or storing, the rope is generally coiled in either the mountain coil or the butterfly coil. Normally, ropes are coiled in accordance with how they are about to be used. To uncoil a rope, untie the cinch knot and then uncoil the rope one loop at a time flaking the rope into a pile.

4.11 Flaking. Before a rope is coiled and after it is uncoiled it should be flaked to remove any twists and should be inspected at the same time. To flake a rope, start at one end and pull the rope through both hands creating a loose pile of rope, at the same time check the rope for damage. It must be ensured that the ends of the rope stay clear of the pile, as shown in Figure 4–26.
4.12 Mountain Coil. The mountain coil is usually used for ropes that are about to be stored, or carried over the shoulder. The rope is coiled on top of itself. Once all the rope is coiled, it is secured by one tail being folded back to form a bight, the other tail is then tightly wrapped around the bight and all the coils four to six times. The tail is passed through the bight and the first tail pulled tight. Excess should be tied with a reef knot, and the tails should not be longer than the mountain coil itself. The mountain coil is shown in Figure 4–27, Step 1 to Step 5.
Figure 4–27: The Mountain Coil

4.13 The advantage of the mountain coil is ease of carriage over a pack and ease of coiling long lengths (over 50 m) or short lengths (under 30 m).
4.14 A mountain coil may be coiled the following ways:
   a. up to 20 m in hands, by an individual
   b. up to 60 m, by an individual over the head/shoulders or with assistance
   c. around the feet and neck, by an individual or with assistance for 60 to 100 m
   d. if any longer, bagging must be considered.

4.15 To uncoil a mountain coil:
   a. release the cinch and untangle the ends from the coil
   b. hold the entire coil in one hand; with the other hand unfold the coils one loop at a time, dropping these to the ground.

4.16 Butterfly Coil. The butterfly coil is suited for ropes that are about to be used (after storage and flaking, in preparation for use) or during an expeditionary activity where the ropes will be used, carried and used again. This is due to the fact that it does not place a twist in the rope and when the rope is used again it will pay out without kinking. The butterfly coil can be started with two ends together or at one end. This is a personal preference and usually depends on whether the rope is being coiled for a top rope climbing activity or a lead climbing activity.

4.17 The following process creates the butterfly coil using the hanking method:
   a. To begin, lay approximately 2 m of rope on the ground. Grasp the rope over-hand in the right and under-hand in the left hand then stretch the rope across the chest, forming a large bight in the rope.
   b. With the right hand, place the rope across the palm of the left hand completing the bight in a fist to palm motion. Next stretch the rope across the chest and bring the right hand back to the left in a palm to palm direction.
c. Continue this action until approximately 2 m of rope is left. If this has been done correctly, there will be no twists formed in the rope.

d. To finish the coil, grasp both ends of the rope and wrap them around the folds four to six times.

e. A loop is then formed and passed through the eye of the folds.

f. Grasp the loop and fold it over the top of the rope, locking the coils off.

4.18 An alternate method is as follows:

a. Loop the rope around the neck and down over the chest, creating neat loops at waist level.

b. Leaving 2 m of slack at each end, the tails are tightly wrapped around the folds four to six times at the top and a bight is formed and passed through the fold.

c. The bight is then pulled up over the top of the folds and down.

d. While holding the bight in this position pull the tails tight. This will lock the butterfly coil into position.

4.19 The rope is now ready for use. The butterfly coil is shown in Figure 4–28.
4.20 The butterfly coil can be tied around the body for ease of carrying by leaving 3 m of tail at each end of the rope instead of 2 m when coiling. The coil is placed on the back with the knot at the top. A tail of the rope is pulled over each shoulder and passed under the arms to the back, crossing each other and the coil. The rope tails are pulled through to the front of the body and tied off with a reef knot at the waist, as shown in Figure 4–28.

4.21 The hanking method is a useful tool for preparing a rope for throwing.
**SECTION 4-5. ROPE THROWING**

4.22 A rope is prepared for throwing by securing an end and flaking. Approximately two-thirds of the rope is coiled ensuring that the running end is longer than the coils. This is important to ensure that the running end cannot pass through the coils and thus form knots. The coil is then split in half and held in each hand with slack between the coils. The rope is then ready to throw, as shown in Figure 4–29.

![Preparation to Throw Rope](image)

**Figure 4–29: Preparing to Throw Rope**

4.23 **Nil to Low Wind.** The rope is thrown underarm. The coils at the running end are thrown first, then the remaining coils.

4.24 **Moderate to Strong Winds.** The rope is thrown over-arm and directed downward. The coils at the standing end are thrown first, then the remaining coils at the running end. This method requires considerable practice.
4.25 **Bagged.** If the base of a cliff has many trees or the area for the rope to land is very tight then the rope may be bagged using a rope bag. The rope is secured to the base of the bag with a tail length of at least 1 m, and then flaked on top of itself rather than coiled. The standing end of the rope is secured, and the bag is suspended under an abseiler from their descent device. Caution must be taken to ensure that the rope does not tangle. Rope bags can also be thrown, however; extra safety considerations must be taken as described in the following paragraphs.

4.26 **General Safety for Throwing Ropes.** The following safety precautions are to be adhered to when throwing ropes:

- a. The thrower is to be secured by a safety line.
- b. The thrower is to identify where the rope will be thrown from and is to look down the cliff’s face if possible to identify any obstacles or hazards.
- c. The thrower calls ‘ROPE BELOW’ before throwing the rope.
- d. The thrower must be clear of entanglement.
- e. The rope must be secured to an anchor point.
- f. Rope bags are not to be thrown if the base of the cliff cannot be visually cleared prior to throwing.
- g. Rope bags are to be packed in such a way that they do not contain excess rope once they reach the base of the cliff.
- h. The thrower, while remaining secured by a safety rope, must inspect the line the rope has taken to ensure that it has not become entangled, caught or obstructed.
CHAPTER 5

ROPING SITE SELECTION AND CLIFF HEAD PROCEDURES

Site Section

5.1 Selecting a site suitable to achieving the aims and objectives of the user’s activity can be a difficult process. This chapter covers both general and specific considerations associated with site selection and provides a detailed list of safety requirements. Site selection is one of the most important aspects of organising a roping activity.

5.2 The ADF supports minimum impact practices for roping activities. Over time, however, the impact upon areas being used for roping has become noticeable. Current problems associated with roping and hiking (to and from abseil sites) include:

a. soil erosion
b. trail degeneration
c. damage to trees
d. damage to bushes and rock flora (such as lichens)
e. litter
f. human waste
g. the indiscriminate use of fixed anchors.

5.3 ADF members using areas for roping activities are to set an example for all user groups by working to reduce or eliminate environmental impacts. To ensure the future of open access to roping training areas, minimal regulation and a healthy environment, each participant must do everything they can to prevent or reduce impact.
5.4 **Rubbish.** Guidelines for rubbish and waste control during roping activities are as follows:

a. Use toilets when available.
b. Do not leave human waste within 50 m of any water source or at the base of a cliff.
c. Do not urinate on the cliff face.
d. Consider the use of a ‘pee bottle’ to carry out urine.
e. Bury faeces at least 15 cm below the soil surface or use a ‘poo tube’ or ‘wag bag’ if available.
f. Carry out used toilet paper in a snap lock bag (do not bury or burn).
g. Carry out all rubbish, including food scraps.

5.5 **Erosion and Track Maintenance.** Guidelines for erosion and track maintenance during roping activities are as follows:

a. Ensure that participants remain on abseil access tracks.
b. Avoid travelling cross-country whenever possible and do not cut across trail switchbacks.
c. Be aware of the surroundings and respect the wilderness by avoiding steep slopes with loose soils and staying on solid rock whenever possible. The worst damage to soil and vegetation may occur while walking to and from an abseil site.
d. Observe all closures and regulations. National Parks management close some areas temporarily or seasonally to protect fauna (such as nesting birds), to protect hikers passing below trailside routes, or allow overused areas to recover from erosion. Check area specific climbing guides, web pages, and training area managers for current closures and regulations.

5.6 **Roping Ethics.** Guidelines for good environmental ethics while roping are as follows:

a. Do not sculpt, chisel or deface the rock.
b. Do not remove vegetation from the rock face.

c. Adopt a ‘minimum impact’ frame of mind concerning abseiling.

d. Do not stray from park tracks unless it is a designated abseil access trail.

e. Ensure that rope protectors/tree protectors are used on all trees.

5.7 Planning Considerations. The following factors must be considered during the planning stage of a roping activity as these factors directly affect the final site selection:

a. the number of participants

b. equipment available

c. UATL/instructor/supervisor support

d. timings

e. transport requirements

f. accommodation

g. medical support (including an evacuation plan to the nearest hospital)

h. the objectives of the training (what is to be achieved)

i. land clearances required to operate or use specific areas (from the appropriate land management agency).

Natural Features

5.8 Natural features are existing cliffs and quarries that provide a location to conduct descending and ascending activities. When a number of proposed sites have been identified, a detailed reconnaissance of each site needs to be conducted to determine its suitability. The factors to consider are as follows:

a. Stability of the Cliff. The cliff must be stable and free from the danger of rockfall. Beware of quarries as blasting and drilling has fractured the rock. If unsure of the stability of the site, seek advice.
b. **Cliff Head.** The cliff head must offer a suitable area on top that has a stable and safe platform for dispatching and to conduct rescues.

c. **Cliff Base.** The cliff base area must be large enough to allow personnel to avoid rockfall. The base must have a safe and stable platform from which to complete abseiling and to belay from.

d. **Anchor Points.** Anchor points at the cliff site must be suitable and must be fail-safe. The anchor points available will influence the equipment required.

e. **Cliff Height.** The cliff height must meet the activity requirements and be suitably safe for the participant skill level.

f. **Variety of Training.** Depending on the training to be conducted, the cliff should have a variety of ascent and descent routes to cover different situations such as slabs, overhangs, and free hanging abseils.

g. **Initial Training Area.** Depending on the experience and skills of the participants of the activity, the cliff should have an initial training area (such as a ground training area, or small slope) to introduce participants to the requirements of the activity.

h. **Routes.** Safe routes to the top and bottom of the cliff are required.

i. **Rescue.** A rescue plan and the provision of equipment needed must be planned, including the location of the nearest hospital or medical facility including the services available and the means of communication (and reception available if using mobile communications).

j. **Stores Required.** The stores required will vary with the type of activity, location, height and access.

k. **Location of Stores.** Stores will need to be located in an area free from damaging chemicals, POL and sunlight. The stores area should be large enough to permit the
issue and receipt of stores efficiently and should be close to vehicle access.

l. **Administration and Waiting Areas.** Areas for participants to wait, eat, and smoke must be allocated. The areas should be large enough to hold all participants and should be clear of all hazards relating to the activity.

m. **Safety Vehicle Parking.** The safety vehicle must be accessible and available to the appointed medics, drivers, UATLs, and instructors.

n. **Vehicle Parking.** All vehicles should be parked in an area free from hazards relating to the activity.

o. **Walk In/Out.** If access to the training area is to be by foot, consideration of the route must be undertaken to ensure that the route is environmentally sound and that all equipment can be carried in.

**Artificial Features**

5.9 Artificial features are abseiling towers, buildings, bridges, dam walls, water towers, and other man-made objects and structures that may be used for ascending and descending training. As for natural features, there are a number of factors to consider for their use, these are as follows:

a. **Artificial Feature.** The feature must be free of the danger of falling objects.

b. **Feature Head.** The feature head must offer an area on top that has a suitable and safe area for dispatching.

c. **Feature Base.** This area must be large enough to allow personnel to operate safely and effectively. The base must have a safe and stable platform from which to complete abseiling and to belay from.

d. **Anchor Points.** Anchor points at the site must be suitable and be fail-safe. The anchor points available will influence the equipment required. Anchor points are to be specifically built for descending and ascending activities.
e. **Feature Edge.** The edge of buildings and towers may not have guardrails. The safety distance from the edge is to be assessed by the OIC of the activity.

d. **Edge Construction.** Due to the nature of construction materials used in buildings and on artificial surfaces, special consideration needs to be given to protecting ropes at the edge.

g. **Feature Height.** The feature height must meet the activity requirements and be suitable for the equipment and ropes that are available.

h. **External Features.** Many buildings and artificial features have external fixtures such as utilities and windows. The route must be established such that participants are in no danger of breaking windows or building fixtures.

i. **Variety of Training.** Depending on the training to be conducted, the feature should have a variety of descent routes to cover different degrees of descending and ascending ability of participants.

j. **Initial Training Area.** Depending on the experience and skills of the participants of the activity, the area should have an initial training area (such as a ground training area) to introduce participants to the requirements of the activity.

k. **Routes.** Safe routes and access to the top and bottom of the feature are required. These may include elevators, stairs, or external ladders.

l. **Rescue.** A rescue plan and the provision of equipment needed must be planned, including the location of the nearest hospital or medical facility including the services available and the means of communication (and reception available if using mobile communications).

m. **Stores Required.** The stores required will vary with the feature location, height and access.
n. **Location of Stores.** Stores will need to be located in an area free from damaging chemicals, POL and sunlight. The stores area should be large enough to permit the issue and receipt of stores efficiently and should be close to vehicle access.

o. **Administration and Waiting Areas.** Areas for participants to wait, eat, and smoke must be allocated. The areas should be large enough to hold all participants, and should be clear of all hazards relating to the activity.

p. **Safety Vehicle Parking.** The safety vehicle must be accessible and available to the appointed medics, drivers, UATLs, and instructors.

q. **Vehicle Parking.** All vehicles should be parked in an area free from hazards relating to the activity.

**5.10 Sources of Information.** Information about suitable areas can be obtained from the following sources:

a. climbing and outdoor magazines

b. guidebooks

c. the internet

d. outdoor centres (military/civilian)

e. climbing/outdoor shops

f. training area managers

g. UATL network

h. local knowledge such as other personnel who may have used the area under consideration.

**Abseiling Towers**

**5.11** Abseiling towers require the same guidelines as for artificial abseil features. Any site-specific guidelines must be adhered to. Due to the complexities and many configurations of abseil towers, all rigging of anchor points cannot be detailed. It must be ensured, however, that basic anchor principals are applied and that if the roping tower has not been purpose-built, then the
5.12 A purpose-built abseiling tower should be used in accordance with the engineering specifications of that structure. Examples of roping towers are shown in Figure 5–1.

Figure 5–1: Examples of Roping Towers
CHAPTER 6

ROPING ANCHOR POINTS AND SYSTEMS

SECTION 6-1. INTRODUCTION

6.1 This chapter will cover the various types of anchor points and systems, their application, and both general and specific considerations. Natural, fixed and artificial anchors should be understood and practised before undertaking any AT roping activity. Anchor systems are the basis of all roping activities. Primarily this includes activities such as ascending, descending and rescue. There are two main elements to constructing anchors:

a. anchor points
b. anchor systems.

SECTION 6-2. ANCHOR POINTS

6.2 Creation of an anchor point involves the securing of a rope or a sling to a strong fail-safe object. There are three types of anchor points, these are as follows:

a. natural anchor points
b. fixed anchor points
c. artificial anchor points.

6.3 A single anchor point is the minimum anchor requirement needed for a safety line and expeditionary or multi-pitch abseiling. It is also the basis for setting up an anchor system as detailed later in this chapter.

6.4 General Considerations for Anchor Points. The following considerations apply to the use of all anchor points:

a. Each anchor point must be fail-safe.
b. Two anchor points constitute one anchor system.
c. The direction of pull must be equal in relation to the anchor points and culminating point.

d. Sharp areas that may cut or damage the rope or nylon tape need to be protected.

e. Nylon tape slings should be doubled around or through natural anchor points if possible.

f. Locking karabiners are to be used where possible.

g. Clip gate karabiners may be used, but must be used in pairs, with the gates reversed and opposed (cross-gate). They also must be as far to the rear of the system as possible (behind locking karabiners).

h. Karabiners are to be used so the forces are directed along the spine. Three directions of pull or cross-loading must not be placed on karabiners.

SECTION 6-3. NATURAL ANCHOR POINTS

6.5 Natural anchor points are created when a rope or tape is passed around, over, or threaded through a natural feature such as a tree or rock.

6.6 **Tying Natural Anchor Points.** Methods in which nylon tape can be attached to natural anchor points are shown in Figure 6–1. Methods in which rope can be attached to natural anchor points are shown in Figure 6–2.
Figure 6–1: Anchor Points using Nylon Tape

Tape should be doubled

Thumb knot
Threads are multi-directional

Figure 6–2: Anchor Points using Rope
Trees

6.7 When selecting a tree to be used as an anchor point, its size (diameter), species, root systems, and the soil consistency must all be taken into account. The following considerations apply to the use of trees for anchor points:

a. **Size.** A tree must be large enough to support the varying loads that will be placed on it. A tree’s trunk diameter when chosen for an anchor point will also be dictated by what type of tree it is, as certain types of timbers are stronger than others. As a guide, a tree must have a trunk diameter of at least 100 mm to be considered as an anchor point.

b. **Living.** If the tree is dead, it must not have begun to rot and it must still be firmly embedded into the ground. The tree must also be checked to ensure that it has not been eaten out internally by white ants, termites, other insects or rodents.

c. **Root Depth.** Roots must not be just on the surface such as is often found in rocky areas. In most cases, tree roots will be limited in their ability to obtain depth in areas such as cliff heads. This will significantly reduce the stability of any tree used as an anchor.

d. **Tie Low.** The anchor must be tied as low as possible on the tree to take advantage of its strength. When an anchor is tied around a tree, rope protectors or padding should be used to protect the tree from rope damage. The higher the rope is tied around a tree the more leverage is created, reducing the effectiveness of the tree as an anchor.

Rocks

6.8 The following considerations apply to the use of rocks for anchor points:

a. **Stability.** The rock must be stable, and must not be balancing on only a few points. If it can be moved or rocked, then it is not suitable for use as an anchor point.
b. **Size.** The rock must be big enough to take the load to be placed on it. An acceptable stand-alone boulder should be at least 1 m³. The position of boulders on slopes, or unstable ground must also be considered.

c. **Shape.** The rock must not be angled towards the load as this will allow rope to slip off. Some rocks may have holes carved through them known as threads. These are excellent for anchor systems but must be checked to ensure that they do not have any sharp edges and are strong enough to support the loads placed on the anchor point.

d. **Sharpness.** Rocks with sharp edges will require padding to protect the rope and ensure that it is not cut. If rope protection is not readily available then the most likely point of wear or damage is to be protected. Packs, jumpers and rope bags may be used as padding and protection.

6.9 **Threads.** Threads are small tunnels, holes or arches in rock. Strong threads make good anchors because they are secure.

6.10 **Chockstones.** Chockstones used as anchors should be firmly wedged and of strong, compact rock so that it will not crumble or pull free. The crack should become substantially narrower in the direction of loading so that the load acts to more firmly wedge the chockstone. If a suitable crack is available, but does not already contain a good chockstone, then a rock can be selected and inserted by hand. Alternatively, a poorly positioned chockstone may be repositioned. Ensure that the sides of the crack do not crumble or fracture.

6.11 **Bollards.** As a general rule, bollards should be a minimum of 300 mm in diameter. This will be dependent on the rock type as anchors using rock such as sandstone will need to be larger. With slender bollards, the greatest strength is obtained by tying to the base of the bollard, to eliminate leverage.

6.12 Whenever using rock it is a good idea if a rope or sling is wrapped around the rock to add friction and bite onto the rock
for extra security. This will prevent the rope moving which will reduce abrasion to the rope or tape sling.

SECTION 6-4. FIXED ANCHOR POINTS

6.13 Fixed Anchor Points. Fixed anchor points are permanent fixtures; designed, constructed and placed specifically for use as an anchor. Fixed anchor points can be established using a variety of hardware as shown in Table 6–1. A fixed anchor must be inspected and assessed for its suitability for the task, paying particular attention to its placement and method of affixation (glued or expansion). Fixed anchors may be treated as anchor points if inspection reveals that they are robust, undamaged and otherwise fail-safe. A fixed anchor may include:

a. bolts
b. chains
c. bollards
d. pipes.
## Table 6–1: Fixed Anchors

<table>
<thead>
<tr>
<th>Anchor Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Longlife</strong></td>
<td>This 12 mm stainless expansion anchor cannot be dismantled. The expansion is via a hammer-driven shaft. It is simple to place, as it does not require tightening.</td>
</tr>
<tr>
<td><strong>Collinox/Bat’inox</strong></td>
<td>These are resin anchors, 10 and 14 mm in diameter respectively. The Collinox is suited to hard rock (granite, limestone) while the Bat’inox is well suited to softer rock (sandstone).</td>
</tr>
<tr>
<td><strong>Ampoule Collinox/Bat’inox</strong></td>
<td>This is the resin required for the placement of the Collinox and Bat’inox anchors. It sets hard in 2 minutes but does not reach full hardness for 12 hours.</td>
</tr>
<tr>
<td><strong>Coeur Goujon</strong></td>
<td>This expansion bolt and hanger is available in two sizes, 10 and 12 mm. It is suited to all types of rock and is tightened with a ring spanner.</td>
</tr>
<tr>
<td><strong>Fixe-2</strong></td>
<td>Two Fixe-2 anchors make a safe belay station as descending takes place from two independent anchors.</td>
</tr>
<tr>
<td><strong>Belay Chain</strong></td>
<td>This setup has been designed for use as a belay station in multi-pitch routes, as well as an abseiling stance for canyoning. The bottom ring is placed perpendicular to the wall to make rope recovery easy.</td>
</tr>
<tr>
<td><strong>Super Shut</strong></td>
<td>The super shut is strong, long-lasting and safe. It must be placed with 10 mm by 90 mm stainless steel bolts or longer and in pairs. It is best suited for single-pitch routes.</td>
</tr>
</tbody>
</table>
6.14 **Types of Bolts.** There are a variety of bolts used in the construction of fixed anchors. It is essential that the type of bolt in use is clearly understood and its limitations are considered. The most common and their considerations are:

a. *Carrot Bolts.* Carrot bolts are usually stainless steel industrial bolts that have had the threads ground down towards the tip, resulting in a carrot-like shape. They are bashed or glued (less common) into a hole drilled electrically or by hand. Carrot bolts are good in shear but poor in tension (pull-out). Each carrot bolt should always be considered to be the equivalent to half an anchor point (ie, two must be joined together to create a single anchor point). The methods by which two carrot bolts can be joined are shown in Figure 6–3.

b. *Ringbolts.* Ringbolts are stainless steel P-shaped bar or cast eyebolts secured by epoxy resin or cement, or U-shaped bars secured by epoxy resin or cement. These types of bolts are specifically designed for use as an anchor, and normally carry load ratings. After careful inspection and consideration a ring bolt can be considered to be the equivalent of a single anchor point.

c. *Drilled Expansion Bolts.* Drilled expansion bolts are sleeves of varying diameter, secured by expansion and fitted into a hole created by a hand or electric drill. Drilled expansion bolts are typically used when placing fixed hangers and other hardware as shown in Table 6-1. After careful inspection and consideration these can be considered to be the equivalent of a single anchor point. The term ‘hanger’, in the context of this text, refers to the visible exterior part of any anchor that is placed by drilling a hole in a rock surface. The sleeve, bolt or pin that enters the hole is the ‘bolt’.
6.15 **Chains.** In some situations, chains can be used to construct a fixed anchor. It is essential that the type of bolt used to construct the chain anchor is understood and limitations of

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*LWP-G 7-6-2, Adventurous Training – Roping, 2018*
those bolts understood. Karabiners may be clipped through the culminating link if the chains are joined.

6.16 **Bollards.** Bollards are usually constructed or installed by land management agencies to prevent environmental damage in areas that may be environmentally sensitive or have heavy traffic. When using a bollard, consideration to its construction and placement must be given. A bollard can be considered to be the equivalent of a single anchor point.

6.17 **Pipes.** In the context of a fixed anchor, pipes are usually steel, shaped and cemented into the ground. After careful inspection and consideration a pipe can be considered to be the equivalent of a single anchor point.

6.18 **Bolt Plates and Hangers.** Bolt plates are small pressed metal plates designed to fit over the head of carrot bolts. When used as part of an anchor, locking karabiners must be placed through all bolt plates and hangers to ensure that the plate is locked onto the carrot. Additionally the rope is not to run directly through the plate or hangers. A karabiner is to be used to form the surface through which the rope will run.

6.19 **Rescue.** Bolts used in rescue are an area of some debate and controversy. Some modern bolts are perfectly suitable for large rescue loads; other older bolts are certainly not. If a UATL is faced with a pitch where ringbolts are in place, then for all reasonable situations they can be assumed adequate. The UATL responsible for rigging must be confident that the anchors are suitable for the rescue load being placed on them. If in doubt, the anchor should be backed-up. See Section 6-7 for backing up an anchor.

**SECTION 6-5. ARTIFICIAL ANCHOR POINTS**

6.20 **Artificial Anchor Points.** Artificial anchor points are used when no natural or fixed features are available or suitable and may include:

a. chocks (active and passive climbing protection)
b. steel stakes/star pickets, or
c. a vehicle.

Chocks

6.21 See Section 6-16 for the placing of protection.

Steel Stakes/Star Pickets

6.22 Two steel stakes in line with each other and 1 to 2 m apart may be used to form an anchor point. The stakes must be linked together by a taut rope. A figure eight on the bight knot must be used to secure the rope to the furthermost stake. The rope is then secured to the stake closest to the cliff using a clove hitch. The rope must have even tension between the two stakes. The stakes are to have padding to protect the rope against cuts and wear. If in doubt of the solidity of the ground, more stakes in line can be used. Figure 6–4 shows an example of the use of steel stakes as an anchor point.
6.23 The following considerations apply to the use of steel stakes (star pickets) for anchor points:

a. Stakes must be driven into the ground a minimum of 75 cm.

b. The angle of the stakes is 60 to 75° (depending on soil composition, strength and consistency) sloping away from the direction of pull.

c. Padding is to be wrapped around the stake to protect the rope from being cut.

d. When stakes are sited, the scoop or “V” is to be facing away from the cliff edge.

6.24 When using stakes, an assessment of the ground’s stability should be made, especially after heavy rain. If in doubt of the integrity of the steel stakes, more stakes in line or further sets of stakes may be used.

Vehicles

6.25 To form an anchor system, a vehicle may be used. It must have two strong attachment points low on the vehicle to be used as anchor points, as shown in Figure 6–5.

![Figure 6–5: Use of a Vehicle as an Anchor System](image)
6.26 The following considerations apply to the use of vehicles for anchor systems:

a. The vehicle must not be the safety vehicle.
b. The vehicle must be parked parallel to the cliff.
c. The hand brake must be on.
d. The vehicle must be in gear (or in park for automatic vehicles).
e. The wheels must be chocked.
f. The rope must be attached low to the strong part of vehicle, such as the chassis.
g. The vehicle’s keys are to be removed.
h. Brake lines and areas of grease and heat are to be avoided.

SECTION 6-6. ANCHOR SYSTEMS

6.27 It is difficult to ascertain the strength, or guarantee the integrity of an object used as an anchor point, as different roping activities create different loads and may have a cumulative effect that degrades its reliability. During rigorous roping activities, or where practically efficient to do so, anchor systems composed of two or more anchor points are required. When two or more independent anchor points are joined together, they form an anchor system.

6.28 The word ‘independent’ has a very powerful influence with anchor systems. If an anchor point’s ability to remain in position is dependent on another one then the advantage of having a system has been wasted. Thus, each anchor point must share the load with the other point, but must not be reliant on the other point if it should fail.

6.29 Anchor System Use. Anchor systems in roping activities are the minimum requirement for rescue operations, and for sports
abseiling or normal abseiling involving a large number of participants.

6.30 Anchor System Types. An anchor system may be constructed using totally natural, fixed or artificial anchors or a combination of different anchor types (eg, a natural point and a fixed point).

6.31 General Considerations. The following considerations apply to the use of all anchor systems:

a. Each anchor point in the anchor system must be fail-safe (ie, not ever going to fail).

b. All anchor ropes in the system must equally share the load.

c. The anchor system must not shock load if an anchor point fails.

d. The angle of the ropes between anchor points must not exceed 120°.

e. Figure-eight knots are not to be split by more than 60°.

f. Each anchor point must be independent of the other point being used to create the anchor system.

g. Sharp areas that may cut or damage the rope or tape sling need to be protected.

h. Tape slings should be doubled around or through natural anchor points. Rope should be used in preference to slings where possible and practical.

6.32 Karabiners. The following applies to the use of karabiners:

a. Locking karabiners are to be used; where possible preference is to be given to the use of steel karabiners.

b. Clip gate karabiners may be used, but must be used in pairs, with the gates reversed and opposed (cross-gate). They also must be as far to the rear of the system as possible (behind the locking karabiner).
c. Karabiners must be used so the forces are along the spine. Three-way directional pulls (exceeding 60°) must not be placed on karabiners.

6.33 Anchor System Construction. Limitations for the construction of anchor systems are the type of anchors available (natural, fixed and artificial), the equipment available and, most importantly, the imagination of the person establishing and setting the anchor. The preferred type of rope is 11 mm static, and for retrievable systems is 9 mm static. While there are many possible sequences for the construction of an anchor system, a single rope method is as follows:

a. The UATL constructing the anchor first identifies the section of cliff on which the abseiling or ascending is to be conducted. If required, the UATL identifies an anchor point, ties a safety line to that anchor, ties the safety line to them, and moves to the edge and inspects the descent or ascent route.

b. From their position on the cliff edge, the UATL constructing the anchor turns their back to the cliff, views the cliff-top area, and identifies possible suitable anchor points (including the one they are on).

c. With a rope long enough to tie the complete anchor system, connect the rope to the first anchor point using an appropriate method, with a bight of rope left at the anticipated culminating point, the rope is run to the second anchor point. The rope is then connected to the second anchor point (see Figure 6–6[a]). Options for connection may be a rethread figure eight on a bight, or a rope sling using three figure eight on the bight knots and a karabiner, clove hitch, attached to a nylon sling with a karabiner and so on (see Figure 6–6[b]).

d. At the culminating point, the rope coming from both anchor points is pulled in the direction of anticipated force, creating equal tension in each anchor. This equal tension distributes an even force on each anchor point. A figure eight on the bight knot is tied in each side of the

\[ \text{Figure 6–6[a] and Figure 6–6[b]} \]
rope, leaving an isolation loop of slack rope between the two knots.

e. Two karabiners are clipped into both figure-eight knots from each anchor point, unless the angle is over 60° when the karabiners should be separated to one in each figure eight on the bight to prevent cross-loading. The rope that is to be used as the line for ascending or descending is then clipped into both karabiners with a figure eight on the bight (see Figure 6–6).

6.34 The anchor systems depicted in Figure 6–6 uses a combination of both a rock and tree and a thread and tree. The top diagram (see Figure 6–6(a) shows the system constructed using one rope for the anchor system with two figure eight on the bight knots. The bottom diagram (see Figure 6–6(b) is similar in construction, with one rope for the anchor system but with a rope sling attaching the anchor rope to the second anchor point (the tree). A separate abseil line has been used in both illustrations. In each anchor system, there are two karabiners in the culminating point ensuring that there is no single point of failure rearward of the descent or ascent rope.
6.35 **Length.** When constructing anchor systems, it is essential that both ropes are equally tensioned, this will be more difficult if one rope is longer than the other.

6.36 **Direction of Pull.** The direction of the force is very important when constructing the anchor system so that the rope is established in the appropriate position to take advantage of the area identified for use. Equal tension is also important in the

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*Figure 6–6: Anchor Systems Created using Ropes*
event of one anchor point failing as the other anchor point will not suffer a shock load (dynamic load).

6.37 Angles of Anchors. Having two or more anchor points not only provides redundancy if one fails, but with each rope having equal tension it can share the load and reduce the load that is being applied to each anchor. An anchor system with its anchors directly in line with the ascending or descending force will theoretically have 50 per cent of the load on each point. A system with a 90° angle will have approximately 71 per cent on each point and at 120° it will be equal. Beyond 120° it begins to amplify exponentially. Thus, the angle between two anchor points must never exceed 120°. The effect that angle has on the loading of anchor points is shown in Figure 6–7 (shown is an angle of 120° for a 100 kg load on the rope).
Figure 6–7: Angles and Loading in an Anchor System
6.38 Angles of Knots. When constructing and tying anchor systems, the angle of the ropes used in the system are to be taken into account to ensure that knots are not split. Figure-eight knots should only be split to a maximum of 60°. Beyond this angle they begin to roll and become weaker.

6.39 For all AT activities, culminating points, irrespective of the angle created, are to be constructed using two figure eight on the bight knots with two locking karabiners. This will ensure that figure-eight knots are not split beyond 60° and there is no single point of failure within the anchor system rearward of the culminating point. This ensures that each anchor point is independent. Such an anchor system is shown in Figure 6–8.

**WARNING**

The maximum angle for any anchor system is not to exceed 120° in order to avoid more than 100 per cent of load being applied to each point. This could result in anchor point failure possibly causing serious injury to personnel, or death.
Figure 6–8: Anchor System to 120 Degrees
6.40 **Angles for Karabiners.** The strongest part of a karabiner is along the spine. With an anchor system, rope or tape can approach the anchor from different directions and angles. When this angle becomes greater than 60° the karabiner suffers three-way loading which applies forces on the karabiner’s weaker sections.

6.41 Karabiners are to be used so the forces placed on it are along the major axis (see Figure 6–9(a). Three directions of pull must not be placed on karabiners, as shown in Figure 6–9(b).

![Figure 6–9: Directional Pull on Karabiners](image)
6.42 Locking karabiners should be used when constructing anchor systems, steel is preferred for its ability to resist wear. Clip gate karabiners may be used if nothing else is available but they must be used in pairs opposite and opposed (cross-gate), as shown in Figure 6–10.

![Figure 6–10: Cross-gated Karabiners](image_url)

6.43 Equipment Precedence. When using equipment with lower abrasion resistance or breaking strains such as clip gate karabiners or nylon tape, it is important to have them placed to the rear of the anchor system and as close to the anchor points as possible. This is so that the weaker equipment does not reduce the strength of the overall system but only what is behind it. If a weaker karabiner is placed in the culminating point, then that weaker breaking strain has affected all parts of the anchor to the rear of it.

6.44 Nylon Tape. Use of nylon tape should be limited if possible as it has a lower abrasive resistance than rope. If nylon tape is to be used within an anchor system, it should be doubled in a loop and tied off with a thumb knot at each end. This ensures that if one side were to break or cut, the other side would still provide...
support for the anchor. Rope protectors must be used where necessary. A tape sling using nylon tape is shown in Figure 6–11.

![Figure 6–11: Tape Sling around Anchor Point](image)

**Establishing a Descent Rope**

6.45 The descent rope can be a fixed line or a lowerable system. The fixed line is established by attaching two locking karabiners, preferably steel, into the culmination point, tie a figure eight on the bight on the end of the rope, and attach this rope to both karabiners. There are two karabiners used in the culmination for redundancy. Ensure that the karabiners have the widest end toward the widest load and that the gates are away from any rock or possible rub point.

6.46 The lowerable system is also established by attaching two locking karabiners, preferably steel, into the culmination point. A belay device is attached to the culmination point and tied off at the desired length. The purpose of this system is to enable the quick lowering of an abseiler if necessary. For rescues on these systems see Chapter 9.

6.47 The rope may now be deployed as described in Chapter 4.

**Rope Protection**

6.48 To pass a wrap-around rope protector while ascending or descending, release it from the rope and reattach it once you have passed. Tie-off or use the brake person if having difficulty...
repositioning the protection. The more protectors that are fitted on each pitch, the slower the ascent or descent will be.

6.49 Carpet or another type of suitable material (rope bags, etc.) is a good substitute to protect the abseil line below the culmination point as it is generally easier to reposition on the transition past the rub point than the wrap-around protectors.

6.50 For the placement of the rope protectors it is suggested that the first protector is placed at the top of the pitch if required prior to the first member descending. If the rub points are known the first descender can position the protection on their descent. If the rub points are not known the first descender will need to inform the person at the top during their descent. The protection will then be placed by the next member to abseil. This should occur prior to novice participant’s abseiling. Each abseiler can correct the initial placement during descent.

6.51 Rope protection should be considered from the cliff backwards as the most forces occur closest to the abseiler or climber.

**WARNING**

Descent lines routed through waterfalls, tight squeezes and/or overhangs prevent identification of sharp edges and inhibit visual detection of damaged rope.

This situation may lead to a participant descending past a section of damaged rope, thereby placing them in a position of grave danger should the rope fail.

If a rope is deployed in such a manner, the UATL is to assess the risk and mitigate where possible. The brief to participants is to include the identification of this risk and detail the participant’s actions on should a damaged section of rope be identified.
Safety

6.52 Distance from Edge. An abseiler should hook up to the descent rope at a safe distance from the cliff edge (no closer than 2 m to the cliff edge as a minimum distance). If at any stage this cannot be achieved, a safety line must be attached to the abseiler while hooking up. The safety line is to be released only when the abseiler has adopted the brake position and has it firmly applied. The safety line should not allow the abseiler to reach the edge of the cliff, just to the hook up point. The UATL must have a safety line to allow them to see over the cliff edge at all times during dispatching. This ensures their safety if a rescue needs to occur and enables continued facilitation.

6.53 Each roping site will require a different anchor system and will be governed by different limitations. Anchor systems are easy to construct if practised constantly.

Fixed Lines

6.54 Handline. A handline needs at least one anchor point and can be constructed by various methods. It is used as an assist over difficult terrain. For more information see Section 8-5.

6.55 Traverse. A traverse needs at least two anchor points, one at each end, with independent points throughout its length. Anchors should be placed high where possible to avoid shock loading during a fall. Due to the rope not being loaded, it can be rigged around corners or through constrictions. There are several ways of setting a traverse including self-belay or being belayed across. For more information see Section 8-5.

SECTION 6-7. BACKING UP AN ANCHOR

6.56 When an anchor system is required for a rescue or when the fixed point provided is suspect, it may be necessary to convert the anchor point into an anchor system, sometimes while the point is under load.
6.57 Considerations. When building the system, take care to minimise any changes in the line of descent, the first anchor point would have been chosen to place the rope on the best line of descent down the pitch. There are several ways of adding a second anchor point to a line that is under load. Two methods of doing this is are:

a. The Half Backup Anchor. The half backup anchor is better when space is limited but can be more complicated to conduct rescues from.

b. The Full Backup Anchor (Superimposed). The full backup anchor is generally easier to create and conduct rescues from, however, takes up more space.

6.58 Half Backup Anchor. Find an anchor point to the rear of the original point. Thread a sling or rethread a figure eight through the existing karabiner. This then needs to be attached to the rear anchor point and tension applied until both anchor points are sharing the load. The karabiner being used for rescue can then be put through the created culmination point as shown in Figure 6–12.

![Figure 6–12: Anchor System using Half Backup Anchor](image)

6.59 Full Backup Anchor (Superimposed). To create a superimposed anchor, find an anchor point near the original anchor. Create a culmination point by attaching the rope to both anchor points with a bight large for the two figure eight knots to be tied as per a normal anchor system.
6.60 The type of backup point chosen (natural, fixed or artificial) is dependent upon the environment in which the UATL is operating.

SECTION 6-8. MULTI-PITCH ANCHOR POINTS

6.61 There are numerous methods used for rigging of multi-pitch abseils. The use of these methods depends on the anchor point options available, the distance between the pitch head and anchors, the length of descent and the make-up of the descent itself.

Points

6.62 Fixed Anchor Points. The following are examples of how to rig anchor points:

a. **Ring Bolts.** The rigging of an anchor point on a ring bolt can be done with the use of slings or the descent line. It is imperative that both of the descent lines are isolated for all but the last person to descend. The last person to descend the pitch will break down the system before descending, so that it can be recovered from the bottom of the pitch. The constructions of the two methods discussed are shown in Figure 6–13 and Figure 6–14. The system broken down and ready for recovery is shown in Figure 6–15.
Figure 6–13: Anchor Construction using a Sling
Figure 6–14: Single Rope Retrievable Anchor System
b. **Chains.** When rigging a point that incorporates chains, the chains replace the need for slings and therefore make for a less complicated system. Safety lines can be connected to any link in the chain. The safety line karabiner must go through a link in the chain or chain culmination point to ensure that the integrity of the anchor point is maintained in the event that one bolt fails. In most cases, the chains that run from the two bolts will be joined using a maillon rapide. If the chains are not joined, then they must be joined using a locking karabiner before the safety line is attached. The constructions of these two methods are shown in Figure 6–16 and Figure 6–17.
Figure 6–16: Chain Anchor Construction using a Maillon Rapide
SECTION 6-9. MULTI-PITCH ROPE RECOVERY

6.63 For multi-pitch abseiling it will be necessary to recover ropes from the base of the abseil. When conducting this activity, double ropes will be required. An anchor point can be used in these occasions as the descent should be slower, more controlled and each person will only abseil once (expedition abseiling).
6.64 Method 1 – Directly Around the Anchor Point. When there are four or more abseilers descending a pitch which requires rope recovery, the double ropes are to be established so that both ropes are independent. This ensures that if one rope were to be cut, the other would not be affected. When conducting multi-pitch abseiling and using an anchor point that is smooth enough to not be damaged by a pulled rope, or damage the rope, or in an emergency when a sling cannot be left behind the following method can be used:

a. Two abseil lines will be required. If two ropes are required they should be tied together using an appropriate rope joining knot. If only one rope is available it should be halved to create two lines and the centre should be identified.

b. The rope is passed around, over or through the anchor point at the halfway mark, then a figure eight on the bight knot is tied in each rope either side of the point. The figure-eight knots are connected together with a single locking karabiner (steel preferably), as shown in Figure 6–18.

![Figure 6–18: Multi-pitch Anchor Point – Step 1](image)

c. Two more figure eight on the bight knots are tied and attached to the locking karabiner creating two isolations, as shown in Figure 6–19.
d. Ensure that there is a stopper knot large enough not to be able to pass through the descent device being used, approximately 1 m from the end of the rope.

e. The rope is thrown down the cliff taking all the necessary safety measures (safety line attached).

f. The system is to be rechecked before any descent is commenced.

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**WARNING**

Ensure that both ropes are threaded through the descent device. Failure to do so could increase the likelihood of a serious fall resulting in serious injury to personnel, or death.

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**6.65** The following changes are required to be made to the point prior to the last person descending:

a. All figure-eight knots are to be untied.

b. The karabiner is removed, leaving the rope around the anchor point. There is now one continuous rope, which is dependent on each side for attachment. If the rope on one side of the point were to be cut, the other side would also fail, as shown in Figure 6–20.
c. After resetting the ropes they can be pulled from the base to ensure freedom of movement for recovery of the ropes before the last person descends. Once this is confirmed the last abseiler may descend. The abseiler must ensure that they identify which rope must be pulled on reaching the base of the abseil. This can be done by placing a karabiner on the selected rope and abseiling with it in their non-master hand. This side of the rope should then be pulled through to recover the ropes to the base.

6.66 Method 2 – Through Slings for Easier Retrieval. If there are no fixed anchors, or pulling the rope may cause damage to the anchor or rope, then a sling is to be used. The rope is passed through the slings and is then isolated back to the slings with two figure-eight knots and a karabiner as shown in Figure 6–21.
Any slings used in this type of system will not be able to be recovered. Where possible two slings should be used in this system to provide redundancy in the event that one should fail. Slings that are already in place should be carefully inspected for any signs of damage or deterioration from the elements.

Before the last person is to abseil, the figure-eight knots are removed and the karabiner is retrieved, as shown in Figure 6–22.

Rope Joining Knots. Double rope abseil will require ropes to be joined with a knot. Some knots have a propensity to catch on edges and jam in cracks when pulled down, whereas others tend to slide well. If you are pulling your rope over a sharp edge, you should consider whether the knot you use will slide over the
edge or whether it will catch. Further information on suitable rope joining knots is contained in Chapter 4.

Combination Ropes

6.70 Anchors and descent lines can be constructed using 9 mm and 11 mm ropes. The two different-sized ropes can be joined using a reef knot with a double fisherman’s knot on either side, once they have been threaded through the anchor to be used to descend the pitch.

6.71 The 11 mm rope can, at this point, be isolated to form the descent line for all participants. The 9 mm rope can be used to construct the top belay for the first or all participants.

6.72 Once all participants are at the bottom of the pitch, the isolation in the 11 mm rope and the top belay rope can be broken down for the UATL to descend on both ropes.

6.73 Riding the Knot. If there is a likelihood that the knot used may jam, then the UATL may have to ‘ride the knot’ past the cliff head. This is done by feeding the opposite rope, (which is the one that will not be pulled on), through the descent device, while maintaining a break on the other rope. Once clear of the cliff head, the UATL can continue on in the normal fashion. Great care must be taken during this procedure to ensure that the two tails of the descent rope remain at the bottom of the pitch.

**WARNING**

Riding the knot is not to be done when rope passes through a tape sling or other nylon anchor as the heat created from the friction may cause the tape or other nylon anchor to snap resulting in serious injury to personnel, or death.
If rope entrapment is caused by pulling the rope, the following methods can be used to free it:

a. Holding one end of the rope, walk away from the cliff. This will increase the angle on the entrapped part of the rope – with a few good flicks of the rope it should become free.

b. If this fails, a hauling system may be required to free the rope.

c. If, after hauling, the rope remains entrapped and both ends are not on the ground, there is no other option but to regain as much rope as possible, cut it and continue on.

d. Only ascend the descent lines to clear the obstruction if both ends are still in contact and can be reached.

**WARNING**

Ensure that both lines are used when ascending so as to ensure that the rope does not release from the entrapment and slide through the anchor point resulting in a fall which could cause serious injury to personnel, or death.

On small pitches, rope management is very important when using long ropes. It may be better to have shorter lengths of ropes to cover the small pitches. If using a longer rope, use only what is required on one side and isolate that side into the anchor point. With the other side use what is required with the remainder isolated at the top. The GL removes the isolations and abseils on the ropes that have now been lowered down. Be sure to pull on the longest end when recovering the rope.

All ropes should be prepared for use before entering the canyon. It is recommended that the ropes be coiled in a single butterfly coil (single hank). This is to ensure that the ropes are
ready for use immediately. Rope bags can be used for longer ropes.

6.77 A rescue rope is to remain at the top of a descent until the last person descends.

SECTION 6-10. DISMANTLING OF ANCHORS AND SYSTEMS

6.78 Anchor points and systems are extremely important safety features of any roping activity. When setting up anchors, UATLs, instructors and operators will usually take meticulous care to ensure that safety procedures are adhered to.

**WARNING**

At the end of a long day, attention wavers and often the safety procedures are not as strictly followed. This can lead to the serious injury or death of members involved in the activity due to carelessness.

6.79 The following are rules to be observed when dismantling anchor points and systems:

a. Anchor systems are only to be dismantled after explicit command from the OIC. The command is to be clearly acknowledged and understood. The OIC is to personally inspect all lines, to ensure that they are clear of personnel, and is to ensure that all personnel are accounted for prior to giving the order to dismantle.

b. As a general rule, abseil lines should be hauled to the top of the cliff before being disconnected from the system. This ensures that if a person remains on the line, they will soon be discovered and their safety will not be compromised. If the roping site is one that would allow the ropes to be dropped, it is imperative that they be visually inspected by the UATL, instructor or operator, or given the all clear from a UATL or instructor at the base.
of the cliff to ensure that nobody is still attached to the line.

c. The anchor system is to be dismantled generally in the reverse order to which it was constructed, beginning with the ascent or descent line and working backwards towards the anchor points and the safety line.

6.80 The procedure for dismantling a system is as follows:

a. approval given to dismantle the system by the OIC
b. ascent or descent line cleared and recovered to top (carpet or rope protection recovered if used)
c. culminating point dismantled (figure-eight knots untied and hardware recovered)
d. first anchor point dismantled (hardware and protection recovered if used)
e. second anchor point dismantled (hardware and protection recovered if used)
f. safety line recovered
g. all ropes and equipment accounted for
h. inspection of roping site prior to departure.

6.81 All OICs, UATLs, and instructors are to be aware of all actions, especially at the end of the day.
WARNING

Under no circumstances is a participant or member to interfere with or dismantle any part of an anchor system without the explicit order to do so from the OIC of the activity and only after the ascending/descending line has been cleared. Qualified UATLs, roping instructors, and operators may carry out adjustments to an anchor system, if required, after notifying the OIC.

Failure to ensure this may result in the anchor system failing causing a participant to fall resulting in serious injury or death.

SECTION 6-11. TOP ROPE CLIMBING ANCHORS

6.82 When establishing top rope anchor systems, the following factors must also be taken into consideration:

a. It may be difficult to access the selected site to place the system.

b. An anchor system must be in place for top rope climbing whether the set-up is for top belay or bottom belay.

c. When equalising this type of system, it is important to allow for a certain amount of stretch and movement as the rope settles into a position, such as when the knots tighten under tension or when a climber takes a fall.

d. The culminating point in an anchor system for top rope – bottom belay climbing must be positioned over the cliff’s edge and must allow two locking karabiners, preferably steel, to be attached to the culminating point. The climbing rope will then be able to move freely through the karabiners. Therefore, suitable rope protection must be used to prevent wear or damage to any equipment.
e. The culminating point for an anchor system for the top rope – top belay must be positioned back from the edge of the cliff, similar to the abseil culmination point, to allow space for the belayer to work.

SECTION 6-12. CANYONING ANCHORS AND RIGGING

6.83 When establishing canyoning anchor systems, the following factors must be taken into consideration:

a. Take additional care to inspect any anchor as environmental degradation can be severe. Check for damage from water, fire/heat and nylon-on-nylon wear. If any doubt exists backup or replace the anchor.

b. Anchors in a canyon may be smaller than generally acceptable. It is important to attempt to find the most secure anchor possible and back it up if there is any doubt.

c. The minimum requirement for an abseil in a canyon is an anchor point, however, use an anchor system whenever practical.

d. Most canyons that are frequented by canyoning groups are likely to have fixed anchors placed in the rock wall or floor in places where there are no natural anchor points.

e. It is normally very difficult to travel back up a canyon, so care must be taken to ensure that abseils are rigged and operated effectively. There is always the risk that an established fixed anchor point may not be available or may be unsafe to use. Because the only way out may be by descending through the canyon, the UATL will be required to apply judgement and adaptation to safely rig and conduct canyoning abseils.

6.84 At most pitches, trees will make obvious anchor points. If a good fixed anchor can be found, it is to be preferred over a
natural anchor to protect the environment. If there is any doubt, back it up.

Redirections

6.85 There may be times when a redirection will need to be used within a canyon. A redirection can be used where there is an anchor point that will enable the rope to be redirected away from a particular area. It generally consists of a sling attached to an anchor point and clipped into the main rope with a karabiner. The sling needs to be long enough to deviate the rope from its natural path and take it away from its rub point. This type of point may also need to be strong enough to take a fall, depending on the direction of the rope. Even though there are two points being used, they do not share the load equally and therefore do not constitute a system. A redirection is shown in Figure 6–23.
Artificial Anchors

6.86 Artificial anchors can be used when no natural or fixed anchors are available. Artificial anchors are created using passive protection; see Section 6-16 for the placing of passive protection. The only time that artificial anchors are likely to be used while canyoning is to create an anchor system to backup an anchor point (see Section 6-7).
SECTION 6-13. CAVING ANCHORS

6.87 The following considerations must be taken into account:

a. Take additional care to inspect any anchor as environmental degradation can be severe. Check for wear from water and use.

b. At most pitches, speleothems and rocks will make obvious anchor points. If a good fixed anchor can be found, it is to be preferred over a natural anchor to protect the environment. If there is any doubt, back it up.

c. It may be difficult to access the selected site to place the system. Ensure that safety is a priority.

d. Anchors in a cave can be more difficult to identify. It is important to attempt to find the most secure anchor possible and back it up if there is any doubt.

e. Ensure that all abseilers have control of their technique when abseiling in the cave environment.

f. The minimum requirement for an abseil in a cave is an anchor point, however; use an anchor system whenever practical.

g. Some caves that are frequented by caving groups are likely to have fixed anchors placed in the rock wall or floor in places where there are no natural anchor points.

Types of Caving Anchors

6.88 Speleothems. Speleothems (cave formations such as stalagmites and columns) can provide tempting and often adequate anchors, but they should be used with care. Some may have formed over a sub-layer of clay from which they can detach without warning under relatively little tension. The regular crystalline structure renders them surprisingly easy to snap, so they should always be tied as low as possible to reduce leverage. A speleothem less than 100 mm thick should be avoided. Another danger is that speleothems can form in mud or sand and be easily dislodged. Similarly, bedrock is
often subject to fracture along cleavage planes. These can occasionally be seen as tiny lines in clean rock or inferred by the way other rocks break.

6.89 **Fixed Anchors.** In caving, fixed anchors are typically either ring bolts or self-drill bolts. They are normally placed to allow for rigging that leaves the rope hanging in free space.

6.90 **Self-drill Bolts.** Self-drill bolts are alloy sleeves 12 mm in diameter for an 8 mm threaded bolt with an integrated drill. They are secured by an expansion plug and fitted with a separate steel or alloy hanger using a short M8 machine nut. Examples of fixed anchors found in caves are shown in Table 6–2.
SECTION 6-14. CAVE RIGGING

Rigging

6.91 Rigging ropes on cave pitches can be a very demanding area of vertical technique. For every pitch, a rope must be selected, anchored and arranged in a way that permits each caver to make a safe descent and ascent without danger from rope abrasion, rockfall or water.
Rope Length

6.92 The first task in rigging is to make sure that a rope of sufficient length is available. In descents of known caves this is done before going underground. Normally, a map would be consulted to obtain pitch lengths, but the UATL must take care to carry sufficient rope to tie the anchor system as well as cover the length of the pitch. Before rigging the rope, it is important for the UATL to check that it is actually at the correct pitch. Maps can be misread.

6.93 In an unknown cave, an estimate will need to be made of the pitch length. This is done by dropping a solid fist-sized rock down the pitch, taking care to give it no initial velocity, although a light outwards toss may be necessary to make it fall down the centre of the shaft. Full time is counted to the nearest half second using a watch. Using this time, a rough estimate can be calculated using the following formula:

\[ D = 5 \times T^2 \]

Where:  
\( D \) = depth in metres  
\( T \) = time in seconds

Therefore:  
a 3 second drop would give: \( 5 \times 3^2 = 45 \text{ m} \)

6.94 In most cases this will give an exaggerated figure but it is better than nothing. Once the rock bounces, accurate estimation is not possible, though it still gives some indication as to whether the pitch is deep or shallow. Unfortunately, when it is greater than about 5 seconds, large errors start to appear because the time taken for the sound to travel up the pitch becomes a significant factor, as does the air resistance on the rock. Table 6–3 shows time versus depth more accurately for those who wish to write an aide-memoire and place it in the inside of their helmet. This technique should only be used when a UATL is in a situation where the map does not depict the pitch length.
Choosing Anchors

6.95 A single anchor point may be all that is available; nevertheless, some form of backup should be considered. The position of this anchor system or point is critical. Considerations must be given to the dangers of rope abrasion, loose rock and to the provision of safe access for getting on and off the pitch.

Rope Abrasion

6.96 Rope abrasion results from rope bounce produced by the motion of ascending and to a lesser extent descending. If there is bounce, there is a likelihood of rope abrasion at every point where the abseil or ascending rope touches the rock. Whether or not this likelihood will amount to a danger at any particular point of rubbing (rub point) depends on a number of factors, including:

a. **Type of Rock.** The abrasion risk at the rub point will partly be determined by the roughness of the rock. It is important to examine the texture of the rock surface, the grain of the rock, its hardness and whether it contains quartz mineral veins. Rough, coarse-grained hard rock

### Table 6–3: Rope Length Gauge

<table>
<thead>
<tr>
<th>Time (seconds)</th>
<th>Rough Depth (using formula) (m)</th>
<th>Actual Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>2.5</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>3</td>
<td>45</td>
<td>41</td>
</tr>
<tr>
<td>3.5</td>
<td>60</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>71</td>
</tr>
<tr>
<td>4.5</td>
<td>100</td>
<td>88</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
<td>108</td>
</tr>
</tbody>
</table>

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*LWP-G 7-6-2, Adventurous Training – Roping, 2019*
with mineral veins is the most abrasive type, while smooth, fine-grained, soft rock with no veins is probably the least dangerous.

b. **Shape of the Rub Point.** In general, a sharp lip poses more of a risk than a rounded bulge, care is required if a rounded bulge has a small irregularity which is only obvious on close inspection of where it has had contact with the bend in the rope. The situation where the rope forms a sharp angle over a lip is more dangerous than where it only touches. The abrupt edge at the top of many pitches is a very dangerous point. The smaller the radius of the bend, the greater the abrasion risk.

c. **Length of the Pitch.** The amount of abrasion caused by any rub point will be greater on a long pitch due to the elongation of the rope, the longer the rope the more elongation. On a short pitch of 10 m or less, the abrasion risk is rarely substantial, although care is still required.

d. **The Position of the Rub Point on the Pitch.** The amount of abrasion at any rub point depends on the length of each rope bounce at that point. The greater the bounce length, the greater the danger of abrasion. In turn, bounce length depends on the position of the rub point on the pitch. The further from the anchor a rub point is, the longer the bounce will be. The net effect is that (all else being equal), rub points become more serious further down, until they become so close to the pitch bottom that relatively little abseiling and ascending is done below them.

e. **The Number of Rub Points on a Pitch.** A rub point nearly always poses less risk if there are a number of other rub points below it. The reason is that friction at the lower rub points take some of the bounce out of the rope. As a result, if the rope is rigged against a wall where there are many rub points, all but the worst can be ignored. The most dangerous situation arises where a rub point has a long free hang below it.
Rope Protection

6.97 A caving group should carry rope protectors if unsure of any rub points on particular pitches. If there is a severe rub point then it is safer to set up a deviation or a rebelay.

Rebelay

6.98 A rebelay is an intermediate anchor set up within a pitch to ensure that the rope hangs free from the rock surface, or to reduce the amount of rubbing on a single pitch. A rebelay must be a full anchor point, allowing only enough rope for a person to unclip a descender or calculated to have enough slack for a foothold.

6.99 To rig a rebelay, potential rub sites must be identified. Abseil down to the rebelay point, check anchor and attach a short cowstail. Abseil gently onto the anchor point and attach a clip-in from below the device as a backup safety in case the anchor fails. Do not just tie off the device as this will be shock-loaded in the case of anchor failure. Measure the length of slack desired and tie a figure eight or nine to attach to the anchor point and therefore rig the next pitch. Figure 6–24 shows an example of a rebelay.
Figure 6–24: Rebelay
Deviation

6.100 A deviation is similar to a redirection and can be placed as an alternative to a rebelay. A deviation is faster to rig than a rebelay as it does not anchor the rope in any way. Generally a deviation will consist of a sling joining the anchor point to the rope, pulling the rope away from the rub point. The sling needs to be long enough to allow the caver to pass without any undue effort. Figure 6–25 shows an example of a deviation.

Figure 6–25: Deviation
6.101 The anchor point for the deviation never receives the full body weight of a person nor is it possible to shock load the anchor point if rigged correctly. The angle that the rope sits after it has been deviated should be kept to a minimum otherwise all the weight will be placed onto the deviation. The main disadvantage with a deviation is that only one caver can ascend or descend at a time.

Pendulums

6.102 It is often a requirement to pendulum to one side in a cave to gain a ledge or safe ground. The pendulum can be a difficult manoeuvre to perform. The lack of a wall to push off from or a lack of rope out from the last anchor can prevent the caver from conducting an effective pendulum.

6.103 Once a pendulum has been successfully completed the first UATL will need to rig an anchor to set the rope to. Ensure that enough slack is left in the rope to allow the rest of the group to cross over to the anchor.

SECTION 6-15. CLIMBING PLACEMENT OF PROTECTION CHOCKCRAFT

6.104 In the early days of rock climbing many routes were ascended with a rope linking climbers, with no protection used to arrest a fall. As climbing progressed and routes became more challenging, there became a need to protect climbs. Early climbers protected themselves by hammering pitons of different shapes and sizes into the rock or by placing rope slings around rocks or trees. Some climbers carried small pebbles which they placed in cracks. These pebbles were then threaded with a sling that was joined by a karabiner. The small pebbles became known as chockstones.

Passive Protection

6.105 Nuts. As the climbing progressed, so too did chockcraft, and climbers began using machine nuts instead of pebbles and stones. Machine nuts of various sizes were adapted for climbing nuts by filing out the thread and placing a sling through
the hole. This allowed the nuts to be placed in cracks, avoiding the laborious task of threading. These machine nuts used for protection were given the obvious name ‘nuts’. Wedge-shaped chocks appeared as a result of this and became known as ‘chocks’, ‘nuts’, ‘wedges’ or ‘stoppers’. There are many similar styles of nuts available, all known by different brand names, but in general they perform the same function and have similar characteristics. Chocks are available from manufacturers in a range of sizes, usually numbered and ranging from 1 to 13.

6.106 Hexentric Stoppers. The hexentric (hex) consists of an irregular offset hexagonal shape with three sets of parallel sides, all of differing length. This shape gives two camming widths and a lengthwise width. Thus the hex can fit into three different width cracks.

6.107 Only passive protection devices should be used in anchors. Figure 6–26 and Figure 6–27 show examples of passive protection stoppers and hexes.
Figure 6–26: Stoppers
Pitons

6.108 In some locations, fixed pitons may be left to act as anchor points. The piton is a metal spike that is hammered into a crack. The use of pitons is not obsolete; however, they are used as a more specialised piece of protection to aid climbing. Due to their destructive nature when placed, pitons are generally used as a last resort. UATLs should never place pitons; only existing pitons, after careful inspection and consideration, should be used. Figure 6–28 shows an example of a piton.
Quickdraws

6.109 Quickdraws often consist of a straight clip gate karabiner (used for clipping into the protection), a variable length of looped or sewn sling and a bent clip gate karabiner (used for clipping the rope into the karabiner). Two straight gate clip gate karabiners are also suitable, but two bent gate clip gate karabiners are not, as a bent gate clip gate karabiner should not be clipped into a piece of protection. Most climbers use quickdraws made with commercially available sewn slings of various lengths, as these often have more rigidity and are easier to use (see Figure 2–3).

Active Protection

6.110 The term ‘active’ refers to the way a piece of protection operates due to moving parts. While the most common device available is the SLCD, there are many variations of active protection, such as ‘big bros’, sliding nuts, sliding balls and two-part wedges. The majority of these devices are readily available and, while many new designs are constantly being invented and tested, most have failed to live up to expectations. Other than SLCDs, active protection will not be considered in this publication.

6.111 Spring-loaded Camming Device. The SLCD, like the hex, is available in a range of sizes. The basic design has three or four cams mounted on one or two axles, which are connected to a trigger mechanism on a flexible stem. When the trigger is pulled the cam retracts, narrowing the profile of the device for placement in a crack or pocket. When the trigger is released, the cams open up against the sides of the rock. Materials used in the construction of an SLCD include alloys, steel and titanium for the cams; and plastic and braided wire cable for the body. Figure 6–29 shows an example of a double-axle SLCD.
6.112 Even with infrequent use the nylon on SLCDs need to be replaced by the manufacturer. Ensure that you check the manufacturer’s specifications to understand when the slings need to be replaced.

SECTION 6-16. PLACING PASSIVE PROTECTION

6.113 The placing of protection is an important aspect of all expedition roping exercises. The basic principles are very simple: the GL must find a crack with a constriction at some point and place stoppers of the appropriate size above the constriction. The stoppers are pulled in the direction of load to set it firmly in the constriction.

6.114 While the placement of passive protection is simple in theory, it takes considerable experience to place protection proficiently. The ability to use stoppers safely, correctly and skilfully takes experience and practice. The best way to learn the placement of stoppers is to practise on the ground in a controlled situation before attempting the ‘real thing’.
6.115 Chockcraft involves the following considerations:

a. Cracks that are crumbly and brittle with deteriorating rock are to be avoided.

b. Flake cracks must be avoided, as they may be detached from the rock face. Even if a flake is large and seems solid, it may have to move only a fraction of an inch for the stoppers to become loose and fall out. The expansion force of a stopper against the side of a crack during a rescue or fall can be enormous, causing the edges of the flake to crumble and dislodge the chock.

c. Flaring cracks must be avoided. These cracks can look secure, but when a stopper is placed there is a possibility of it being dislodged when weighted, due to the flaring nature of the crack.

d. Before placing stoppers, the rock surrounding the stoppers must be checked to ensure that it is solid and not hollow.

6.116 When placing a stopper, GLs should always look for a likely constriction in the crack, and then select the stoppers to fit, rather than selecting a stopper and then looking for somewhere to put it.

6.117 Once the optimal placement is found, the GL chooses stoppers and applies the following considerations:

a. In best practice, stoppers should have at least two-thirds contact with the rock in the direction of pull to be regarded as safe.

b. The stoppers must be placed as deep as possible in the crack. If this cannot be achieved, a different size must be chosen. Deep placements are safer than shallow placements.

c. A stopper must be placed with consideration given to the direction of forces in a system. When loaded on a climb, the force on a stopper will be downward and slightly
outward, and in an anchor system the forces will be forward and slightly downward.

d. In a climbing role, stoppers must also be placed to consider the pull of the rope, which may dislodge the stoppers as the climber ascends beyond the chock.

Stopper Placements

6.118 Wedging stoppers are tapered down from top to bottom so they will fit into a constriction. They have a wide axis and a narrow axis. All wedge-shaped stoppers can be placed in the following ways:

a. Narrow Axis Placement. The strongest placement for a stopper is the narrow axis placement. This is due to the large surface area that is in contact with the rock. A narrow axis placement is achieved by placing a stopper in a constriction using the obvious large front and back sides of the stopper. The idea is to get the greatest possible contact between the stopper and rock. This placement may be used in a horizontal or vertical crack. Figure 6–30 shows a stopper in a narrow axis placement in vertical and horizontal cracks.
b. **Wide Axis Placement.** The wide axis placement is a good placement when used correctly. It has less surface contact with the rock due to the small sides of the stopper. A wide axis placement is achieved by wedging the stopper in a constriction using the sides of the chock. The idea is to get the greatest possible contact between the stopper and rock. This placement may be used in a horizontal or vertical crack. Climbers should be wary of placing small sizes on this axis, as the stopper may twist out because the surface area in contact with the rock is quite small. It is recommended that no smaller than a Wild Country Rock Size 4 stopper or equivalent be used on this axis. Figure 6–31 shows a stopper in wide axis placements.

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Figure 6–30: Narrow Axis Stopper Placement in Vertical and Horizontal Cracks
Figure 6–31: Wide Axis Stopper Placements

c. *Keyhole Placement.* A keyhole placement is when a stopper is passed through a narrow hole and rotated through 90° so that the wide axis wedges inside the hole. This has limitations in that the stopper may be dislodged if the stopper is twisted. It is recommended that no smaller than a Wild Country Rock Size 4 stopper or equivalent be used in this placement.

d. *Thread Placement.* A thread placement is when the wire of the stopper is threaded through a hole securing the stopper in a crevice. These can be very secure when placed correctly. Care is to be taken to ensure that the stopper is not able to pull through the hole where the wire was threaded.
e. **Deadman Placement.** A deadman placement is when a stopper is placed in a crack or pocket with only the bottom end of the stopper in contact with the rock. A sideways force or movement cannot be allowed to remove the stopper. This has limitations in that the stopper is sitting only on the rock and not wedged. The stopper may lift out if the placement is shallow. Deadman placements are not recommended for inexperienced ropers. Figure 6–32 shows a deadman placement.

![Figure 6–32: Deadman Stopper Placement (Not Recommended)](image)

6.119 There are many different brands of stopper, and they are all available as sets of different sizes, usually numbered from 0 or
1 (smallest) to 13 or so. In many sets, the wide axis of one size is equal to the narrow axis of the next larger size.

Hexentric Placements

6.120 The hex can be placed in a similar way to the stopper. It can be used in a passive wedging or camming placement. There are two common ways to place a hex in the camming role: a wide camming axis placement and a narrow camming axis placement. The four flat sides of the front and back of a hex are all set at different angles. Once the hex is placed on a camming axis, this causes either a wide or narrow camming placement. Hexes can be placed in the following ways:

a. Passive Wedging Placement. A hex in a passive wedging placement uses the same principle as a narrow axis placement of a stopper. This placement is a good solid placement when used correctly. A passive wedging placement is achieved by wedging the hex in a constriction using the sides of the hex. The idea is to get the greatest possible contact between the hex and the rock. As for a stopper, the hex must have at least two-thirds surface area in contact with the rock. Figure 6–33 shows a hex in a passive wedging placement.
b. **Passive Camming Action.** To achieve a passive camming action, the hex needs to be placed in such a way that when the hex is weighted, the force will try to rotate the hex into the crack. This causes a camming action that prevents the hex from being dislodged. The more weight placed on the hex, the tighter the camming action should be. As each hex has two pairs of available parallel sides, the hex can be placed so that it cams on either pair of sides (one of which is wider than the other). The camming placement of a hex can be used in both vertical and horizontal cracks. Figure 6–34 shows the camming action of a hex in a horizontal crack.
c. **Incorrect Camming Placements.** When placing a hex on a camming axis, it is important to note that if placed incorrectly it could be dislodged very easily. It is important to place the hex so that it cams itself into the crack when weighted. If this does not occur, the hex may simply pull out when force is applied. If a hex is placed in an inward flaring crack on a camming axis, slack on the hex could cause it to move back in the crack, thus making the camming action of the hex useless. The hex could simply rotate and may be pulled out when force is applied. Figure 6–35 shows a hex in a poor placement and in an inward flaring crack.
d. **Deadman Placement.** A deadman placement with a hex is the same as a deadman placement with a stopper (see paragraph 6.118e). The hex is placed in a crack or pocket that has only the bottom end of the hex in contact with the rock. A sideways movement or force cannot be allowed to remove the hex. This has limitations in that the hex is only sitting on the rock and is not wedged. The stopper may lift out if the placement is shallow. A deadman placement is not recommended for inexperienced ropers. Figure 6–36 shows a hex stopper in a deadman placement.
e. *Incorrect Placements.* Hexes are not to be placed with only the corners in contact with rock. This will cause the hex to be dislodged out of the crack when weight is applied due to the limited surface area in contact with the rock. Figure 6–37 shows a poor hex placement with minimal rock contact.

Figure 6–36: Hexentric in a Deadman Placement (Not Recommended)
SECTION 6-17. PLACING ACTIVE PROTECTION

6.121 The placing of active protection normal refers to the placement of SLCDs. As the placing of passive protection is an important aspect of all climbing activities, so too is the placing of active protection. The placing of active protection is normally used for lead climbing and not top rope climbing. This is because there are many moving parts of a piece of active protection, and these parts need to be put under more scrutiny than a piece of...
passive protection that has no moving parts. SLCDs are only to be used in an anchor point or system when they are able to be under constant visual supervision.

6.122 All pieces of active protection work on the same following principles:
   a. When a trigger is pulled, the piece is deactivated and can be placed.
   b. When the trigger is released, the piece springs out, causing it to be lodged in a crack or pocket.

6.123 Placing active protection takes a bit of skill and each piece has a limited size range. This needs to be understood and practised. The best way to learn the placement of active protection is to practise on the ground in a controlled situation before attempting the real thing.

6.124 Placing active protection involves the following considerations:
   a. Cracks that are crumbly and brittle with deteriorating rock are to be avoided.
   b. Flake cracks must be avoided, as they may be detached from the rock face. Even if a flake is large and seemingly solid, it may only have to move a fraction for the SLCD to dislodge. The expansion force of an SLCD against the side of a crack during a fall can be enormous, causing the edges of the flake to crumble and dislodge the SLCD.
   c. Flaring cracks must be avoided. These cracks can look secure, but when an SLCD is placed there is a good possibility that it could ‘walk’ in or pop out of the crack or pocket.
   d. Before an SLCD is placed, the rock surrounding it must be checked to ensure that it is solid and not hollow.

6.125 When placing an SLCD, the climber should always look for a likely place in the crack and then select the SLCD to fit, rather than selecting an SLCD and then looking for somewhere to put it.
6.126 Once an optimum placement is found, the climber chooses an SLCD and applies the following considerations:

a. The SLCD must have all cams in contact with the rock to be regarded as safe.

b. Deep placements are safer than shallow placements but it is important that the trigger on the cam can still be used. If this cannot be achieved, the placement may not be suitable.

c. An SLCD must be placed to consider the direction of force in a fall. A fall will place a downwards and slightly outwards force on an SLCD.

d. An SLCD must also be placed to consider the pull of the rope as the climber ascends beyond the SLCD, which may dislodge the SLCD or cause it to walk.

e. The chance of the SLCD ‘walking’ needs to be considered. Due to the nature of their construction, SLCDs tend to walk deeper into a crack, especially if the crack width increases with its depth. If an SLCD is to be used in an anchor point or system it must be under constant visual supervision.

f. The SLCD must never be over-cammed or under-cammed. An SLCD is over-cammed if the trigger is pulled back further than three-quarters of its motion, and under-cammed is generally anything less than half of the pulled motion. An over-cammed piece may become stuck in the crack to a point that it is not possible to recover, and an under-cammed piece may walk or not hold well.

g. Rigid-stem SLCDs must be placed in a way that will prevent the stem being snapped in the event of a fall.

h. The limitations of the placement must be understood.

Spring-loaded Camming Device Placements
6.127 An SLCD is a very versatile piece of protection, but most can only be placed in a camming mode. Those with a double-axle
6.128 When placing an SLCD in a crack, it is important to place the piece so that when force is applied the piece does not change its position. The SLCD should be placed so that the force will run down its centre, causing the piece to be pulled in a direction to make effective use of the cams against the rock. This is imperative when using a rigid-stem SLCD, if the piece is not in line with the direction of pull then this could cause the stem of the rigid-stem SLCD to snap.

6.129 When an SLCD is placed in a crack or pocket, it needs to be prevented from being over-cammed or under-cammed (see Figure 6–38). An SLCD is over-cammed when the cams are retracted to the stage that any force applied would not achieve a camming action. It would simply be a wedging action whereby the ends of the cam had gone past the mid-point and overtaken each other. An under-cammed SLCD is one that has not even been retracted at all; it is simply just sitting in the crack or pocket. This does not allow the camming action to occur, as no cams are in contact with the rock.
Figure 6–38: Over-cammed and Under-cammed Spring-loaded Camming Devices

6.130 **Vertical Spring-loaded Camming Device.** Vertical SLCD placement (see Figure 6–39) is very quick and efficient when correctly placed. The SLCD needs to be placed so that the stem will point in the anticipated direction of pull, allowing the load to be transmitted along the axis of the stem. This maximises the strength of the placement.
Figure 6–39: Vertical Spring-loaded Camming Device Placement

6.131 Horizontal Spring-loaded Camming Device Placements. A horizontal SLCD placement (see Figure 6–40) is just as effective as a vertical placement. The main area to watch with a horizontal placement is stem breakage. With flexible stem SLCDs this is not such a problem, but when using rigid-stem SLCDs this needs to be considered. To prevent a rigid stem from breaking, the SLCD needs to be placed as deep as possible in the crack or pocket to reduce torque on the stem. If this is not possible, then a tie-off loop of accessory cord needs to be attached through the largest hole on the stem closest to
the cams. The loop needs to be slightly shorter than the SLCD sling. The loop is clipped with the SLCD sling, which places most of the force near the cams and prevents force being placed at the end of the stem.

![Figure 6–40: Horizontal Spring-loaded Camming Device Placement](image)

6.132 **Flaring Cracks.** Because each cam works independently, it can individually expand to fit a flaring crack. Problems will occur if the crack flares too much. Some of the cams could overexpand, causing an unstable placement. The piece may then be more susceptible to rotation or rope movement and be less able to cam properly under load. Flaring cracks can allow the SLCD to walk.

6.133 **Walking Spring-loaded Camming Devices.** The term walking is used to describe an SLCD that has moved backwards into a crack or pocket due to rope movement. This can make a piece ineffective if the crack flares inwards. When the SLCD moves backwards, it starts to expand and, if the crack is deep enough, eventually the cams expand totally, thus stopping it from using a camming action. The SLCD either moves into a deadman action or is ineffective.
6.134 Folding Spring-loaded Camming Devices. The term ‘folding’ is used when the cams of an SLCD all fold backwards into the centre due to the force being placed on the bottoms of the cams from a deadman placement. This can occur only with a single-axle SLCD. A double-axle construction prevents an SLCD from folding and is the only SLCD suitable for a deadman placement.

6.135 Deadman Placement. A deadman placement (see Figure 6–41) is achieved when the SLCD is placed into a crack so that no camming action is used and all the force is placed on the bottoms of the cams. A sideways force or movement cannot be allowed to remove the SLCD. This method should be used only if there is no other placement available. Only SLCDs rated as passive protection should be used as a deadman placement.

Figure 6–41: Spring-loaded Camming Device, Deadman Placement
SECTION 6-18. CLIMBING ANCHORS AND BELAYS

6.136 Artificial protection may be used to secure rope or slings to create a climbing anchor. This section details artificial anchor points and systems and belay points and systems.

6.137 Anchor systems are the basis of all roping activities, including abseiling, ascending and top rope climbing. The following are the two types of artificial anchors:

a. Artificial Anchor Points. Artificial anchor points are created using various types of climbing protection. They are strategically placed into fail-safe areas of rock to provide a point of secure attachment for rope or a sling. Two pieces of artificial protection constitute one artificial anchor point and are the minimum anchor requirement needed for a safety line. Artificial anchor points are used when no natural features are available or suitable.

b. Artificial Anchor Systems. When two or more independent anchor points are joined together, they form an anchor system. The word ‘independent’ has a very powerful influence with anchor systems. If an anchor point’s ability to remain in position depends on another one, then the advantage of having a system has been wasted.

6.138 Lead climbing uses belay points and belay systems, as follows:

a. Belay Points. A belay point may be constructed using a single fail-safe piece of protection, including fixed protection. A belay point is the minimum requirement of the second climber belaying a leader climbing a route.

b. Belay Systems. A belay system uses two or more independent belay points, thus two or more independent and equalised pieces of protection. A belay system is the minimum requirement that a leader must construct at the completion of a climb or pitch in order to belay a second.

6.139 This section should also be read in conjunction with Chapter 19 which covers the construction of a single-pitch lead climbing
belay system. Artificial anchor systems can be used for abseiling and roping activities, top rope climbing and lead climbing. Belay points and systems may be used only for lead climbing activities.

SECTION 6-19. ARTIFICIAL ANCHOR POINTS AND SYSTEMS

Considerations

6.140 Some general considerations that must be implemented when constructing artificial anchor points or systems are as follows:

a. As with all anchor points and systems, they must be fail-safe. Active protection is susceptible to movement and therefore may only be used where there is constant visual supervision.

b. Two items of passive protection equate to one anchor point. Therefore, to create an anchor system using artificial protection, four pieces of protection are required.

c. Active protection is susceptible to movement and therefore may only be used where there is constant visual supervision.

d. The direction of pull once the system is placed under tension must be considered. As such, it is imperative that all lines used are equalised, distributing even force throughout.

e. Suitable rope protection must be used to prevent wear or damage to any equipment.

f. Steel locking karabiners are preferred but not necessary. Alloy locking karabiners are acceptable. Alloy, if used in conjunction with steel, is to be placed to the rear of the system.

g. Clip gate karabiners may be used, but in pairs, with the gates reversed and opposed (cross-gated). They must
be as far to the rear of the system as possible, behind locking karabiners.

h. It is imperative that any artificial anchor points or systems are checked on a regular basis while in use, looking for any signs of movement, wear or equipment damage. All knots must also be inspected.

Artificial Anchor Points

6.141 Chocks (eg, nuts, wedges, hexes and wires) and bolts are to be positioned so that there are always two or more pieces of protection attached to the rock, which are independent of each other. If possible, the pieces of protection should not be located in the same crack or rock feature.

6.142 If a single figure-eight knot is to be used in the culminating point of the anchor point, the maximum angle must not exceed 60°. For angles between 60° and 120°, two figure-eight knots are to be used in the culminating point of the anchor point. For further information on angles of anchors refer to Section 6-6. An artificial anchor point is shown in Figure 6–42.
Figure 6–42: Artificial Anchor Point
Artificial Anchor Systems

6.143 An artificial anchor system (see Figure 6–43) consists of two independent artificial anchor points. The maximum angle of the ropes or slings joining the two anchor points must not exceed 120°. Two figure-eight knots are to be used in the culminating point of the anchor system.
6.144 Construction. There are numerous ways to construct artificial anchor systems. All have advantages and disadvantages. An
artificial anchor system constructed using a single rope is shown in Figure 6–44.

Figure 6–44: Artificial Anchor System Constructed with One Rope
6.145 An artificial anchor system constructed using three ropes is shown in Figure 6–45.
An artificial anchor system constructed using two ropes is shown in Figure 6–46.

Figure 6–46: Artificial Anchor System Constructed with Two Ropes
6.147 A combination anchor point and natural anchor point is shown in Figure 6–47.
Regardless of how they are constructed, artificial anchor systems must be constructed with two independent anchor points, must have two figure-eight knots and two steel locking karabiners in the culminating point, and must have no single point of failure to the rear of the culminating point.

SECTION 6-20. BELAY POINTS AND SYSTEMS

Belay points and systems are for use in lead climbing only. As such, they can be under constant tension and must be under constant supervision.

Considerations

Some general considerations that must be implemented when constructing a belay point or system are as follows:

a. As with anchor points and systems, they must be fail-safe.

b. A single fail-safe piece of protection creates a belay point. A minimum of two equalised and fail-safe pieces of protection create a belay system.

c. Active protection may be used, but it must be placed in a position that allows it to be constantly supervised.

d. A single figure-eight knot may be used in the culminating point of a belay system.

e. It is imperative that any belay points or systems are checked on a regular basis while in use, looking for any signs of movement, wear or equipment damage, and knots should be inspected.

Further information detailing the construction of belay points and belay systems is contained in Chapter 19. An example of a belay point is shown in Figure 6–48.
Figure 6–48: Belay Point
CHAPTER 7

DESCENDING

SECTION 7-1. DESCENDING A VERTICAL FEATURE

Introduction to Descending

7.1 Abseiling is the term used to describe descending down a rope; controlling speed and progress by friction against the rope.

7.2 Rope descending can be divided into two types as follows:
   a. Rearward Descent. This refers to abseiling backwards carefully without bounding, with the aim of getting to the base of the descent.
   b. Forward Descent. This is also known as the rundown or the karabiner rundown. It refers to abseiling forwards with the aim of increasing the perceived fear, as well as enhancing the confidence of the abseiler.

7.3 When descending, the rope is secured to an abseiler by passing it through a friction device attached to the person's harness with a locking karabiner.

7.4 Mechanical types of descent use the types of descending devices mentioned in Chapter 2.

7.5 There are numerous descent devices available on the market. A common device is the figure 8 descender, which is chosen for its versatility. Other devices may also be used and many are specific to particular environments.

7.6 With all methods, the abseiler’s hands grasping the rope control the speed of descent. A slow controlled descent may be made without gloves but under normal circumstances gloves are recommended to prevent rope burns. When making a forward descent, gloves are to be worn.
Individual Equipment

7.7 The minimum individual equipment to be carried by a participant is as follows:
   a. an approved UIAA helmet
   b. an approved harness or a tape seat
   c. two locking karabiners
   d. a descending device
   e. gloves
   f. a whistle.

Preparation for Abseiling

7.8 All loose items should be tucked away in preparation for abseiling. Shirts, straps and hair should be secured. Anything that is caught in the descender may cause the abseiler to become stuck fast on the rope. Harnesses should be fitted with a locking karabiner attached (see Chapter 3). Helmets also need to be fitted and gloves should be clipped to the harness gear loops for storage and carriage. Figure 7–1 shows an abseiler fitted with all required equipment to abseil.
WARNING

Only locking karabiners are to be used to connect a descent device to a harness. It must be ensured that locking karabiners are not opened while in use (said to be ‘live’) or when placed under load within any system. If the system fails and a live karabiner is open, there is no backup and the whole system may fail possibly causing serious injury or death.
SECTION 7-2. FIGURE 8 DESCENDER

7.9 The figure 8 descender is a very safe device as it fully encloses the rope in the system. Once the figure 8 descender is connected to the karabiner correctly it will not allow the accidental release of the rope. The device can be used in cliff rescue techniques as it can easily be set up in the double wrap figure 8 configuration to allow good control over descent speed even with a substantial increase of weight.

Rear Descent

7.10 Hooking Up the Figure 8 Descender. To hook up using the figure 8 descender, for a rearward descent the abseiler should stand with the rope on their master side when their back is facing the cliff edge. The abseiler places the descender in their non-master hand with the small hole pointing towards the direction of the abseil. With the master hand the abseiler picks up the rope, makes a bight, and then places the bight down into the large hole of the figure 8. The bight of the rope is pulled up and over the smaller hole to rest on the stem. The small hole of the figure 8 descender is clipped into the locking karabiner and the locking karabiner is secured, as shown in Figure 7–2. For best practice the belay loop needs to sit within the wide end of the karabiner and the spine of the karabiner on the wearer's master side.
7.11 **Double Wrap Figure 8.** In order for the figure 8 descender to provide more friction (slower descent), the bight is placed down through the large hole and then once over the stem. It is then continued through the large hole again to rest on the stem, as shown in Figure 7–3.
7.12 Figure 8 with Double Ropes. A figure 8 descender can be used for abseiling with double ropes. A figure 8 rigged for a double rope descent is shown in Figure 7–4.
7.13 **Pre-dispatch Checks.** Prior to being dispatched over the edge of a cliff when hooked up for an abseil, a number of safety checks should be made by the dispatcher (such as a UATL, ATLI or operator). These checks are the sole responsibility of the dispatcher and can be described to a nervous participant to calm them down. Instruction on the checks can also be a useful facilitation tool; however, they remain the responsibility of the UATL dispatching and cannot be transferred to the abseiler. The six-point safety check to be carried out is shown in Table 7–1.
**Table 7–1: Six-Point Safety Check**

| A – Anchors                  | Confirm that individual anchor points are fail-safe.  
|                             | Confirm that no single point of failure exists, other than the abseil rope and the harness.  
|                             | Confirm that the abseil rope is tied into the cumulating point.  
|                             | Confirm that knots are appropriately and correctly tied.  
|                             | Confirm that anchor ropes are equalised. |
| B – Buckles                 | Confirm that buckles are adjusted and done up correctly.  
|                             | Confirm that helmet chin strap is secured. |
| C – Karabiners              | Confirm that karabiners are orientated correctly.  
|                             | Confirm that all locking gates are secured.  
|                             | Confirm that the karabiner is connected correctly to the harness for the type of descend or ascent. |
| D – Devices – Descending and or Ascending Devices | Confirm that the device is appropriate for its intended use.  
|                             | Confirm that the device is correctly orientated and rope is threaded properly.  
|                             | Confirm that the self-belay system is correct (if used). |
| E – Everything Else         | Loose clothing and hair are tucked away.  
|                             | Gloves are on hands if required. |
| F – Friend                  | Inform the brake person by making an abseiling call and receiving a response. |
7.14 Making the Descent. The procedure and position for a rearwards abseil is as follows:

a. Once called forward by the dispatcher, the abseiler is to clip into the safety line onto the belay loop, if required and move to the appropriate side of the rope.

b. The dispatcher or abseiler is to hook the descent device to the rope and clip it to the locking karabiner ensuring that the gate is locked.

c. The abseiler is to place gloves on, if required.

d. The abseiler is to grasp the standing end of the rope with the non-master hand and the running end of the rope with the master hand.

e. The dispatcher, or abseiler if they are qualified, is to carry out the six-point safety check (see Table 7–1).

f. The abseiler is to shout to the brake person ‘ABSEILING LINE...’ (number of designated rope), if more than one rope is being used. The brake person is to shout the reply ‘OK, LINE...’ (number of designated rope); if more than one rope is being used. The abseiler must wait until the reply is heard before commencing the descent.

g. If a safety line is being used it can now be disconnected.

h. The abseiler is to approach the cliff edge and is to allow the rope to flow under control through the hands and the descent device, ensuring that the descent device does not cross over onto the gate of the karabiner.

i. On reaching the cliff’s edge, the abseiler keeps feet shoulder-width apart and slowly lowers the body, under control, over the edge and adopts an upright L-position. The trunk of the body should be upright and the legs at approximately 90° to the cliff-face. The feet need to stay shoulder-width apart for balance, with the knees slightly bent to improve stability. By looking over the shoulder the abseiler has a view of the route to be descended. The abseil start position is shown in Figure 7–5.
Figure 7–5: Abseiling Start Position
j. While descending, the abseiler should place the non-master hand high above the figure 8 descender to stop the body tipping backwards. The master hand should pivot clear of the body so that the rope does not rub against the harness while abseiling.

k. To brake, the abseiler must tighten their grip with their master hand and move that hand under the buttocks, as shown in Figure 7–6.
Figure 7–6: Abseiling Brake Position
7.15 To have the brake person apply the brake, the abseiler shouts: ‘BRAKE, LINE…’ (number of designated rope). The reply by the brake person is: ‘OK, LINE…’ (number of designated rope). When the abseiler is ready and wants regain control of the rope, they call: ‘TAKING CONTROL, LINE…’ (number of the designated rope). The reply by the brake person is: ‘OK, LINE…’ (number of designated rope).

7.16 Once the abseiler has completed the descent, made themselves safe, and removed the descent device from the abseil line they then call: ‘OFF ROPE, LINE…’ (number of designated rope). The reply from the dispatcher at the top of the abseil line is: ‘OK, LINE…’ (number of designated rope). In a situation where it is difficult to hear and see from top to base of the cliff it is advisable that the abseiler does not call off rope until they also have gloves off and are in the break position ready for the next abseiler.

7.17 Under certain circumstances it is necessary to stop and tie-off mid descent. After completing the tie-off the abseiler calls: ‘SAFE, LINE…’ (number of the designated rope). The reply by the brake person is: ‘OK, LINE…’ (number of the designated rope); at this point the brake person can move away from the rope. Once the task is complete and the abseiler is ready to recommence their descent they call: ‘ABSEILING, LINE…’ (number of the designated rope), in response the brake person returns to the rope and when in position replies: ‘OK, LINE…’ (number of designated rope).

Forward Descent

7.18 The forward descent method of abseiling is an alternate method of descending a vertical feature. The figure 8 is the preferred device to be used for this abseil as it provides the best control.

7.19 Harnesses are to be used in accordance with manufacturers' specifications. Only harnesses with rated rear attachment points designed for descending or improvised tape harnesses are to be used to conduct forward run down abseils.
For a forward descent, the karabiner is placed around all of the waist strap(s) to the rear of the harness. The locking karabiner is hooked under the waist belt, and the karabiner is rotated so that the wide part is towards the harness with the gate uppermost.

**WARNING**

Forward run down descents are only to be conducted in compliance with commercial harness manufacturers’ specifications. Failure to do so could result in serious injury, or death.

**7.21 Hooking Up the Figure 8.** To hook up for a forward descent with the figure 8, the abseiler should stand on the non-master side of the rope, facing the cliff edge. The abseiler places the descender in the direction of the abseil then, taking up the rope and making a bight, places the bight down through the large hole of the figure 8. The bight of the rope is pulled up and over the smaller hole to rest on the stem. The small hole of the Figure 8 descender is clipped into the locking karabiner and the locking karabiner is secured. From the standing end, the rope should now pass through the descender from the non-master to master side with the bight located on the upper stem of the figure 8 descender. A figure 8 hooked up for a forward descent is shown in Figure 7–7.
7.22 **Pre-dispatch Checks.** The same pre-dispatch checks should be made for a forward descent as are made for a rear descent. These can be found in Table 7–1.

7.23 **Making the Descent.** The procedure and position for a forward descent right-handed is as follows:

a. Once called forward by the dispatcher, the abseiler is to clip into the safety line onto the belay loop, if required and move to the appropriate side of the rope, facing the cliff edge.

b. The abseiler is to place gloves on.

c. The abseiler is to grasp the running end of the rope with the master hand or both hands, if required.

d. The dispatcher or abseiler, if qualified, is to carry out the safety checks (see Table 7–1).

e. The abseiler makes their call; the abseiler must wait until the reply from the brake person is heard.

f. If a safety line is used, it can now be disconnected.
g. The abseiler is to approach the cliff's edge and allow the rope to run freely through their hands and the figure 8 descender, ensuring that the descent device does not cross over onto the gate of the karabiner.

h. On reaching the cliff's edge, the abseiler should stand with their feet half hanging over the edge (as shown in Figure 7–8), then lower the body at a controlled rate while pivoting the feet on the edge. The body remains straight and the feet must remain shoulder-width apart for balance. When the body is at 90° to the cliff face the abseiler commences running.

![Figure 7–8: Forward Descent Start Position](image)

i. While descending, the brake hand remains on the rope, and is kept forward and to the master side. The body remains straight and the legs run down the cliff face. The faster that the abseiler runs over the edge and down the cliff face, the easier this method is.

j. To brake, the abseiler pulls the rope across the front of the body and both hands tighten their grip, as shown in Figure 7–9.
Figure 7–9: Braking Position
Safety

7.24 **Brake Person.** During descents, a brake person can be placed at the base of the cliff. By pulling on the rope the brake person can arrest the abseiler’s descent. This may be harder if the rope is new, very long, or if the abseiler is descending quickly. The brake person must maintain a constant watch on the abseiler as they descend and is also to maintain a constant but light grip on the abseiler’s rope. The brake person can hold the rope at shoulder height with an overhand grasp or at chest height with an underhand grasp. This rope should be slack enough to allow the abseiler free movement but not so slack that it cannot be pulled tight quickly. If the abseiler begins to fall the brake person is to pull the running end of the rope tight, in order to arrest the fall. The actions of a brake person are shown in Figure 7–10.
7.25 Emergency Brake Descents (Regains). In the event that a UATL is descending a rope with no brake person, and loses control or contact with the rope for whatever reason, an immediate regain is to be performed. This will arrest the abseiler's uncontrolled descent and assist them to regain control of the rope. Emergency brake descent training is only conducted under supervision of an ATLI while on a UATL course.

7.26 The regain must be conducted very quickly in order to arrest the abseiler's fall. The abseiler must look and identify the descender, then clap with both hands onto the descender smothering it, to apply a positive brake. The master/brake hand then grips the running end of the rope, sliding down until they are able to regain the brake position. If the regain is not initially
successful then the process is to be repeated until the fall is arrested.

SECTION 7-3. SPECIALIST AND IMPROVISED DESCENT DEVICES

Five and Six Bar Racks

7.27 The five or six bar rack is an in-line descent device consisting of a frame that connects to the karabiner and a series of bars. Each bar has a hole drilled at one or both ends so that they can slide freely on the frame. Every second bar has an open notch so that the end of that bar can be lifted up; allowing the rope to be threaded through the rack. When under tension, this will hold the bars in place on the frame. In most cases, the rack is arranged with a series of 19 mm solid aluminium or hollow stainless steel bars. The rack is to be oriented so that the bars that move open to the master side. An advantage of the five or six bar rack is that when it is placed onto the harness via a locking karabiner it will not have to be taken off the karabiner to release or rethread the rope each time a descent is made.

7.28 Hooking up the Rack. To hook up the rack descender for a normal rearward descent, the abseiler should stand with the rope on their master side when their back is facing the cliff edge. A rack can be hooked up to the rope while being already attached to a locking karabiner on the front of the harness. For best practice the belay loop needs to sit within the wide end of the karabiner and the spine of the karabiner on the wearer's master side. The rack must be placed on the rope with the swivelling bars resting on the stainless steel frame. The rack is held in the non-master hand, the bars are lifted up and a bight of rope is passed through from the back of the device. Once there is a bight of rope over the swivel bar it can be locked into place, as shown in Figure 7–11.

7.29 It is possible to abseil with a rack in the traditional way (ie, figure 8); however, further control can be gained by holding the rope out and applying the brake by lifting the rope up until it is parallel with the abseil line.
7.30 Positive break can be achieved by pushing the bottom bar upwards or grasping the rope tightly to the device to create more friction.

Figure 7–11: Feeding a Five Bar Rack

7.31 **Extra Friction.** To add extra friction when required (such as in a rescue situation or when heavy loads are being carried), the abseiler can place the running end of the rope up and over the first bar again. The rope is placed between the two horns of the top of the descender; this forces the bottom bar to compress bars together creating greater friction on the rope, as shown in Figure 7–12.

7.32 The descent method with this configuration is the same as descending with a figure 8 descender.
7.33 **Double Rope.** A rack can be used for abseiling with double ropes. Both ropes are threaded into the rack as for a single rope. A locking karabiner may be attached to the harness or above the rack and clipped around one of the ropes. This will assist in preventing the rope twisting through the rack.

**Belay Device**

7.34 There are many belay devices available. While not designed specifically for abseiling, these devices are an alternative to the figure 8 descender or rack. While models vary, the operation of all is similar. As with the figure 8 descender, the belay device provides the user with a rope-enclosed system. Once the rope
is engaged in the belay device and the locking karabiner is secured, the rope cannot accidentally come off.

7.35 **Hooking Up the Belay Device.** To hook up using the belay device for a normal rearward descent, the abseiler should stand with the rope on their master side when their back is facing the cliff edge. Most belay devices will have a catcher’s loop made of accessory cord or wire that should be clipped into the same locking karabiner that the rope goes into. The abseiler places the belay device in the non-master hand and with the master hand picks up the rope, makes a bight, then places the bight down into one of the slots of the belay device. The abseiler then clips this bight of rope into the locking karabiner attached to the harness, ensuring that the catcher’s loop remains clipped, and locks the karabiner. For best practice the belay loop needs to sit within the wide end of the karabiner and the spine of the karabiner on the wearer’s master side. The rope should now pass through the belay device, as shown in Figure 7–13.
Figure 7–13: Hooking Up the Belay Device
7.36 **Double Rope.** A belay device can be used for abseiling with double ropes. Both ropes are threaded into the belay device as for a single rope set-up. Each rope occupies its own slot in the belay device. It must be ensured that both ropes are clipped into the karabiner and that there are no twists in the ropes, as shown in Figure 7–14.

7.37 The descent method used for a belay device is the same as used when descending with a figure 8 descender.

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**CAUTION**

Ensure that both ropes are threaded correctly through the descent device.
Figure 7–14: Belay Device Double Ropes
The Münter hitch (also known as the Italian hitch) is a specialised knot that requires no extra equipment. It is very easy to set up and use and the only equipment needed is a large locking karabiner preferably pear shaped. Although it is preferable to use a specialised descender, this hitch is worth knowing as a backup for the time when gear is lost, damaged or forgotten. The Münter hitch is an improvised belay method and is designed mainly for arresting a falling climber as it has a very positive braking action on the rope. However, it may be used as a descent method in controlled abseil descents. As with the figure 8 descender, the Münter hitch provides the user with a rope-enclosed system. Once the rope is engaged and the locking karabiner is locked, the rope cannot accidentally come off. Due to the rope-on-rope friction, the sheath can become damaged or frayed and, as it also causes the rope to twist and kink, it should not be used for long or quick descents.

Hooking Up the Münter Hitch. To hook up using the Münter hitch, for a normal rearward descent for a right-handed abseiler, the abseiler should stand with the rope on their master side when their back is facing the cliff edge. The abseiler ties a Münter hitch and places it into the locking karabiner on the front of the harness (the karabiner is attached in the same manner as for all descent devices). The participant locks the locking karabiner, ensuring that the Münter hitch is located in the karabiner correctly (with the wide end towards the Münter, and the running end of the rope against the spine of the karabiner, not the gate). The running end of the rope should now run through the right and behind the abseiler. The Münter hitch is shown in Figure 7–15.
Figure 7–15: Hooking Up the Münter Hitch
7.40 A Münter hitch may also be used for abseiling with double ropes, where one large Münter hitch is tied treating both ropes as one.

7.41 It is possible to abseil with a Münter hitch in the traditional way (ie, figure 8); however, further control can be gained by holding the rope out and applying the brake by lifting the rope up until it is parallel with the abseil line.

7.42 The positive break can be achieved by smothering the hitch with the non-master hand.

SECTION 7-4. DESCENT TIE-OFF

7.43 An abseiler may wish to cease their descent at any time while abseiling, or may need two hands free to operate equipment or perform a rescue. In all cases a tie-off should be performed. A tie-off will lock the descent device to the rope, allowing the abseiler to safely remove both hands from the rope.

Figure 8 Tie-off (Option One)

7.44 This procedure allows abseilers who are descending a rope to stop and secure themselves so that both hands are free to carry out a task. It can only be used on abseil techniques that involve a rearward descent.

7.45 The advantages of the first style of tie-off shown in Figure 7–16 is that it prevents the drop that occurs in the second style, and when tied not-under-tension it is less likely to be tied incorrectly. It has the disadvantage that it can be difficult to use this style of tie-off in the case of a knot bypass. The two styles of tie-off with a figure 8 descender are carried out as follows:

   a. Step 1. The abseiler applies a positive brake by choking the rope and figure 8 with the non-master hand. The master hand passes the running end of the rope through the karabiner as shown in Figure 7–16.
Figure 7–16: Figure 8 Tie-off – Step 1
b. **Step 2.** Release the non-master hand momentarily while keeping tension on the bight of rope to maintain the brake and then manoeuvre the bight of rope upwards beside the figure 8 and readjust the positive brake to incorporate this of the tail as shown in Figure 7–17.

![Figure 7–17: Figure 8 Tie-off – Step 2](image)

c. **Step 3.** The running end of the rope is now pushed through the large eye of the figure 8 from the front of the device and two half hitches are tied above the device, as shown in Figure 7–18.
To release the figure 8 tie-off, the following steps are to be followed:

a. **Step 1.** The abseiler applies positive brake.

b. **Step 2.** Untie the two half hitches.

c. **Step 3.** Pull the running end through the karabiner until the normal brake position can be adopted. The descent may be continued.
Figure 8 Tie-off (Option Two)

7.47 The tie-off with a figure 8 descender option two is carried out as follows:

a. **Step 1.** The abseiler applies a positive brake by choking the rope and figure 8 with the non-master hand. The running end of the rope is placed over the back of the master hand and under the thumb; this hand is then lifted up to the standing end of the rope so that palm rests on the rope and the thumb is under it as shown in Figure 7–19.

b. **Step 2a.** Identify the running end on the small finger side of hand and use fingers to pull this through the gap created between the hand and the standing end, as shown in Figure 7–20.

c. **Step 2b.** Holding the rope in the master hand, the positive brake is released ensuring that the hand is removed quickly. The abseiler will drop a small distance as the knot tensions. The abseiler must ensure that the non-master hand is kept well away after releasing the positive brake. Figure 7–21 shows the position of the abseiler after the drop.

d. **Step 3.** The running end of the rope is pulled through until there is enough rope to tie two half hitches around the standing end, as shown in Figure 7–22.
Figure 7–19: Figure 8 Tie-off Option 2 – Step 1
Figure 7–20: Figure 8 Tie-off Option 2 – Step 2a
Figure 7–21: Figure 8 Tie-off Option 2 – Step 2b
Figure 7–22: Figure 8 Tie-off Option 2 – Step 3
Figure 8 Tie-off Release (Option Two)

7.48 To release the figure 8 tie-off, the following steps are to be followed:

a. Step 1. The abseiler unties the first two half hitches. Keeping the thumb of the non-master hand in the loop, the master hand pulls the running end through the lock-off leaving 3 to 4 cm protruding and ensures that the rope is not twisted within the bight as shown in Figure 7–23.
Figure 7–23: Figure 8 Tie-off Release – Step 1
b. **Step 2.** Grasp the running end with both hands. As shown in Figure 7–24. With a quick swift jerk, the rope is pulled through to the left and (maintaining a firm grip on the rope) the hands and rope are swung across to the body to the right into the normal brake position. The descent may be continued.

![Figure 7–24: Figure 8 Tie-off Release – Step 2](image-url)
Rack Tie-off

7.49 This procedure allows abseilers who are descending a rope to stop and secure themselves so that both hands are free to carry out a task. It can only be used on abseil techniques that involve a rearward descent. The tie-off with a rack is carried out as follows:

a. **Step 1.** The abseiler applies a positive brake by pushing the bottom bar of the rack upwards with the non-master hand. This will push all of the bars together, placing more friction on the rope. Then, with the master hand, the running end of the rope is manoeuvred over and pulled down behind the horns of the rack, as shown in Figure 7–25.

b. **Step 2.** Keeping a grip on the running end, the abseiler forms a bight of rope and feeds it through the front of the rack beneath the bottom bar of the device. A bight of rope is pulled through the rack; this needs to be long enough to tie two half hitches to the rope above the horns of the rack, as shown in Figure 7–26.

7.50 The abseiler is now tied-off to the abseil rope and is able to carry out any tasks.
Figure 7–25: Rack Tie-off – Step 1
Figure 7–26: Rack Tie-off – Step 2

Rack Tie-off Release

7.51 To release the rack tie-off, the following steps are to be followed:

a. *Step 1.* The abseiler unties the first two half hitches. With the master hand, the abseiler pulls the running end through the rack, ensuring that a firm grip is kept on the running end of the rope.

b. *Step 2.* The abseiler holds the running end with the master hand and lifts the rope up and off the top of the rack. The abseiler may place the positive break on if they need more assistance. The descent may then be continued.
Belay Device Tie-off

7.52 This procedure allows abseilers who are descending a rope to stop and secure themselves so that both hands are free to carry out a task. It can only be used on abseil techniques that involve a rearward descent. The tie-off with a belay device is carried out as follows:

a. **Step 1.** Apply a positive brake by choking the rope onto the belay device. Then, with the master hand the running end of the rope is threaded through the karabiner attached to the harness, under the belay device, as shown in Figure 7–27.

![Figure 7–27: Belay Device Tie-off – Step 1](image)
b. **Step 2.** Keeping a firm grip on the rope, the abseiler then ties two half hitches around the standing end of the rope completing the tie-off, as shown in Figure 7–28.

![Figure 7–28: Belay Device Tie-off – Step 2](image-url)
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Belay Device Tie-off Release

7.53 To release the belay device tie-off, the abseiler smothers the device before releasing the half-hitches, allows the rope to fall back into a natural position, takes control, and continues descent.

Münter Hitch Tie-off

7.54 This procedure allows abseilers who are descending a rope to stop and secure themselves so that both hands are free to carry out a task. It can only be used on abseil techniques that involve a rearward descent. The tie-off with a Münter hitch is carried out as follows:

a. *Step 1.* The abseiler applies a positive brake by pulling the running end of the rope up until it is parallel to the standing end and grasps the Münter hitch with the non-master hand. Then, with the master hand, the running end of the rope is passed around the standing end of the rope, above the karabiner to form a hitch.

b. *Step 2.* Keeping a firm grip on the rope, the abseiler then ties another half hitch with the running end of the rope around the standing end of the rope and pulls them tight down onto the karabiner.

7.55 To release the Münter hitch tie-off, the abseiler smothers the Münter hitch before releasing the half-hitches, takes control, and continues descent.

SECTION 7-5. TOP BELAY ABSEIL SYSTEMS

7.56 A top belay system can be used to safeguard an abseiler while abseiling. The belaying method is similar to that used in climbing.

7.57 When running an activity for cadets, a top belay abseil system must always be used when there are no adults acting as brake people. It is also a good tool to use for abseilers who are extremely nervous or apprehensive or for a first abseiler if there
are no spare UATLs as it provides added security to the abseiler.

Set Up of Top Belay Abseil System

7.58 The top belay abseil system is set up as follows:

a. The belay rope is flaked out and a figure eight on the bight knot is tied in the end of the rope.

b. The figure-eight knot tied in the end is placed into the culminating point of the abseiling line using a locking karabiner.

c. The rope is run forward toward the cliff and a figure-eight knot is tied in the rope at the cliff edge; ensuring that the knot does not extend over the edge of the cliff when loaded.

d. A locking karabiner and belay device are clipped into the figure-eight knot at the cliff edge.

e. A figure-eight knot is tied at the other end of the belay rope (this is the end that will be attached to the abseiler).

f. A bight of rope approximately 1 m from the abseiler’s end is fed into the belay device and the locking karabiner is locked.

7.59 The belay is to be set up to allow the belayer to easily connect to or escape from the system by using a karabiner. Where possible the belayer is to be positioned in order to see the abseiler.

7.60 The top belay abseil system can be set up using 11 mm and 9 mm static or 11 mm dynamic rope. The complete top belay set-up is shown in Figure 7–29.
SECTION 7-6. CHANGEOVERS

7.61 Descending to Ascending Changeover. At times there may be a requirement to change from descending to ascending. The process for this is as follows:

a. The abseiler descending the rope ties-off. The abseiler sets up for the ascending technique to be used as detailed in Chapter 8. Ensure that the ascent set-up is attached to the rope above the descender; this may require standing on one ascender while connecting the second.

b. Once the ascent set-up is ready, the abseiler ascends up the ascent line unweighting the descent device. Once unweighted the descending device is recovered.
The abseiler continues ascending.

**Descending Past Rebeleys and Deviations**

7.62 **Rebeley.** While descending there may be a requirement to pass a rebelay. For information on how to rig a rebelay see Chapter 6. Only one person is to descend between each rebelay point at a time. The method for descending past a rebelay is as follows:

a. Descend until level with the rebelay point and clip the short end of the cowstail to the karabiner on the rebelay point in front of the rope (there is no requirement to tie-off unless the rebelay is difficult to clip into); check the anchor point and rigging of next pitch.

b. Gently descend until the cowstail is weighted.

c. Remove the rope from the descent device.

d. The abseiler puts the upper rope to one side and behind the cowstail, threads the descent device onto the lower rope as high as possible to the rebelay point, ensuring that no rope or connections are made between the descender and the cowstail.

e. Tie-off the descent device correctly.

f. Stand on a ledge or put a foot or knee in the loop of the rebelay and unclip the cowstail and lower onto the descent device.

g. Untie the descent device and continue the descent.

**WARNING**

Ensure that the descender is attached correctly to the down rope before removing the cowstail. Failure to do so could result in a fall, causing serious injury to personnel, or death.
7.63 Deviation. While descending there may be a requirement to pass a deviation. For information on how to rig a deviation see Chapter 6. When using a deviation only one person can descend the entire rope at a time. The method for passing a deviation is as follows:

a. Abseil onto the karabiner attached to the deviation.
b. Clip the short end of the cowstail to the eye of the knot on the deviation in order to not swing away from the deviation.
c. Unclip the deviation and clip it above the descent device.
d. Unclip the cowstail and continue the descent.
e. There is no need to tie-off as the operation can be done with one hand (if both hands are required the descent device will need to be tied-off).

**WARNING**

As a deviation is not always rigged as an anchor point, the deviation must never be crossed using the same techniques as for the rebelay. Doing so may cause catastrophic failure of the deviation point resulting in serious injury to personnel, or death.
CHAPTER 8

ASCENDING

SECTION 8-1. ASCENDING A VERTICAL FEATURE

8.1 Ascending is an invaluable tool for any member participating in roping activities, from participants to experienced UATLs and ATLIs. A rope can be ascended using traditional techniques whereby accessory cord and friction knots are used, or through modern techniques which employ the use of mechanical ascenders to perform the ascent. This chapter details the types of ascent systems and techniques used, the variants, the procedure for ascending a rope, the safety precautions and general and specific considerations for each system. It is important to note that there are many more types of ascending systems which are not covered in this chapter.

8.2 Ascent systems may have a variety of configurations and are divided into the following three main groups:

a. non-mechanical

b. mechanical

c. mixed or combination (mechanical and non-mechanical).

8.3 Friction Knots. This refers to knots that are constructed using accessory cord that is approximately 4 mm thinner than the rope being ascended. These cords are light and compact and should always be carried for emergency use. The cord should be joined into a loop with a double fisherman’s knot to form a catcher’s loop, which is then attached to the ascent rope using a friction knot. The most suited and most common knot for use in non-mechanical ascent is the classic Prusik knot (see Chapter 4).

8.4 Mechanical Ascenders. Mechanical ascenders are quicker and easier to use than friction knots. For more information on mechanical ascenders, see Chapter 2.
8.5 Sit-stand. The sit-stand method is the main method used in ascending. It is characterised by the motion of sitting in the harness to enable raising the foot while at the same time pushing the ascender that is connected to the foot loop up the rope, then standing in the foot loop to enable the ascending equipment that is attached to the harness to move up the rope. The cycle is repeated to ascend the rope.

8.6 Safety. During all ascending, there must be two independent points of contact between the harness and the rope at all times. If this cannot be achieved then the climber must clip-in and clip-out as a backup. The procedure is as follows:

a. Two extra locking karabiners are to be attached onto the front of the sit harness specifically for this purpose.

b. Once the climber is 3 m off the ground a clip-in is to be conducted. A figure eight on the bight is tied on the running end, approximately 1.5 to 2 m below the climber and is attached to one of the locking karabiners which is on the front of the harness and locked. After ascending another 2 m (5 m in total), another figure eight on the bight knot is to be tied and attached to another locking karabiner on the front of the harness and locked.

c. At this stage, the first figure eight on the bight knot tied can be removed from the first locking karabiner and the knot untied.

d. This procedure is repeated every 5 m until the top of the ascent is reached.

e. It is recommended that just before going over the top when on a single point of attachment or bypassing an obstacle this procedure is completed as close as possible to the area to reduce a fall.
SECTION 8-2. NON-MECHANICAL ASCENT

The Improvised Ascent

8.7 The improvised ascent method is as follows:

a. A 1.5 m length of accessory cord is tied with a double fisherman’s knot to form a catcher’s loop. To gauge the correct length of the loop, the cord should be measured from the thumb to the centre of the bicep when tied in a loop. Using a classic Prusik knot, the accessory cord is attached to the ascending rope then to the sit harness (using the belay loop) by a locking karabiner, as shown in Figure 8–1. A girth hitch should be used to attach the accessory cord to the locking karabiner.

![Figure 8–1: Accessory Cord Attached to the Ascending Rope](image)

b. The ascent rope below the classic Prusik knot is then wrapped around the foot either by wrapping multiple times, or tying a clove hitch, with the foot raised, the foot wrap is shown in Figure 8–2.
Figure 8–2: Wrapped Rope around the Foot – Improvised Method of Ascent
c. The climber stands on the foot wrap and moves the Prusik knot as high as possible up the rope.

d. The climber then lowers into the sit position, until the body weight is on the catcher's loop. At the required distance the rope below is clipped in, in accordance with paragraph 8.6. Figure 8–3 shows a rope clipped in.

e. These actions are repeated until the climber has reached the top of the rope.

WARNING

As the improvised method only employs a single point of attachment to the rope, there is a requirement to clip-in and clip-out during the ascent. Failure to do so could result in injury to personnel, or death.
Figure 8–3: Sit Position – Improvised Method of Ascent
Non-mechanical Ascent

8.8 To conduct non-mechanical ascent in addition to individual equipment, the following stores are required:

a. one 1.5 m accessory cord
b. one 5 m accessory cord
c. three locking karabiners (two for clip-in clip-out as required).

8.9 The non-mechanical ascent system using accessory cords is described as follows:

a. A 1.5 m length of accessory cord is tied in a catcher’s loop with a double fisherman’s knot. To gauge the correct length of the loop, the cord should be measured from the thumb to the centre of the bicep when tied in a loop. Using a classic Prusik knot, the accessory cord is attached to the ascending rope then connected to the sit harness using a locking karabiner connected through the belay loop. The catcher’s loop is to be secured to the karabiner with a girth hitch.

b. Using a 5 m length of accessory cord, tie a double figure eight on a bight (bunny ears) on one end. Each loop needs to be made large enough to fit a foot.

c. The accessory cord is looped around each foot and held tight to ensure that the length is measured up to the sternum. A figure eight on the bight knot is tied with the eye of the figure eight approximately one hand’s length. When standing in both foot loops, the centre of the figure-eight knot should now be at navel height (optimum height).

d. The single figure eight on the bight knot on this cord is now attached onto the ascending rope using a classic Prusik knot, placed below the classic Prusik knot of the catcher’s loop.

e. The climber slides the catcher’s loop classic Prusik knot up the rope until it is taut. The climber then slides the foot
cord classic Prusik knot up the rope until it is against the catcher’s loop classic Prusik knot. The remaining tail is now pulled taut and tied with a figure eight on the bight knot which is then clipped (using a girth hitch) into a separate locking karabiner connected through the belay loop. This forms the second independent point of contact. Any excess accessory cord should be tucked away.

f. Ascent is achieved by the sit-stand method as described in paragraph 8.5. Figure 8–4 shows a non-mechanical ascent system.
Figure 8–4: Non-mechanical Ascent System
8.10 Mechanical ascent involves the use of purpose-built mechanical ascenders to climb a rope rather than accessory cords. Mechanical ascenders are more efficient than accessory cords with many different commercially available models. As with non-mechanical ascent, there are a number of different methods of mechanical ascent.

Mechanical Ascent System

8.11 To conduct mechanical ascent in addition to individual equipment, the following stores are required:
   a. one 5 m accessory cord
   b. two mechanical ascenders
   c. one 3 m x 25 mm tubular tape (chest harness)
   d. four locking karabiners (two for clip-in, clip-out as required).

8.12 Chest Ascender. The type of ascender used can be either with or without a handle. The ascender without a handle is preferred. If using an ascender with a handle as the chest ascender, an additional karabiner will be required to connect the top of the ascender to the chest harness.

8.13 The chest ascender is connected to the harness attachment point, and held in position using a chest harness, as described in Chapter 3. This forms the first point of independent contact. If using an ascender with a handle, the non-master hand ascender is used, and connected to the chest harness using a separate karabiner. The set-up for both types of ascenders is shown in Figure 8–5.
Figure 8–5: Fitted Chest Ascender Set-up with and without Handled Ascenders
8.14 Hand Ascender. The type of ascender chosen should have a handle and suit the user’s master hand, either left or right. The set-up is as follows:

a. Using a 5 m length of accessory cord, tie a figure eight on the bight in one end and attach it to the sit harness using a girth hitch (the tail is passed around the waist and crutch straps on the harness and fed through the figure-eight knot loop).

b. The hand ascender is placed onto the rope at roughly head height.

c. A locking karabiner is placed in the bottom hole of the mechanical ascender directly below the cam.

d. With the accessory cord that has been girth hitched to the harness, the cord is raised and pulled taut towards the locking karabiner on the hand ascender. A figure eight on the bight knot is tied into the accessory cord at this point and clipped into the karabiner attached to the hand ascender. This forms the second independent point of contact. When the arm is holding the hand ascender in the fully raised position (the catcher’s loop is taut), the arm must be 3 to 4 cm short of full extension for maximum efficiency. The length of the catcher’s loop is adjusted if required. The hand ascender attachment is shown in Figure 8–6.

e. In the running end of the accessory cord tie a double figure eight on the bight (bunny ears), large enough to place a foot in each loop.

f. The chest ascender is now clipped onto the rope below the hand ascender, and the feet placed in the foot loops.

g. To measure the correct length of the foot cord the climber lowers the hand ascender until it is as close to the chest ascender as possible. Pull the accessory cord that is attached to the feet up until it is taut and measure to the base of the karabiner, which is hanging off the base of the hand ascender, tie a clove hitch and clip it...
into the locking karabiner. This allows the foot loop to be adjusted during ascent if necessary allowing the karabiner to remain locked.

h. If the clipping in and clipping out procedure is required, a locking karabiner is attached to the sit harness on the belay loop of the harness. The clip-in clip-out procedure is described in paragraph 8.6. A cowstail may be used in place of the additional clip-in clip-out karabiners.

Figure 8–6: Hand Ascender

8.15 Ascent is achieved by the sit-stand method as described in paragraph 8.5. The rope should naturally pull through the chest ascender otherwise it may have to be fed manually. This can be achieved by pulling down on the rope below the chest ascender with the non-master hand, or by applying a small weight to the end of the rope to overcome the excess friction within the set-up.

8.16 To move an ascender down a rope the user must depress the cam without disengaging the safety lock. To do this the forefinger is placed on the top of the cam. As the cam is depressed the ascender is raised slightly to allow the teeth to disengage from the rope. While lowering, the ascender must be
8.14

held in line with the rope or the teeth will catch the rope. The safety lock must not be deactivated, as this can disengage the ascender from the rope. Depressing the cam is shown in Figure 8–7.

![Figure 8–7: Depressing the Cam](image)

8.17 There is no requirement to clip-in and clip-out using the mechanical ascent method unless there is a need to pass an obstacle, or remove one point of contact.
8.18 Wire rope ladders are designed for use in difficult places when a rigid ladder would be impractical. They are strong and flexible allowing them to be coiled and carried in a pack.

**Inspection**

8.19 All wire rope is to be inspected for frays, cuts or damage and the C-clips are to be checked to ensure that they have not been distorted or twisted. Maillons may be used in place of the C-clips. They provide more strength and security at no additional weight. Maillons used must have a safe working load of 250 kg or greater.

**Use of Wire Rope Ladders**

8.20 When climbing a ladder, all novices are to be top belayed. UATLs and experienced participants can use a chest harness with an ascender attached to run along a safety rope, as detailed in Section 8-3. If this method is employed, a second point of contact must be used. Mechanical, non-mechanical and clip-in/clip-out procedures are all acceptable options for the second attachment point.

**Setting Up Wire Rope Ladders**

8.21 The ladder must be secured to an appropriate anchor point. The ladder may be deployed from the top of a pitch by lowering it down or by a person abseiling down and laying the ladder into place. This abseil rope can be used as the safety rope for the ladder. The ladder must be between the rope and the cliff face. It is important to remember the ladder is an aid to climbing and the rope is the safety feature.

8.22 A wire rope ladder must be anchored using a minimum of one anchor point.

**Coiling Ladders**

8.23 Wire ladders may be coiled using any method that is neat, simple and does not place stress on the wire over too sharp an angle. An effective method for short ladders is to take one end
of the ladder and link the C-clips around the ladder, forming a small loop with the first rung lying adjacent to the third rung. The ladder is coiled by rolling it up, placing the side wires within the coil and the successive rungs alongside each other. The ladder is then secured by undoing the inner set of C-clips and fastening them outside the coil, as shown in Figure 8–8.

8.24 A second method, for longer ladders is to S-fold every three or four rungs until the end of the ladder and secure it with the wire trace around the centre of the ladder. The ladder can then be easily secured to a person’s back.

8.25 A third method, for use in expedient deployment, is to coil the ladder into a bag in the same way a rope is coiled into a bag. It is important not to kink the wire when doing this and not to leave the ladder in the bag longer than necessary or place anything heavy on top. The ladder should not be stored in a bag when folded this way as it increases the possibility of kinking the wire and making the ladder usable.

8.26 No more than two people are permitted on a wire rope ladder at any time; each person must be independently belayed.
SECTION 8-5. FIXED LINES

8.27 Fixed lines can be described as either a handline or a traverse. A fixed line is set to assist a person through an area that is difficult to negotiate, or protect a person moving through an area where a fall may have serious consequence. For further information on anchor set-up for fixed lines see Chapter 6.

8.28 Handline. A handline is a rope that is anchored to the route and left in place or it may be recovered by the last person. It can be rigged to assist a person up a slippery or steep surface. If there is risk of serious injury or death the participants must be belayed. A handline needs at least one anchor point and can be constructed by various methods.

8.29 Only one person should climb a handline at a time. This method of ascent may require significant effort and teamwork is often enhanced through its use.

8.30 One technique is to climb the rope, with a hand-over-hand technique. Loops of rope created by alpine butterfly knots, directional figure-eight knots, or overhand knots may be tied into the line or an etrier can be used as handholds or footholds. To climb the rope, the rope is straddled and gripped with an overhand grasp. While ascending, the legs are kept as close to 90° to the slope as possible. This assists in maintaining balance and prevents the feet from slipping out from under the climber. Ascent is obtained by pulling up on the rope and walking up the slope.

8.31 Traverse. A traverse is an excellent tool to not only protect participants past a hazardous area but to also raise the perceived risk of an activity. The simple fact that the participant has to rely on their own dexterity manages to amplify the perceived danger.

8.32 It is important that the user of the traverse maintains one point of contact at all times, and only one person on each segment at a time. Safety on a traverse can be assured by using a clip-in clip-out method either with safety lines, an ascender and safety line, or accessory cords.
8.33 There are several ways of setting a traverse including self-belay or being belayed across. If there is significant risk of falling then an advanced roper should be used to set the traverse.

Safety Considerations

8.34 The anchor points should be above waist high. Only one person is to be between points at any one time. Personnel are to maintain at least one point of contact at all times.

To Set Fixed Lines

8.35 There are many variations in how to set fixed lines, each appropriate for the certain conditions and types of lines. The following are two options:

a. A climber is belayed along the route setting anchor points every few metres at around waist to shoulder height. The climber creates anchor points, if necessary, and then clips their belay rope into these so that it can still run free; this will stop any large falls. The climber is belayed until they reach the end of the traverse or rope. The climber then fixes the line to an anchor point and makes sure they are safe before communicating to the belayer to also fix their end. Once both ends are fixed the climber can return to the start (or the next person if qualified to do this) using the line as a traverse and at each anchor point, makes themselves safe, before unclipping the rope from the karabiner. They can then tie alpine butterfly knots or clove hitches to create independent spans between each point.

b. A climber fixes a line at the start point anchor and attaches themselves to the rope using a safe method so they can move freely along the route. The climber needs to be able to use their hands as they move along the route. At each anchor point they tie alpine butterfly knots or clove hitches until they reach the end and fix the line to an anchor point.
8.36 **Method of Use.** A climber, using their personal safety line, is secured to the fixed line by either an ascender (mechanical or non-mechanical) (see Figure 8–9) or locking karabiners. This will depend on the steepness of the area. The following method can be used:

a. The ascender, accessory cord, or karabiner (depending on the system used) is attached to the fixed line.

b. The second karabiner is then attached to the rope below the ascender if used.

c. The process at each point is: the karabiner is moved first to the new section of the fixed line followed by the ascender, accessory cord, or the other karabiner. This is to reduce any falls during the move from one line to the other, remembering that the karabiner needs to be below the ascender if used.

d. This process is repeated until the end.

e. For safety, only one person should be on the line between each anchor point.

![Figure 8–9: Karabiner and Ascender Attachment](image-url)
SECTION 8-6. ASCENDING CHANGEOVERS

Ascending to Descending Changeover

8.37 A situation may exist where a climber may need to change from ascent to descent. The process is as follows:

a. The climber attaches their descent device to the rope as close as possible below their lower ascender, and ties it off correctly, as shown in Figure 8–10.

b. The climber moves their top ascender down to just above their lower ascender, then steps up to disconnect the unweighted ascender, gently lowering themselves onto their tied off descender.

c. Once all body weight has been transferred to the descent device, the remaining ascender is retrieved and the descent is commenced.

Figure 8–10: Ascent to Descent Changeover
Ascending Past Rebelays and Deviations

8.38 While ascending there may be a requirement to bypass a rebelay. For information on how to rig a rebelay see Chapter 6. Only one person is to ascend between each rebelay point at a time. The method for ascending past a rebelay point is as follows:

a. Stop the hand ascender a couple of centimetres below the knot to allow for release of the ascender.
b. Stand and clip the long end of the cowstail into the karabiner on the rebelay point.
c. While standing, remove the chest ascender from the lower rope and attach it to the upper rope.
d. Sit back on the chest ascender and remove the hand ascender from the lower rope.
e. Attach the hand ascender onto the upper rope above the chest ascender.
f. Ascend until the cowstail is unweighted then disconnect the cowstail from the rebelay and continue ascending.

8.39 While ascending there may be a requirement to pass a deviation. For information on how to rig a deviation see Chapter 6. When using a deviation only one person can ascend at a time. The method for passing a deviation is as follows:

a. Ascend to the deviation karabiner until the hand ascender is just below the karabiner.
b. Clip the long end of the cowstail into the karabiner on the deviation point.
c. Unload the deviation and unclip it.
d. Pull up a loop of rope from below and clip the deviation to it.
e. Unclip the cowstail from the deviation and continue ascending.
CHAPTER 9

VERTICAL RESCUE

SECTION 9-1. INTRODUCTION

9.1 The first principle of rescue is to be prepared. From the moment the site reconnaissance is conducted, all rescue situations should be considered and the appropriate equipment required placed into a rescue kit. This chapter details:
   a. rescue techniques and types
   b. rescue system considerations
   c. appointments
   d. the safety aspects of conducting rope rescue.

9.2 A sound understanding of the basic principles of rescue are required by all UATLs, and rescue scenarios and the techniques employed need to be practised on a regular basis.

General Considerations

9.3 If a complex rescue is required, all activity is to cease and all participants are to be made safe. This may require that some continuation is required, as any participants on a rope must continue their progress until clear of the rope or tied to an anchor point. All personnel involved in the activity must move to a central location, be accounted for, briefed on the situation, and provide manpower and equipment if necessary. Rescue situations should always start with the simplest solution and progress to more complicated systems, as required.

9.4 UATLs are responsible for the safety of their participants. Prevention is the best; however, sometimes things can go wrong and a rescue may be required. Carrying out a rescue does not always imply an equipment, time and effort intensive operation; it can be as simple as talking a nervous participant through a difficult spot. A measured appropriate response is a good guiding principle.
9.5 The rescue of a casualty up or down a cliff should only be used when necessary and conducted by experienced personnel. The raising of a casualty is a serious and complicated process that should only be undertaken when lowering is either not viable or is unsuitable.

9.6 The OIC or GLs should only carry out those actions that they have been trained to do or are qualified to do. If there is any danger that the actions taken may, in fact, make the situation worse, no action should be taken and outside assistance must be requested.

9.7 Whenever attempting a rescue, the following should be considered:
   a. *Keep It Simple.* The more complicated the rescue, the greater chance of something going wrong.
   b. *Planning.* It is important to think before acting ('When there's a life on the line, take your time.').
   c. *Safety.* Do not allow other members of the rescue party to become casualties. Do not forget that other participants are looking on.
   d. *Casualty.* What is the nature of the injury?
   e. *Limitations.* Avoid attempting anything beyond the training, qualifications, or experience of the OIC or GLs. Also avoid attempting any rescue beyond the resources available including: manpower, time and the abilities of the participants.
   f. *Direction of Rescue.* Where suitable it is preferable to lower a casualty than to raise them.

Assessing the Situation

9.8 The primary goal is to evacuate the casualty as quickly and safely as possible. The medical intervention should only be as extensive as is required to achieve this goal.

9.9 The first step towards achieving the primary goal is to make the casualty as comfortable as possible and to reassure them.
When assessing a medical care situation the following must be considered:

a. environmental hazards to the rescuers
b. the location of the casualty
c. environmental hazards to the casualty
d. obstacles to evacuation
e. the time estimated for evacuation
f. consideration for fatigue on the part of the rescuers.

9.10 If it is at all possible for the casualty to walk, or walk with assistance, with their injuries, the decision to haul or walk the casualty out of the area is entirely up to the UATL. Before making a decision, the UATL should consider the following:

a. the UATL’s experience in rescues
b. the group’s experience in rescues
c. the strong and weak points of the groups
d. the potential for more injury to the casualty if the wrong decision is made.

9.11 The most important point with all rescue techniques is to practise them thoroughly in simulated rescue situations. Then in a real emergency the drills or the SOP will become second nature, thus effecting a speedy evacuation. Whether to rescue or not to rescue a casualty is a big decision. If in doubt, call the professional rescue organisations. Do not let pride interfere in making a decision; it could make the difference between life and death.

Preservation of Evidence

9.12 In the unfortunate case of an incident in which there is a death or major casualty, the site of the incident should be kept as sterile as possible. Obviously, if a fatal accident takes place in fast-flowing water, little can be done to preserve the water environment. But in all cases, after all necessary emergency action responses have been completed, the area should be
kept sterile; that is, the area should be roped off and access controlled and limited to only those personnel who are required to enter the area. As much documentary and photographic evidence of the incident site as possible is to be obtained. The site is to be handed over to emergency services personnel or police services as soon as possible, and the group is to comply with all requests by such services.

9.13 Guidance on the response to an emergency and search and rescue is detailed in LWP-G 7-6-1, *Experiential Learning and Adventurous Training* and current Defence Incident Management Policy.

9.14 *Rescue Site.* A rescue site for a raising or lowering operation must have the following characteristics, if possible:

- fail-safe anchor points
- a suitable loading and unloading platform
- room for a rescue group to move around safely.

9.15 *Rescue Team.* A rescue team should consist of the following:

- *Team Leader.* This member is responsible for the organisation of the team.

- *Safety Supervisor.* This member is responsible for all safety aspects of the rescue and stands back to supervise all proceedings as the team establishes the system. Where only one UATL is present, the UATL is to appoint a safety supervisor who is to observe all actions to ensure that all personnel stay safe during the rescue.

- *Team.* These members are the personnel (workforce) required for the task.

- *Escort.* This member will ascend next to a casualty being raised or abseil beside a casualty being lowered (if required).

9.16 No rescue operation will commence until the team leader and safety supervisor have checked and confirmed all components of the system together.
9.17 Rescue Equipment. During the site reconnaissance the OIC must consider all likely rescue scenarios, equipment and length of ropes required to conduct a rescue. All equipment used for rope rescue must meet the safe working load requirements of the situation.

9.18 Rope Management. Rope management is critical in rescue operations. The ropes used for rescue are highly stressed and are susceptible to damage caused by abrasion, rockfall and cutting on edges. Sharp edges need to be protected using rope protection or edge rollers. Good rope management is very important for ensuring the simplicity of the system. It ensures that the rescue system does not become difficult to follow and is easily checked by the safety supervisor and team leader. It also reduces the chance that the wrong rope is unclipped.

Selecting a Rescue Technique

9.19 The type of rescue system will be determined by whether the descent line was set as a fixed line, or a lowerable system. It is important that the OIC, UATL or an ATLI must assess the situation and select the required technique. Where possible, lowering the casualty is the preferred option as that is often quicker and safer than raising. The casualty can then be tended to and recovered from the base of the cliff. Suggested techniques for rescue are as follows:

a. Self-rescue is the immediate action taken by a person to remove themselves from a dangerous situation based on that person’s skill, knowledge and ability.

b. Casualty requires lowering from the top of a cliff – assisted abseil if casualty has sustained a minor injury.

c. Casualty is suspended, caught or unable to continue:

   (1) rescue by raise-lower when obstruction is known
   (2) suspended abseiler rescue when obstruction is unknown
   (3) rescue by lowerable system when obstruction is either known or unknown
(4) if a casualty is injured or frozen on a ledge requiring assistance, verbal coaching or as a final resort go over the edge and assist the casualty, or

(5) pluck-off when assistance to the casualty is time critical.

d. Casualty has sustained minor injuries and is in no danger of losing consciousness – rescue by lowering or raising without a stretcher and without an escort.

e. Casualty has sustained serious injuries and may lose consciousness. The casualty is not capable of providing any assistance – rescue by lowering or raising with a stretcher (commercial or improvised) positioned horizontally or vertically and with an escort.

SECTION 9-2. SELF-RESCUE

9.20 Self-rescue is the immediate action taken by a person to remove themselves from a dangerous situation. Self-rescue is based on a person’s skill, knowledge and ability.

9.21 Conducting Self-rescue. Self-rescue, in rope-related activities, requires a person to have a good working knowledge and skill in the use of knots, descending and ascending techniques. Situations may occur at any time while descending or ascending a rope which may pose a difficult problem to an abseiler if they cannot carry out a self-rescue. If the skills are possessed and practised, the abseiler may be able to carry out functions such as reversing direction up or down the rope, changing ropes, or carrying out a knot bypass and continuing to abseil. Only continued practice and training will retain the skills required to perform self-rescues.

9.22 When experienced abseilers are abseiling on long multi-pitch routes, each abseiler must be in possession of at least two long accessory cords so that they can perform self-rescues if required.
SECTION 9-3. KNOT BYPASS PLANNED METHOD

9.23 The knot bypass is used when the abseiler is aware that there is a knot located in the abseil line (two ropes tied together due to being the incorrect length for the descent).

9.24 Consideration must be given to the method used to join the ropes in order to allow for a loop to clip into as well as a foot loop to stand in.

9.25 A bypass method using two long accessory cords is as follows:
   a. The abseiler descends to approximately 1 to 1.5 m above the knot.
   b. The descent device is tied off.
   c. With a long accessory cord, the abseiler halves the accessory cord and creates a bight and places a classic Prusik knot on the abseil line just above the tie-off.
   d. The remainder of the accessory cord is tied to the harness using a round turn and two half hitches (easily released under load). It must be ensured that the accessory cord is passed through both the waist belt and crutch strap and that it is taut.
   e. The abseiler clips into the rope using the pre-prepared clip-in point.
   f. The descent device is untied and the abseiler descends until the accessory cord and Prusik knot becomes taut and the tension is off the descender.
   g. The descent device is removed from the abseil line, ensuring that the device is not dropped.
   h. The descender is threaded back onto the abseil line, below and close as possible to the knot and tied off. This part of the sequence is shown in Figure 9–1.
   i. The abseiler clips out by reversing the clip-in procedure.
j. The abseiler can then use either the pre-prepared step or another accessory cord (tied into a loop using a double fisherman’s knot) to descend the rope until the descent device is weighted.

k. If all the tension is not fully on the descender, the round turn and two half hitches can be released slowly.

l. All accessory cords from the abseil line are removed and secured by the abseiler.

m. The abseiler releases the tie-off and continues to descend.
Figure 9–1: Descender Configuration
SECTION 9-4. KNOT BYPASS EMERGENCY METHOD

9.26 This method is used if the abseiler descends onto the knot, and/or only has one long accessory cord. The process is carried out as follows:

a. The abseiler applies a positive brake and ties-off the descent device.

b. With a long accessory cord, the abseiler creates a bight at the midway point, and places a classic Prusik knot on the abseil line just above the tie off.

c. The remainder of the accessory cord is tied to the harness using a round turn and two half hitches (easily released under load). It must be ensured that the accessory cord is passed through both the waist belt and crutch strap and that it is taut, as shown in Figure 9–2.
Figure 9–2: Knot Bypass Accessory Cord Placement
d. The abseiler then ascends the rope using an improvised method. The half hitch, clove hitch and foot wraps are shown in Figure 9–3.

Figure 9–3: Half Hitch, Clove Hitch and Foot Wraps

e. The abseiler ascends the abseil line, sliding the Prusik knot up the rope until the tension is off the descender.

f. The abseiler clips in 2 m of rope below as per the clip-in procedure for ascending in Chapter 8.

g. The descent device is removed from the abseil line, ensuring that the device is not dropped.
h. The descender is threaded back onto the abseil line, below and close as possible to the knot and tied off.

i. The abseiler clips out by reversing the clip-in procedure, and unties the figure-eight knot on a bight.

j. The abseiler places a knee in the loop created between the descender and the accessory cord and rolls up onto the knee, while holding the standing end of the rope for balance. The abseiler then breaks the barrel and loosens the Prusik knot; allowing it to slide down as far as possible onto the leg.

k. Without shock loading the accessory cord, the abseiler slowly lowers the body and removes the knee from the loop. An alternative method to using the knee is to use a girth or clove hitch around one foot. The knee roll is shown in Figure 9–4.

l. If all the tension is not fully on the descender, the round turn and two half hitches can be released slowly.

m. The accessory cord from the abseil line is removed and then secured by the abseiler.

n. The abseiler releases the tie-off and continues to descend.

9.27 On some occasions, the knot may pass through the descending device unintentionally. If this happens, the abseiler should continue abseiling.

WARNING

The abseiler must never assume that there is no need to tie-off on the knot, as it may not support the weight of the abseiler resulting in a fall causing serious injury to personnel, or death.
Figure 9–4: Knee Roll
SECTION 9-5. RESCUE BY LOWERING

9.28 In a situation where a person may have to be lowered from the top of a pitch they can be lowered using a descent device attached to the culminating point.

9.29 Lowering Without an Escort. If the casualty has only minor injuries, is not concerned about the descent, and is able to walk, they may be lowered in a sit harness or an FBH (see Chapter 3) without an escort.

9.30 Lowering With an Escort. This is required when the casualty is not capable of making the descent alone but is still conscious and capable of supporting themselves to a degree.

9.31 Descent Device. The lowering rope is passed through a descent device which is attached to an anchor system. The descent device controls the rate of descent. An in-line descender such as a five bar rack is suitable for this purpose. If these are not available a double wrapped figure 8 can be used to create friction required.

9.32 The operation is simple and in most cases will only require the setting up of one lowering rope. During the rescue of a large pitch, there may be a requirement to have a second rope attached to a separate anchor system for control and safety.

9.33 In lowering, there may be a requirement to have a helper/coordinator standing at the cliff head who can see both the casualty/escort and the person operating the descent device, so the rate of descent is controlled. This helper/coordinator must be attached to a safety line.

SECTION 9-6. ASSISTED ABSEIL

9.34 The assisted abseil (or assisted evacuation) is a good technique to use when there is no option but to evacuate both yourself and an injured victim who is unable to assist in any useful way (see Figure 9–5). The assisted abseil can be achieved by the rescuer and the victim abseiling together from the same device, with the rescuer doing all the controlling.
this position the rescuer is allowed full flexibility and can carry the victim in the position that is most practical and comfortable. You can have the victim in front of you, by your side walking down with you, behind you, between your legs or even below you. There are no hard and fast rules to apply to what position the victim should be in, and so much has to be left to the judgement of the rescuer. The following guidelines may be of some help with deciding as to which position is most suitable:

a. Very steep cliff/unconscious victim – across the rescuer’s lap or hanging below. If you choose to have the victim hanging below, you must be very careful to ensure that you do not cause any further injury with your feet.

b. Slabby terrain/unconscious victim – between the rescuer’s legs with the victim’s legs pointing out from the cliff face.

c. Any terrain/walking victim – side by side.
Figure 9–5: Descent Set-up for Assisted Abseil

9.35 Whichever of the possible positions you decide to use, the method of rigging the system is essentially the same. There is only one important variable to consider and that is the length of the sling attaching both the victim and the rescuer to the descending device. For example, if the victim is to be across the rescuer’s lap the victim’s attachment must be shorter than the rescuer’s. If both are to descend side by side then they
must be of equal length. The assisted abseil is conducted as follows:

a. The assisted abseil is conducted down a standard abseil rope, secured with an anchor system at the top of the cliff.

b. The casualty is fitted in a chest harness, an FBH may be used (see Chapter 3).

c. The rescuer places a descent device on the rope (a five or six bar rack is suitable, if a figure 8 descender is used it must be double wrapped to provide more friction).

d. A sling measured to the required length (depending on the system that has been selected) with the centre knot is attached to the descender by a locking karabiner. The side measured for the victim of the sling is connected directly to the casualty’s belay loop with a locking karabiner. The other side of the sling is connected to the harness of the rescuer. This allows the rescuer to sit below or to stand beside the casualty and provide support during the abseil.

e. Alternatively, a self-belay attached to the rescuer’s leg loop is advisable even if there is a brake person available as it will give the rescuer more control over the casualty.

f. The abseil position for the rescuer does not change except that the non-master hand can be anywhere for stability.

g. If the casualty sits across the rescuer’s legs, which act as a platform, there should be no weight placed on the rescuer’s legs. The casualty’s arms may also be placed around the rescuer’s back for additional support.

9.36 The most difficult part of the assisted abseil rescue is manoeuvring the casualty at the top of the cliff head before and during the abseil. To help, it is suggested that the anchor for the abseil line be set up as high as possible or consider placing a redirection on the main descent line to raise it off the ground to a high point.
9.37 The opportunity to adjust the rescuer or casualty’s position once over the edge is limited; therefore, time spent correctly setting up and carrying out minor adjustments on the cliff head is important.

SECTION 9-7. RELEASABLE DESCENT LINE SYSTEM

9.38 A releasable system can simplify the rescue procedure. Two types of releasable systems are described in Chapter 6. The main difference between the two systems only occurs during a rescue. If the rope is twice the length of the pitch a simple rescue can occur. If the rope is not long enough for this another rope can be tied to the end of the first rope and a knot bypass will need to occur.

9.39 The following is an example of a simple rescue using a releasable system:

a. Ensure that the brake person has applied the brake and ensure that the brake person keeps constant tension on the line as the line is lowered throughout this entire process.

b. Release the tie-off and lower the suspended person under control.

c. Retrieve the rope and reset.

9.40 Knot Bypass on a Releasable Descent Line. If the releasable descent line has been joined by one of the preferred knots (see Chapter 4), and you have to bypass the knot the following is a suggested example:

a. Ensure that the brake person has applied the brake and ensure that the brake person keeps constant tension on the line as the line is lowered throughout this entire process.

b. Release the descent line and lower this line until there is approximately 1.5 m of rope between the knot and the belay device and tie off the belay device again (see Figure 9–6).
c. At this stage a figure 8 descender can be used as a rigging plate in the anchor system. Connect a second belay device to the rigging plate and tie it off behind and as close to the rope joining knot as possible (see Figure 9–7).
d. On the loaded line place a Bachmann knot. The accessory cord is attached to the anchor system by a Münter Mariner (see Figure 9–8).

![Figure 9–8: Adding the Bachmann Knot](image)

e. Untie the first descent device and lower the load line while manipulating the Bachmann to prevent it taking up tension until there is just enough slack left in the line to be able to remove the front decent device from the rope easily (see Figure 9–9).

f. Remove the front descent device then release the Münter Mariner and lower until the tension is on the rear belay device and the Bachmann knot can now be removed.

g. The new load line can now be used to lower the suspended abseiler.

h. Retrieve ropes and reset.
SECTION 9-8. HAULING SYSTEMS

9.41 Hauling is defined as the process of raising or lowering a load under controlled conditions; using rope work, winches, pulley systems and manpower. This chapter provides the basic ideas, requirements and techniques required to efficiently and safely conduct hauling operations.

9.42 There are two types of hauling systems:
   a. Basic. Basic hauling systems are those methods of hauling which contain no mechanical advantage.
b. **Complex.** Complex hauling systems are those in which mechanical advantage has been incorporated into the hauling system to assist in the lifting capacity.

9.43 Hauling systems can be used for a variety of different applications including gear or equipment hauling, system, tensioning, and rescue operations where the raising or the lowering of a casualty is required.

**Methods of Construction**

9.44 The two basic methods for constructing hauling systems are as follows:

a. **Single Rope Method.** This refers to a system which is designed around the use of a single length of rope, which is not under tension during the set-up of the hauling system.

b. **Separate or Bolt-on Method.** This refers to the method which is designed to be used on a tensioned rope. It comprises of a separate rope, which is attached to the tensioned line.

9.45 During this chapter, the single rope method will be referred to as such; however, the separate rope method will be referred to as a bolt-on system. Other publications may refer to the bolt-on system as a ‘pig rig’ or ‘pig’. This is due to the system being ‘piggybacked’ onto a separate line.

9.46 Regardless of whether a separate single system or a bolt-on system is being used, the hauling system is always referred to by the amount of mechanical advantage they provide to the user. This advantage is expressed as a ratio. Twice the mechanical advantage is displayed as 2:1, while three times the mechanical advantage is displayed as 3:1 and so on.
SECTION 9-9. MECHANICAL ADVANTAGE

9.47 The mechanical advantage being referred to in a system will always be a theoretical one. With all hauling systems there will be friction placed into the mechanism by ropes, pulleys, karabiners and directional factors. All of these factors and limitations will be discussed in more detail later in this chapter.

9.48 While there are a number of mechanical advantage ratios, this chapter concentrates on the following:
   a. the 2:1 ratio
   b. the 3:1 ratio
   c. the 6:1 ratio.

9.49 The systems of mechanical advantage are detailed in Figure 9–10 and Figure 9–11. These figures depict how the systems must be anchored and at which points the system must be anchored in order to produce the mechanical advantage.

Figure 9–10: System 1 – Mechanical Advantage

LWP-G 7-6-2, Adventurous Training – Roping, 2018
CAUTION

While all levels of mechanical advantage are achievable, the application of mechanical advantage in excess of 6:1 should not be used by hauling teams exceeding one person. The loads placed on equipment, in this situation, will more than likely exceed the safe working limits specified by the equipment manufacturers causing the equipment to fail.

9.50 The amount of force being generated by the mechanical advantage of any system should always be a planning factor prior to using any system. If five adult men were to haul on a 6:1 system, then forces in excess of 1500 kg or 15 kN would be produced.
Components

9.51 There are many components that make up a complete hauling system. While the situation and equipment used may vary from system to system, the basic components and procedures will always remain the same. There are three main components to a hauling system which can be broken down into the following areas:

a. **Load Rope.** This component of the system comprises the part of the load that is to be hauled. This rope will be connected into the culminating point of the anchor system and at no time should it be removed from this point. This rope defines the single point of contact between the anchor, the hauling system and the load. In the case of the single rope method, the load rope component will be incorporated as part of the hauling system.

b. **Anchor System.** This component is critical in the hauling system. An anchor system is always to be used when hauling a load with the use of mechanical advantage as the forces created will be substantial. Anchor points and systems and their uses are detailed in Chapter 6. The integrity of the hauling system is dependent on the anchors. The direction of pull is a consideration and needs to be in line with the anchor system. If this is not possible it is necessary to redirect the pull using a suitable anchor point. A redirection does not add mechanical advantage but does add some extra friction to the system.

c. **Mechanical Advantage System.** This is the component that provides the capability to lift the load and is the main area of concern of this chapter. While this component and the ratio of advantage it provides will vary, the principles of application remain the same. The hauling
system is always to be fixed into the anchor system and has the following key features:

(1) **Block.** This feature provides a locking mechanism that can be engaged while the system is being reset. Due to the amount of rope that is required to be pulled in during the use of a mechanical advantage system, the resetting of the system takes place many times. The block needs to be reset manually.

(2) **Autoblock.** This feature provides the same locking mechanism as the block; however, no manual handling is required. The autoblock is created by adding a belay tube or plate in front of (or instead of) the pulley. A French Prusik is tied in front of the belay device on the load side of the rope. The reason for the belay device is to prevent the accessory cord from being pulled into the system.

(3) **Load Rope Attachment Point (or Grab).** This feature is critical in the system, as all of the force of the load is directed through this point.

(4) **Haul Line.** This is the part of the system where force is applied to the system to create the mechanical advantage.

(5) **Clip-in and Clip-out.** This point provides effective backup to the system during the reset procedure.

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**WARNING**

All hauling systems used in a rescue situation must follow the ‘sudden death’ rule. The sudden death rule states that the sudden death of any member of the rescue team shall not cause a failure of the hauling system nor place the lives of others in danger.
Hauling System 1:1

9.52 The 1:1 hauling system is the only hauling system in this chapter that does not provide the user with mechanical advantage. As the ratio suggests the mechanical advantage is equal. For every 1 m of rope that is hauled in, the load will advance 1 m. This type of system can be very effective for applications which involve long hauls of light to moderate loads. This is a typical type of set-up for hauling on walls where space is limited and the constant resetting of a system is impracticable.

9.53 The 1:1 hauling system can be redirected or run directly through the anchor point. With each redirection, friction will increase. Figure 9–12 shows a 1:1 hauling system using an autoblock.

9.54 The pulley shown in Figure 9–13 could be replaced by karabiners; however, this will increase friction within the hauling system. In a 1:1 system it is acceptable to use mechanical devices, as the working loads have not been increased; however, at no time should any shock loading be allowed to occur in this hauling system.

Figure 9–12: 1:1 Redirected System with Pulley and French Prusik
Hauling System 2:1

9.55 The 2:1 hauling system provides the user with twice the mechanical advantage of any direct 1:1 hauling system. While the principal theory involved shows a mechanical advantage of 2:1, due to friction the actual advantage will be reduced.

9.56 The basic 2:1 hauling system may be constructed using the single rope method or the bolt-on method. The hauling system is anchored into the culminating point of an anchor system and runs down to the load where it is connected with a free moving attachment (karabiner or karabiner with pulley). The rope then runs back up to the culminating point and becomes the hauling line, as shown in Figure 9–13. If an autoblock is used then it is attached at the hauling end of the system. Resetting will not be required under this type of use; however, a block or autoblock may be used to reduce run-back.

Figure 9–13: Single Rope 2:1 Hauling System without Autoblock

9.57 Systems of a 2:1 ratio may also be constructed using the bolt-on method. The setup principles remain the same; however, at the free moving connection point or grab, the hauling system is attached to the load rope with the use of a small Prusik knot. The Prusik knot may require a triple wrap to provide adequate friction, as shown in Figure 9–14.
The attachment point of the hauling system to the load rope can also be a mechanical ascender. Due to the characteristics of the camming device in the mechanical ascender, the load to be hauled will determine whether this type of attachment is appropriate. Mechanical ascenders may tear the sheath of a kernmantle rope under severe loads, while Prusik and similar knots will only slip. The use of a mechanical ascender as a grab on any hauling system requires good judgement and experience coupled with a solid understanding of safe working loads and tolerances.

When constructing a bolt-on 2:1 hauling system it is critical that the load rope is backed up. This may be achieved by clipping in and out the load rope. While the first line of defence against major run-back is the autoblock; in the event of autoblock failure, the redundancy in the system is achieved by the clip-in, clip-out. At no point should the load rope be removed from the system, rather, it is to be clipped in to the anchor system to reduce the accumulated slack. If there is a large enough distance from the edge and enough rope being hauled in during each reset, then the slack in the haul line should be tied into a figure eight and re-clipped into the culminating point. If the haul
distance is small then several resets may be required between each clip-in. Figure 9–15 shows a bolt-on 2:1 hauling system.

Figure 9–15: Bolt-on 2:1 Hauling System

9.60 Figure 9–16 shows the bolt-on 2:1 hauling system that has been clipped in after the load has been partially hauled.

Figure 9–16: Bolt-on 2:1 Hauling System Clipped In

Safe Working Loads and Rescue Loads

9.61 It is important to understand safe working loads or rescue loads in order to be able to assess the reliability of equipment when it is used in a hauling system. By applying the following concepts it will be possible to assess equipment and rigging and whether it is suitable for the hauling situation.

9.62 A safe working load is defined by assessing the given rating of any piece of equipment and then dividing it by a factor of five. This will then give the safety factor of any piece of equipment.

9.63 A rescue load is defined as 200 kg (or 2 kN), which includes casualty, rescuer, rigging and equipment.
9.64 The maximum steady loading on any component of the system is 8 kN. This is based on the equation that a load of 2 kN being hauled in a system with 3:1 mechanical advantage gives 6 kN, plus friction which results in a load of approximately 8 kN.

9.65 Excessive friction or jamming within a mechanical advantage system can quickly raise the forces within the set-up. If a load becomes jammed, and hauling continues, the loads can quickly exceed the maximum allowable limits. Care needs to be taken to ensure that a load under haul does not become stuck and that hauling ceases should it occur.

Reset

9.66 While it is not often a requirement of the 2:1 hauling systems, resetting the system is nearly always required in a 3:1 hauling system. Resetting refers to the situation in which as much of the haul line has been taken up as possible and the load rope attachment point (or grab) must be reset down the load rope closer to the load.

9.67 The process of resetting takes the load off the haul line and places the load back onto the load rope, generally where the load rope has been clipped in to the culminating point of the anchor. As the slack is taken up in the load rope, the load actually lowers. This is known as run-back and may reduce the efficiency of the hauling system. It is essential that the run-back is allowed to operate smoothly, and that no dynamic load is placed on the system.

9.68 In a situation where the mechanical advantage of the system is high (3:1 or greater), and the area of operation of the hauling system is small, the amount of run-back may greatly reduce the efficiency of the hauling system. For example, in a 3:1 hauling system, 3 m of rope needs to be hauled to raise the load 1 m. If the run-back in resetting the system is 0.5 m (easy to achieve), then the load drops that distance, and the load must effectively be hauled twice to raise it to the top.

9.69 One strategy to reduce run-back is the attachment of an additional block or autoblock onto the load rope, which is detailed later in this chapter.
**Hauling System 3:1**

9.70 The 3:1 hauling system, which is also known as the Z-rig or Z-drag, provides an efficient mechanical advantage system. In a situation where a single member may have to haul on their own (with a lifting capacity of 50 kg), the 3:1 system is an effective system.

9.71 The method for constructing a bolt-on 3:1 hauling system is as follows:

a. A small accessory cord is attached to the load rope via a Prusik knot in order to provide the grab and a karabiner is attached to this accessory cord. A haul line is attached to a karabiner with a figure eight on the bight knot and flaked in the Z-configuration, as shown in Figure 9–17.

b. A separate karabiner is placed into the anchor culmination. The haul line is then clipped into the karabiner attached to the grab. A belay device is placed into the karabiner with a bight of the haul rope. Pulleys may be placed at the grab and culminating points to reduce friction and increase efficiency. A French Prusik is then added to the same karabiner over the belay device to act as an autoblock, as shown in Figure 9–18.

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*Figure 9–17: 3:1 Bolt-on Z-Configuration*

*Figure 9–18: 3:1 Bolt-on Z-Configuration with Pulleys and Prusik*
An additional karabiner is connected to the culminating point with a Bachmann block to act as an autoblock on the abseil line. When this system is hauled in, the load rope should be clipped in and out of the culminating point as a backup and to allow the hauling system to be reset. The block will need to be worked during the hauling system. A 3:1 hauling system with a Bachmann block is shown in Figure 9–19.
Figure 9–19: 3:1 Bolt-on with Bachmann Block
Top Belay to 3:1 Hauling System

9.72 As with the 1:1 and 2:1 hauling systems, a 3:1 system can be constructed using the single rope method or with the bolt-on method. The 3:1 single rope system can be very efficient when deployed as it can be easily set up from the basic top belay system. Due to a top belay basically being a 1:1 system, with the addition of only a few pieces of equipment the top belay can become an effective 3:1 system.

9.73 The method for turning a top belay into a 3:1 hauling system is as follows:

a. The brake is applied on the belay device and the belay device is tied off, as shown in Figure 9–20. At this point the line is secure and the dispatcher can use both hands to assemble the system.

![Figure 9–20: Top Belay Tie-off](image)

b. An autoblock is attached by inserting an extra karabiner into the anchor culminating point and a French Prusik is attached to the load rope. The excess portion of the load rope behind the tie-off (leaving at least 3 m of line to work with) should be clipped in so that when the belay device is untied the system will not be relying on an accessory cord only. This is shown in Figure 9–21.
c. A small accessory cord is attached to the load rope via a Prusik knot forward of the autoblock, and is clipped with a karabiner and with a pulley if one is available. The tie-off is released, with the load being transferred to the autoblock (backed up by the load rope clipped in to the culminating point), as shown in Figure 9–22.

Figure 9–22: Load Attachment Point
d. The load rope is threaded through the karabiner (or pulley) and is hauled in back towards the belay. As the haul line/load rope is hauled in, a periodical clip in and out of the haul line should occur to backup the system. At no time should the system rely only on the autoblock to secure the line. The 3:1 hauling system is shown in Figure 9–23.

e. The autoblock is allowed to take the load during the resetting of the system. The autoblock will also allow a degree of run-back as it takes up the load. Assistance by hauling team members behind the belay will assist in the hauling process.
Figure 9–23: Hauling Process
Direction Change

9.74 It will not always be appropriate to haul back in the direction of the culminating point. This may be due to geographic problems or safety issues. If this is the case a redirection will be required to direct the haul line in the direction required. Each redirection will add friction to the hauling system, making it more difficult to haul.

9.75 Normally in a hauling system the forces are generated in line with the load and anchor system. When a redirection occurs, forces are generated at angles to the system. This can make anchor points within the anchor system redundant, thus placing extra loads on some anchor points. Given that the loads are increased in a mechanical advantage system this could result in disaster.

9.76 To prevent redirection forces, an anchor point is required to offset the load of the hauling team. This will keep the hauling system in line and will prevent the culminating point from being pulled sideways to the load. A hauling system with an additional anchor point is shown in Figure 9–24.
Figure 9–24: Redirection of Hauling Line
Culminating Point Dilemma

9.77 Due to the large amount of equipment to be connected to the anchor culminating point, that culminating point tends to become overcrowded. To prevent cross-loading of karabiners, splitting of knots and the jamming of moving parts within the system, a culminating point clean up is required.

9.78 Figure 9–25 shows an anchor culminating point problem and a possible solution. Due to the large size of the hole in the figure 8 descender and its construction, which allows it to be loaded at multiple points, it may be used as a central attachment point, or rigging plate. While every problem cannot be anticipated, most problems can be solved using similar ideas.
Figure 9–25: Culminating Point
Rigging plates are an alternative for the culminating point clean up but may not always be readily available. The rigging plates provide many attachment points to allow for a clean culmination point. Commercially available rigging plates are shown in Figure 9–26.

**Figure 9–26: Rigging Plates**

**Hauling System 6:1**

The 6:1 hauling system follows the same principles as a 3:1 hauling system. A 2:1 is then piggybacked onto the 3:1 giving a mechanical advantage of 6:1. This is a simple way of increasing the advantage in a system without the requirement of a complete re-rig. A 6:1 hauling system is shown in Figure 9–27. Due to the forces generated inside the 6:1 hauling system, the rope grab inside the 3:1 should always be an accessory cord type Prusik configuration. This ensures that the haul line sheath is not stripped.
Figure 9–27: 6:1 Hauling System
While a 6:1 hauling system allows a great deal of force to be applied to lifting a load, there is a lot of hauling force wasted as friction in the system. In addition, a 6:1 hauling system requires that 6 m of rope must be hauled for the load to be lifted 1 m. Due to the force created by the mechanical advantage of a 6:1 hauling system, no more than one person should ever be in the hauling party.

**Other Hauling Systems**

While the basic hauling systems of 1:1, 2:1, 3:1 and 6:1 are the most commonly used hauling systems, other levels of mechanical advantage exist. Caution should be shown when increasing the level of mechanical advantage beyond 6:1 in a rescue situation as equipment tolerances and safe working loads may be exceeded.

A useful hauling system is the 5:1 hauling system. The 5:1 hauling system is easy to build after a 3:1 system has been constructed. By anchoring the haul line back into the 3:1 hauling system with an extra line, extra advantage can be obtained, as shown in Figure 9–28.
Figure 9–28: 5:1 Hauling System
The design and application of hauling systems is only limited by imagination. By placing different devices at different points in the system the characteristics of a system can be improved or changed. While there are many ways to change the components of the system, the principals will remain the same. An example of this is by placing the autoblock at the load point instead of the hauling point. While this is effective, a disadvantage is that the release of the autoblock would be limited. Such a system is shown in Figure 9–29.

The rescue situation will depend which technique should be used. The techniques listed in this chapter are for a fixed descent line; however the techniques are easily adjusted for a lowerable system as required.
Figure 9–29: Autoblock Variation

Variation 1 - Grigri

Variation 2 - Duck
9.86 Ropers become suspended for many reasons, including clothing or other objects caught in the ascender/descender, incorrect tie off procedure, or abseiling onto a knot. Hauling systems can be used to raise a suspended person a short distance in preparation for lowering them to the ground.

9.87 The rescue by raise-lower is a method used when a person becomes suspended on the line and the obstruction cannot be removed and that it is fail-safe.

9.88 The process requires the removal of the tension placed on the line at the culminating point. The removal of tension is to gain access to the top of the line so that a rescue rope can be attached to it. This method is used to control the rate of descent when lowering the casualty and is conducted as follows:

a. The person being rescued is checked to ensure that the obstruction is fail-safe.

b. If the system is set up as a releasable system and the length of rope is long enough to lower the person to the ground you lower the person down. If there is not enough rope then continue from paragraph 9.88c.

c. A figure eight on the bight knot is tied at the end of the rescue rope and is attached to the descent line with a locking karabiner.

d. An additional locking karabiner is placed into the anchor culminating point and the rescue rope with a descending device (figure 8 descender or belay device) is attached to the new karabiner.

e. The rescue rope is then threaded through the descending device and tied off. There is very little slack between the end of the rope and the descent device.

f. A figure eight on the bight knot is tied approximately 5 m further down the rescue rope and is clipped in to another locking karabiner at the anchor culminating point in order to provide more security (see Figure 9–30).
g. A separate hauling system is placed on the descent line, selecting whichever type is suitable or appropriate to the situation (see Figure 9–31). Additional information on hauling systems is in Section 9-8.
h. The hauling system is operated until there is enough slack in the descent line to remove it from the anchor culminating point. Ensuring that the descent line remains connected to the rescue rope as per paragraph 9.88b (see Figure 9–32).

i. The hauling system is lowered under control until tension is taken up onto the tied off descent device.
j. The hauling system is dismantled; the rescue rope that was clipped in for safety can now be clipped out. The tie off is released and the casualty is lowered to safety.

k. A rescue by raise-lower may require a number of people to provide the necessary assistance for hauling.

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**WARNING**

The rescue by raise-lower must only be performed if the obstruction on which the casualty is suspended is fail-safe. The casualty must have no chance of bypassing the obstruction. Failing to observe these precautions could result in serious injury to personnel, or death.

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**SECTION 9-11. SUSPENDED ABSEILER**

9.89 Suspended abseilers occur for many different reasons. If the obstruction is not fail-safe, the rescue by raise-lower cannot be employed and a separate line must be used and lowered down to the rescuee. The suspended abseiler rescue is conducted as follows:

a. The rescuee is to remain in the brake position, or if possible, a brake person (bottom belay) should be employed until the rescuee is made safe.

b. A rescue rope that is longer than the descent is lowered to the casualty with a locking karabiner attached to the end through a figure eight on a bight. The rescuee must then attach the locking karabiner onto their harness.

c. An additional locking karabiner is placed into the anchor culminating point and the rescue rope with a belay device is attached to the new karabiner.

d. Pulling the rescue rope as tight as possible the device is then tied off. The rescuee is then safe.
e. If the rescuee needs to be raised in order to release tension from the descent line, a hauling system may be attached to the rescue rope.

f. If the descent line has been set up for a lowerable system then release the system to remove the tension on the descent line.

g. Once tension is has been removed from the descent line, the rescuee may be able to remove the obstruction and continue the descent.

h. If the lowerable system was used this must be adjusted and the descent line must be secured before the next step.

i. The rescue rope at this stage can be removed from the harness of the rescuee before they commence the descent.

9.90 To assist in the conduct of this type of rescue, a person is attached to a safety line located near the edge. While the setting-up is done, they can relay directions, provide information and reassure the casualty. The rescuer must ensure that the rescuee is doing the correct thing before any lines are disconnected or hauled.

Other Rescue Options

9.91 For many reasons the best option when conducting a rescue is to deal with it from the top of the cliff. However, if a casualty is injured or frozen on a ledge requiring assistance, there may be no option but to go over the edge and assist the casualty.

9.92 The rescuer must abseil down next to the rescuee on a separate rescue rope. This may be attached to the same anchor system. The rescuer descends using a double wrapped figure 8 descender. Once along-side the rescuee, the rescuer
ties off and assesses the situation. The rescuer may perform the following actions:

a. If the rescuee is mildly distressed or injured, the rescuer may be able to talk the rescuee through, allowing the abseil to continue.

b. If the ability of the rescuee is in doubt, the rescuer may attach a quickdraw, a short sling, or a chain of locking karabiners to the rescuee’s crutch and waist strap of their harness.

9.93 If the problem involves an obstruction of the descender and if the rescuee can assist with the following procedure:

a. Using two long accessory cords, the rescuer will have the rescuee ascend up their descent line a short distance taking tension off the descender. When attaching the accessory cords to the rescuee’s harness use a round turn two half hitches.

b. The rescuer can remove the obstruction, rethread and tie off the descender.

c. To place tension back onto the rescuee’s descender, the rescuee descends using the accessory cords.

d. The rescuer removes the accessory cords and removes the safety link that was created between them. The rescuer assists the rescuee in the untie procedure.

e. If in doubt of the rescuee’s ability both continue the abseil simultaneously with the rescuee, remaining connected.

f. If the obstruction cannot be removed without removing tension from the rescuee’s descending device, a pluck off can be conducted.
SECTION 9-12. PLUCK OFF

9.94 The pluck off is a technique which may be used when no assistance can be given by the casualty and/or their rescue is time critical. The casualty may have hair or skin caught so they will be reluctant to move, or they may be injured, and will be unable to assist the rescuer. In this situation the rescuer removes the tension from the casualty’s descender and literally plucks the casualty from their abseil line and suspends them under the rescuer. This technique can also be useful when doing multi-pitch abseils and when an abseiler is suspended on the knot at the end of a pitch. Prior to conducting this type of rescue, all equipment required for the rescue is to be arranged and prepared. The pluck off is conducted as follows:

a. The rescuer must abseil down next to the casualty using a separate rope. If using a figure 8 descent device, the rescuer must ensure that the descender is double wrapped before descending (gloves are not required to be worn for double wrapped figure 8 descenders). The rescuer must have a quickdraw, a small sling, or a chain of three locking karabiners attached to the small hole of their figure 8 descender; in addition to, the locking karabiner which attaches the figure 8 descender to the rescuer’s harness. The rescuer descends alongside and onto the casualty and ties off. The rescuer’s waist must be approximately 50 cm above the casualty’s waist so that the rescuer is sitting in the casualty’s lap (see Figure 9–33).
Figure 9–33: Pluck Off Set-up
b. The rescuer attaches the karabiner chain on the figure 8 descender to a locking karabiner on the casualty's harness, which is on the non-master hand side. All locking karabiners are checked that they are done up. Alternatively, a quickdraw with two locking karabiners may be used as the link.

**WARNING**

If the casualty is unconscious or in excessive pain (e.g., their hair is caught in the descent device), the casualty’s rope may be cut once the link to them has been established and checked. The rescuer must ensure that the correct rope is cut and that the cutting action is away from their rope to prevent further injury.

c. Once the link has been checked, the casualty’s karabiner with their descender attached can be undone.

d. To remove the tension from the casualty’s descender, the rescuer ties a small loop of accessory cord onto the casualty’s abseil line slightly above helmet level using a French Prusik knot (for ease of removal) and attaches a karabiner (a locking karabiner is not required).

e. With a long accessory cord, the rescuer creates a bight at the midway point and attaches this to the casualty’s harness (through the waist strap and crotch loop) on the non-master hand side with a girth hitch. Caution must be taken to ensure that the karabiner attached to the casualty’s descender is not jammed between the equipment that is being added in this process.

f. This accessory cord is to run up and through the karabiner attached to the French Prusik on the casualty’s rope (see Figure 9–34). A knot is tied in this accessory cord as high as possible (approximately waist level of the rescuer), ensuring that the rescuer can place a foot into the loop that has been created.
Figure 9–34: Counterweight
g. The rescuer manoeuvres to one side, giving clear leverage and places a foot into the long accessory cord. The rescuer then stands in the loop, at the same time lifts the casualty by the harness until the tension is off the casualty’s descender. The rescuer must keep the tension off the casualty’s descender in order to remove the casualty’s descender from the locking karabiner it is attached to (see Figure 9–35).

h. The rescuer then slowly releases the counterweight by raising or bending their leg which allows the casualty to be lowered down until the link between the rescuer and casualty has become tight. This technique requires practice and a little strength and must be done slowly so that there is no dynamic or shock loading.

i. The final stage is to collect all equipment used for the rescue. The rescuer then unties and descends under control with the casualty suspended underneath, a self-belay may be attached (see Figure 9–36).

9.95 As with any of the techniques described, it is important to be prepared for the worst. The rescuer must have all the equipment required to conduct a pluck off ready from the moment an abseiler is dispatched; however, it may not be necessary to go that far so a full assessment should be done prior to being committed to this type of rescue. Rope management is very important during the pluck off as it is easy for the rescuer to become suspended.
Figure 9–35: Release
Figure 9–36: Recovering Gear after Lowering
Other Vertical Rescue Techniques

9.96 It is common for the GL to be located above the casualty when an accident or incident occurs; this is typically because a member of a group will have descended a pitch and experienced difficulties after having been dispatched by the GL. It may be possible to either raise or lower the casualty. Lowering is the preferred method on the second or subsequent abseils after the first pitch ropes have been cleared. Should the incident occur on the first abseil, raising may be the preferred option. The hauling system used will depend on the personnel and the room available. If raising or lowering is inappropriate with any casualty, then rescue by pluck-off may be required.

9.97 If the group is in a position where the rescue rope has already been used due to rope entrapment or a rope has been lost and therefore raising is not an option, then descending down the line will be the only COA remaining. This is conducted using two accessory cords in the same method as for a non-mechanical ascent (see Chapter 8). Once with the casualty, the GL can render first aid as required.

9.98 It is important to note that the GL should be the last person to descend the ropes. This will ensure that the GL will always be in a position to control and carry out a rescue if required. The GL should always have the rescue line, as they will be in the best position to use it.

Raising and Lowering Techniques

9.99 In the case of a pitch accident, raising or lowering techniques may need to be employed. The general action taken by the group will depend on whether they are all at the bottom of the pitch below the casualty, all on the top above the pitch, above the casualty, or scattered between both places. Conscious casualties are able to advise the rescue team on the effect that raising or lowering is having on their comfort.

9.100 Regardless of the rescue techniques employed, an anchor system must be used. The confined nature on a multi-pitch abseil, in canyons or caves, may require the raising and
lowering techniques to be modified to facilitate the redirection of the ropes.

9.101 **Raising.** The confinements of the abseil point may hinder the rescue or make it more complicated. Key features of a good hauling system for a pitch rescue are simplicity and versatility. The casualty could be in a delicate state and the hauling rig should be arranged and operated with the casualty's comfort and safety foremost in mind. It may be appropriate that someone travels with the casualty (if the casualty is incapacitated in any way) to monitor them and to help facilitate the rescue; however, this may not be achievable in some instances.

9.102 **Lowering.** In most cases a person injured on a multi-pitch or canyon abseil has to be moved down rather than up. It can be very difficult and dangerous to attempt a climb out after the pitch has been cleared. Even if a pitch is still fixed, it may be quicker to move through down a few pitches rather than up one pitch.

9.103 Should an accident occur underground, those in the group who are not injured immediately become the rescuers until such time as outside help arrives. In situations where outside help cannot be reached, the group assumes the entire responsibility. The first line of action is to quickly assess the casualty's situation and condition, bring them to safety (if necessary) and render first aid.

**Self-rescue or Outside Rescue**

9.104 Once the casualty's condition has been stabilised, decisions should be made concerning the rescue. Possibly after treatment, the casualty will be able to be evacuated by themselves or with the assistance of others. If the casualty is unable to evacuate with minimal or no assistance, the crucial decision has to be made whether to move the casualty using the resources of the group (self-rescue) or to call in a fully equipped outside rescue group. If the group is capable, self-rescue is likely to be faster, but for a casualty in a critical condition inexperienced attention and the lack of a stretcher
could prove fatal or permanently disabling. A well-organised outside rescue gives the advantage of expert medical attention, a stretcher and the support of a strong and experienced crew. However, the rescue crew may take several hours to arrive. During this time hypothermia and weakness from lack of food and warmth are very real dangers.

9.105 The decision to wait for an outside rescue will usually be made in a case of unconsciousness, serious hypothermia or severe injury. If a rescue group is close at hand, the decision will obviously be made in many milder cases also. If the casualty is only suffering from a minor injury such as a twisted ankle or a dislocated shoulder, once the casualty has been stabilised the UATL can commence some form of self-rescue to extract the casualty from the activity site. This can be continued until outside assistance arrives. Advanced rescue techniques are used by a fully equipped rescue party and are beyond the scope of this chapter.

SECTION 9-13. CLIMBING LEADER AND SECOND RESCUES

9.106 This chapter details rescue techniques and the types of rescue, rescue system considerations, and the safety aspects of conducting rescue while climbing. All rescues may be performed by a single rescuer, as climbing generally takes place in pairs, but any assistance provided to the rescuer will enable the rescue to be made more quickly and more efficiently. Not only is a sound understanding of the basic principles of rescue required, but rescue scenarios and the techniques employed need to be practised on a regular basis.

9.107 In all but the most unusual cases, conducting a rescue while top rope climbing will simply involve lowering the casualty on the rope to the ground. If a more complex rescue is required or a lead climber must be rescued then all activity is to cease and all participants are to be made safe. This may mean that some continuation is required, as any participants on a rope must continue their progress until clear of the rope or tied to an
anchor point. All personnel involved in the activity must move
to a central location in order to be accounted for, and to provide
assistance and equipment if necessary. Rescue situations
should always start with the simplest solution and progress to
more complicated systems, as required.

9.108 UATLs and instructors are responsible for the safety of their
participants. Prevention is the best COA; however, sometimes
things can go wrong and a rescue may be required. The OIC,
UATLs or instructors must only carry out those actions that they
have been trained to do or are qualified to do, and those that
will improve the situation. If there is any danger that the actions
taken may, in fact, make the situation worse then no action
should be taken and outside assistance must be requested.

9.109 Once a rescue has been initiated, the considerations for first
aid, emergency response and evacuation must also be applied.

Second Rescue

9.110 When conducting single-pitch lead climbing, in all but the most
unusual cases, conducting a rescue will simply involve lowering
the second on the rope to the ground. When lead climbing on a
multi-pitch route, or when a second has difficulty climbing a
section of the cliff but wishes to continue, the assisted hoist is
suitable to haul the second beyond any difficulties.

Assisted Hoist

9.111 To use the assisted hoist, the second must be a fully
functioning climber (ie, not a casualty) who is less than
one-third of a rope-length below the belay (see Figure 9–37[a]).

9.112 If the second is more than one-third of a rope-length away then
they should ascend the rope by non-mechanical means or be
raised through a mechanical advantage system.

9.113 The assisted hoist procedure is as follows:

a. The leader ties off the belay device and escapes the
system.

b. The leader attaches a small length of accessory cord or
tubular nylon tape to the loaded rope with an autoblock
(ie, a French Prusik knot). This is placed below the belay device and towards the second, and is attached to the belay system. The autoblock can be released under tension, which is an advantage in this situation (see Figure 9–37[b]).

c. A locking karabiner is clipped into a bight of rope below the autoblock and is lowered down to the second. The second clips the karabiner into their harness, encompassing both the waist belt and the crutch loop, and then locks the karabiner (see Figure 9–37[c]).

d. The leader takes in all the slack in the rope to the second. With the rope running from the second, the leader ties a figure eight on the bight knot in the rope and attaches it to the belay system culminating point with a locking karabiner. The leader double-checks all ropes, knots and karabiners, and then slowly releases the tied-off belay device, ensuring that the autoblock takes up tension on the rope.

e. To raise the second, the leader pulls up on the rope between the belay system and the second, while the second pulls down on the rope between the autoblock and themselves (see Figure 9–37[d]).

f. For every 5 m that the second ascends, the leader must ensure that the autoblock takes the tension on the rope, and then clips in and clips out the figure eight tied into the belay system.

g. Once the second has ascended past the obstacle or any difficulties, the leader can then place the second back on belay. To do this, the leader ensures that the autoblock takes up the tension, and then pulls a few metres of rope through the belay device and ties off the belay device. The backup figure-eight knot and the autoblock are released, and the second releases the loop of rope attached to their harness. The leader releases the tied off belay device and the second may continue to climb, belayed from above by the leader.
WARNING

The leader must ensure that the autoblock is effective and takes up the tension on the second’s rope, as it has taken the place of the leader’s belay. Failing to do so may result in an unprotected fall which could result in serious injury to personnel, or death.
Figure 9–37: Assisted Hoist

LWP-G 7-6-2, Adventurous Training – Roping, 2018
Mechanical Advantage

9.114 If the second is more than one-third of the rope-length below the leader then the assisted hoist cannot be achieved. Instead, the leader may have to construct a mechanical advantage system. The most applicable hauling system for second rescue is the 3:1 (Z-drag) hauling system constructed using the single rope method.

Leader Rescue

9.115 Rescuing a leader on a single-pitch climb, which is no greater than half the rope-length in height, generally involves just lowering the leader to the ground. When the climb is greater than half a rope-length in height, or multi-pitch climbing is being undertaken, the leader rescue is an involved and time-consuming process and not without risk. If at all possible, assistance should be sought and other options investigated (eg, abseiling to the leader and performing a pluck-off rescue) before attempting a leader rescue. The key factor — as with all rescue work — is that the OIC, UATLs or instructors must carry out only those actions that they have been trained or qualified to do and that will improve the situation. If there is any danger that the actions taken may make the situation worse then no action should be taken and outside assistance must be requested.

9.116 There are two methods of rescuing a leader casualty: the five-step method and the counterweight method. Both methods are long and involved processes and take considerable time to accomplish, although they may be carried out by a single rescuer (usually the second).
Before attempting a leader rescue using the five-step method or the counterweight method, the reliability of the top piece of protection must be carefully considered. Unfortunately, the second may not be able to visually inspect or reinforce the top anchor. However, the second must have complete confidence that the top piece of protection will support both the leader and the additional weight of a climber ascending the rope. If the second has any doubt about the reliability of the top piece of protection, any actions taken may make the situation worse, and they should not proceed with the rescue but should seek outside assistance. A fallen leader is shown in Figure 9–38.
Figure 9–38: Fallen Leader
The Five-step Method

9.118 The basic sequence for the five-step method is as follows:
   a. tie-off the belay and ascend to the leader
   b. construct a belay system and attach the leader to the belay system
   c. descend and release the bottom belay tie-off
   d. re-ascend to the leader
   e. lower the leader.

9.119 Before commencing to ascend to the leader, the second must decide whether to raise the leader to the top piece of protection (assuming that the leader has fallen) or to lower the leader to the most appropriate position (usually to a piece of protection in the best location to construct a belay system).

9.120 Raising the Leader. Raising the leader to the top piece of protection involves the construction of a mechanical advantage system. It is more time-consuming and more difficult than lowering the leader to a piece of protection, but it may be the most appropriate option in the situation. Construction of a mechanical advantage system will also multiply the force placed on the top piece of protection, a major disadvantage for raising the leader.

9.121 Lowering the Leader. By lowering the leader, the second can move the leader to a piece of protection at the most appropriate position to construct a belay system. Before lowering a leader, the following considerations must be applied:
   a. An unconscious or unresponsive leader, or a leader with severe injuries, should not be raised or lowered unless the leader is escorted. The injuries may be compounded if the leader strikes rocks and obstacles while being raised or lowered.
   b. The leader should be lowered to the best piece of protection but also to a position that is suitable for the construction of a belay system.
c. The more a leader can be lowered, with the amount of rope available, the fewer repetitions of the method chosen will be required.

d. Ledges that may assist the second in providing first aid must be considered.

e. The features of the pitch such as the angle, protrusions or recesses that may hinder the lowering must be considered.

9.122 Step 1 – Ascend to the Leader. The sequence for ascending to the leader is as follows:

a. The second locks off and ties off the belay device.

b. The second must reinforce the belay point, if possible, to construct a belay system. If on a multi-pitch climb and the second is belaying from a belay system, the second should place an additional piece of protection for an upward force, if possible.

c. The second escapes the belay system by removing the karabiner attached to the harness from the two figure-eight knots on the bight.

d. The second attaches a sling to their harness (encompassing the waist belt and crutch strap) with a girth hitch and attaches a locking karabiner to the sling.

e. The second ascends the rope to the leader using three accessory cords as points of contact. The accessory cords may be attached to the rope using any sliding friction knot, although the Prusik is the most appropriate knot. One accessory cord is used for the foot and two accessory cords are attached to the harness (giving two points of contact). Clipping in and clipping out cannot be achieved due to the tension in the rope.
9.123 Due to tension in the rope created by the leader, the rope is more difficult to ascend than a slack rope. The second clips the sling and locking karabiner to the rope and locks the karabiner. While ascending the rope, the second must unclip and re-clip each piece of protection as it is passed. If the accessory cord knots break or slip then the locking karabiner will catch a piece of protection to stop the fall. Step 1 is shown in Figure 9–39.
Figure 9–39: Five-step Method – Step 1
9.124 Step 2 – Construct a Belay System. The sequence for constructing a belay system is as follows:

a. Once the second has ascended to the leader, the second must build a suitable belay system. If a piece of protection placed by the leader is used in the belay system it must be fail-safe.

b. The leader must be clipped into the belay system with a sling or long accessory cord, girth-hitching the sling to the leader's harness, encompassing the waist belt and crutch strap, and attaching the sling or accessory cord to the belay system using a mariner knot. If necessary, a chest harness may be attached to the leader which is used to keep the leader upright.

c. The second also attaches an additional sling to the leader, girth-hitching the sling to the leader's harness, encompassing the waist belt and crutch strap. This sling is attached via a locking karabiner to the belay system. The load should be on the sling tied with the mariner knot.

d. The second then connects the anchored end of the rope to the belay system with a sliding friction knot (generally a Prusik knot) to ensure that a downward force remains on the belay system as the second descends and then re-ascends the rope. Step 2 is shown in Figure 9–40.
9.125 Step 3 – Descend. Descending is the reverse method of the ascent. The descent takes place using three Prusik knots.

9.126 Step 4 – Re-ascend to the Leader. See Figure 9–41 for Step 4 and Step 5, which involve the following sequence:

a. The second will need to attach a figure-eight loop to the harness using the 1 m of slack as an additional backup;
the second can then untie the backup figure-eight knot that is attached to the bottom of the anchor.

b. The second will unload the bottom anchor by removing the descent device.

c. The second will ascend the rope and clean the pitch, backing up regularly using figure-eight loops clipped into the harness.

d. The second’s weight will load the top Prusik knot. The weight of the leader is the backup for the Prusik knot. It is essential to leave any pieces of protection they may need as directional or rappel stations.

**WARNING**

Once the second has reached the leader, the second then clips into the anchor using a sling and a locking karabiner which is girth-hitched to the second’s harness. If both of the anchors that are weighted fail then any pieces of protection above them and the figure-eight backup loops will hold the fall. If both are clipped into the anchor and it fails, with no pieces of protection placed above it, then the system will fail and both climbers may fall and die.

9.127 The Prusik knots used for the ascent and the Prusik knot that was holding the rope are to be removed. At this point, the second will either lower the leader or rappel using the assisted rappel or counterweight rappel techniques.

9.128 The anchor that the second has built to secure the leader should be absolutely reliable. Before lowering the climber, the second should untie the leader, take in the slack, retie the climber and clip the rope through the anchor. This adjustment is much safer because they no longer have to rely on the top piece of protection, which may not have been inspected.

9.129 Step 5 – Lower the Leader. The second should check that the leader is conscious and responsive. The lowering procedure
may further injure the leader by jarring and scraping the leader against the rock. If the leader is not responsive or has serious injuries then an assisted or a counterweight rappel will be necessary so that the second can accompany the leader down.

**Figure 9–41: Five-step Method – Step 4 and Step 5**

9.130 With a conscious climber, the rescuer can use the procedure described in this paragraph, making sure the rope is running through the anchor above them. They will be lowering the climber to the ground using the belaying device as follows:

a. tie off the belay device
b. tie a knot at the end of the rope

c. unclip the sling that is girth-hitched from the climber’s harness to the anchor

d. untie and unload the mariner knot, this will load the second belay device

e. untie the belay device

f. lower the climber to the ground, if the rope does not reach the ground then adjust the rope or establish multiple rappels.

9.131 Variation to the Five-step Method. In some cases, rope adjustments are necessary to complete the rescue. The variation that allows such adjustments to be made is described in this paragraph. If, when the second ascends to the leader, there is not enough rope to lower the leader to the ground then the second can increase the amount of rope available by doing the following:

a. The second and the leader must be attached to the same anchor by slings that have been girth-hitched to their harnesses. Furthermore, the rope must have been released from the bottom anchor to allow the lowering to continue.

b. The second then reinforces the anchor. The anchor must be absolutely secure. If it is not then it is lowered to a more suitable point and a new anchor is built.

c. The rope is clipped into the second’s harness so it is not dropped accidentally.

d. The leader is untied from the end of the rope and the rope is pulled through the piece(s) of protection above.

e. The leader is retied to the end of the rope and the rope is clipped through the anchors.

f. A knot is tied at the end of the rope.

g. The slack is adjusted and the leader is lowered.
Counterweight Rappel Transition

9.132 Counterweight rappel transition is how the second would ascend to the leader and prepare a counterweight rappel. In this rescue, the second must be prepared to ascend the rope to anchor the leader. If the leader is on a route that does not offer a suitable anchor point convenient to the second then the top piece of protection is to be inspected. Figure 9–42 shows the counterweight method.

![Counterweight Method Diagram]

Figure 9–42: Counterweight Method

9.133 This method assumes that the top piece of protection can withstand the forces typically applied to a reliable anchor.
However, the second may not be able to inspect or backup this protection point.

**WARNING**

If the top piece of protection is not reliable then this method is not to be attempted due to the risk that the protection will give way causing serious injury to personnel, or death.

9.134 The method of rescue is as follows:

a. Escape the belay and ascend to the leader as previously described.

b. Upon reaching the leader, secure a Prusik knot to the rope just ascended.

c. Secure this new Prusik to either the loop formed by the figure eight follow-through on the leader's harness (for added safety, two Prusiks are shown in Figure 9–42) or another Prusik knot tied to the rope weighted by the climber at a point 0.5 m above the leader; using a karabiner, attach the opposing Prusiks knots together.

d. Descend and remove the original belay anchors.

e. Ascend the rope to the leader.

f. Set up a counterweight rappel and descend.

9.135 The attachment of a Prusik knot means that the leader will remain in the same location while the second descends and re-ascends the rope.

**Assisting the Leader to Lower**

9.136 In this rescue, the leader has been injured during a fall or is simply backing off a route, and the second wishes to lower the climber. Due to the length of the pitch there is not enough rope to lower the climber to the ground. The leader is able to assist but their unstable position requires the second to remain in control of the rope. Figure 9–43 shows an example of assisting the leader to lower.
Figure 9–43: Assisting the Belayer to Lower

Leader clips into and then weights anchor

Figure-eight loop on slack rope clipped through anchor and clipped to harness

Leader unties and pulls rope through top anchors

First leader reties into end of rope

Then unties figure-eight on loop

Then belayer takes in slack

Then leader unclips from anchor

Finally belayer lowers leader
The process to rescue the leader is as follows:

a. Lower the leader to the closest piece of reliable protection.

b. The leader backs up the protection point and anchors to it with a sling and locking karabiner which is girth-hitched to their harness.

c. Once the leader is anchored, feed out 1 m of slack.

d. The leader clips the slack rope through the anchor, ties a figure-eight loop, and attaches it to their harness using a locking karabiner; the leader is still on belay.

e. The leader unties their original tie-in knot and pulls the rope from the top piece.

f. The leader retires to the end of the rope, clips the rope through the anchor and unties the figure-eight loop.

g. The second takes in the rope until the rope is taut.

h. The leader unclips from the anchor and is lowered by the second.
CHAPTER 10
CANYONING HAZARDS AND CONSIDERATIONS

SECTION 10-1. INTRODUCTION

10.1 There are many different types of hazards in canyoning. It is essential that UATLs correctly identify and deal with each hazard to reduce the risks of illness, injury or death of group members. This includes increasing the group members' awareness of hazards by teaching them what the common hazards are and how to employ equipment and techniques to avoid them. This chapter discusses some of the common hazards in canyoning.

10.2 When planning a canyoning activity, always ensure that the canyons you are planning to visit are open. Bushfires, extreme weather conditions, hazard reduction burns, landslides, planned track work, emergency operations and a range of other events can lead to temporary closures. Always check with land managers or Park officials for access. Ignorance is not a defence, and serious penalties or even criminal prosecutions can occur in certain cases.

SECTION 10-2. CANYONING HAZARDS

Flooding

10.3 Heavy or constant rain in the catchment area around a canyon can cause the water levels in the canyon to rise. If heavy rain has fallen in the catchment area, or heavy rain is forecast, the canyon activity should not to proceed. Water levels in some canyons have a history of rising rapidly and dissipating slowly. Parts of some canyons that are normally dry can suddenly flood without notice due to rain in the catchment area. Canyons that have recently flooded may have debris lodged into crevices in
the walls of the canyons; there may be a sudden rush of water through the canyon if the debris is dislodged up stream.

10.4 Prior to commencing a canyoning activity, the UATL must check the risks of flooding by reading guidebooks, obtaining local knowledge and checking weather reports. A reliable source for this information is the Park Ranger or commercial adventure companies.

10.5 If the water level in a canyon starts to rise during a canyoning trip, the group will normally have two options to avoid this hazard: exit the canyon, or move to a safe area and wait for assistance. There are a number of additional hazards associated with these two options, such as the group becoming trapped in a small area by the rising water, or the group moving to an area where they are unable to escape the rising water. The UATL will have to make a decision based on all the information at hand, including the group’s location inside the canyon, the experience level of the group and the options available for escape.

Falling Objects

10.6 Falling objects such as rocks, trees or equipment can cause injury to people in their path. The following strategies are used to mitigate this risk:

a. Helmets are to be worn at all times.

b. Avoid or spend as little time as possible in the likely landing areas of objects that may fall.

c. If a group is travelling on a sloping part of the canyon that has loose rocks, they should form a tight group so that any dislodged rocks will not have time to build up speed before impacting with group members. Alternatively, one member of the group at a time may travel past the loose rocks to a safe area before the next group member moves.
Slippery Surfaces

10.7 Slippery surfaces are common in the canyon environment; hence, it is important to move through the canyon carefully, using multiple points of contact or equipment, such as a safety line, to prevent group members from falling.

Hypothermia

10.8 The human body has a number of systems to ensure a constant core temperature of around 37 °C. Hypothermia occurs when the body’s temperature falls below 35 °C. Many situations can cause the body to lose more heat than it can generate.

10.9 Hypothermia can occur during a canyoning activity for numerous reasons, including prolonged exposure to cold conditions, immersion in cold water, or being out in windy weather in wet clothes. The risk of hypothermia is not confined to sub-zero conditions, it often happens in temperatures ranging from 0 to 10 °C. Mild hypothermia is relatively easy to treat in the field, but severe hypothermia is life-threatening without prompt medical attention.

Negotiating Obstacles

10.10 There are many different types of obstacles that a canyon party will encounter during a trip. A risk assessment is to be made and a treatment plan established for all obstacles. Participants are not to jump into water of unknown depth. The leader is to ensure that the area is deep enough and is clear of any logs or rocks before jumping. If participants are to jump into the water, the following techniques are to be used:

a. no pack is to be worn (the pack is thrown in before the jump)

b. all personnel are to conduct a stride entry.

Moving Water

10.11 A UATL requires a high standard of practical skills and a thorough knowledge of moving water. All UATLs must be able to interpret the hazards in moving water. One of the first
considerations for negotiating moving water is whether the group members are actually capable of negotiating it or if they are better off finding another route which avoids the water.

10.12 Hazards and Constrictions. A fast moving water hazard is any obstacle or river feature that is capable of harming a canyoner. A hard object (eg, undercut rock) or a fluid danger (eg, hydraulic) can be a hazard. Trees along the bank such as willows, or snags in the river, often pose very serious hazards yet are seriously underestimated by canyoners. The basics of water mechanics are detailed in *LWP-G 7-6-4, Adventurous Training – Whitewater Rafting and Kayaking*.

**Swimming**

10.13 Swimming is a normal part of canyoning, and everyone can expect to take a swim once in a while. The trick is being able to take a swim safely in fast moving water, avoiding hazards and knowing how to escape water features. Personnel will need to swim in fast moving water that is knee height or deeper to avoid a foot entrapment. Personnel will be able to stand up in any water that is below the knees.

10.14 Swimmers may become trapped in or against an obstacle. Generally, trapped participants are known as entrapped. Entrapment is the term used when a body extremity such as a foot, leg or arm is caught in or against the river bottom or a hazard (see Figure 10–1). A simple precaution to avoid entrapment is to never stand or attempt to stand in water deeper than the knees when a current is fast flowing.
Defensive Swimming

10.15 Defensive swimming enables a swimmer to float in fast water that is too deep to stand in safely, but too shallow to swim in effectively. Self-protection is a must in shallow, rocky rapids. The defensive swimming position is for a swimmer to float on their back, pulling up their rear end and getting their feet to the surface facing downstream. They can maintain control by using a backstroke action with their arms. The swimmer’s head is out of the water, looking downstream ready to react to any situation. Keeping their feet out of the water enables the swimmer to push off any objects that may come up in front of them. Figure 10–2 shows defensive swimming in shallow water.
Avoiding Strainers

**10.16** When swimming, there is the potential to become trapped in a sieve or strainer\(^1\). To overcome a strainer from the defensive swimming position, the swimmer should turn over onto their front and swim aggressively toward the strainer. Just before they reach the strainer, they should place their hands out onto the hazard, push themselves over and kick vigorously to keep their legs close to the surface. Once they have negotiated the strainer, they can re-adopt the defensive swimming position. Figure 10–3 demonstrates how to avoid strainers.

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1. These are features, normally created by rocks or submerged dead fall, that create a higher velocity flow through a small space, dragging swimmers into the hole like a plug.
Exiting the Water

10.17 When leaving the river from the defensive swimming position, the swimmer must first identify a suitable, safe eddy in which to swim. Just before they reach the eddy, they should turn over onto their stomach, facing upstream, and swim aggressively into the eddy at a 45° angle to the current vector.

Drowning

10.18 Wet canyons have bodies of water in them that are large enough for an adult to drown in. A swim test designed specifically for the activity to be undertaken is to be conducted prior to the conduct of a canyoning activity to identify weak swimmers. Weak swimmers will require monitoring and may require additional assistance such as floatation aids when in the water.

Falling

10.19 To reduce the risk of falling, the GL should advise participants of the following:
   a. to avoid jumping and sliding uncontrolled down slopes
10.20 Ropes can get caught during the rope recovery process. There is always a risk that a rope may not be retrievable during a canyoning activity. Methods of recovering jammed ropes are described in Chapter 6.

Climbs and Scrambles

10.21 Caution should always be exercised in the poor light and wet-slippery conditions that are associated with canyoning. It is often difficult for participants to judge distances and angles, which increases the risks of injuries when climbing and scrambling over obstacles.

SECTION 10-3. CONSIDERATIONS

10.22 Exploring a canyon requires the use of a variety of techniques which, if used correctly and combined with a positive mental attitude, will assist participants to conserve energy and increase safety.

SECTION 10-4. TECHNIQUES

Descending

10.23 Canyoning is expedition-styled abseiling, which is conducted on double ropes for the ease of rope recovery. It can be done on 9 mm or 11 mm static ropes, or on a combination of both. All personnel descending a pitch are to be under control. The UATL should keep some ascending gear ready to be used, if required, while descending a canyon.

10.24 For any descents where the bottom cannot be seen, a knot placed 1 m from the end should be considered. This allows the first person to tie off on the knot if the rope does not touch the ground. If the abseil is within a waterfall, where there is a risk of
drowning, a self-belay or top belay should be considered in place of the stopper knot.

10.25 Most of the abseils in canyons are slippery or have hard starts or sections. Depending on the area the abseiler may have to sit to start or slide down the waterfall on their side. Good appreciation and briefings will prevent any unnecessary injuries.

10.26 Further details on double rope techniques are described in Section 6-9.

Climbing Techniques

10.27 Exiting a Canyon. If a canyon has a section on the exit route where lead climbing is involved, two exit methods are:

a. An assessment of the distance and grade of climb is to be made prior to entering the canyon, then a competent lead climber in the canyon party is to lead the climb.

b. If no competent lead climber is in the canyon party, ascent lines are to be established on the exit before entering the canyon. This may be done the day before or just before entering the canyon. If the latter, extra time will be need to be added to the trip to allow for the set up.

SECTION 10-5. FOOD CONSUMPTION

10.28 A UATL should be mindful that canyoning is a physically demanding activity. There is a real risk of a participant developing hypothermia during a canyoning exercise. The environment is generally cold. The steep sides of a canyon keep direct (warming) sunlight out for all but a short period of time each day and water in a canyon is usually deep and very cold. Clothing, such as wetsuits, can provide some insulation; however, to keep warm the body needs to create its own heat. This requires energy, which is provided by food. It is important that the right types of food are consumed.
Glycemic Index and Exercise in the Cold

10.29 Foods that have a low glycemic index (GI), such as fruit, vegetables, pasta, meat and most unprocessed foods should be consumed as much as possible. This will ensure that energy is available at most times. However, due to the intensity of the activity and the cold environment, high-GI foods can be used to provide a quick energy boost. Exercise in the cold burns more calories than normal exercise, so energy levels should be replenished with high-GI and low-GI foods as often as possible to avoid the deficit created through the body’s heat and energy loss.

10.30 A balanced healthy diet with additional snack food will usually suffice for participants on a canyoning activity. Snacks should be a mixture of low-GI and high-GI foods. The traditional bushwalkers’ ‘scroggin’ (ie, a mix of dried fruit and nuts, lollies, liquorice and chocolate) is ideal. Muesli bars are also a suitable snack. Warmth and an energy boost can also be provided by warm cordial.
CHAPTER 11
CAVING SAFETY

SECTION 11-1. INTRODUCTION

11.1 This chapter highlights specific safety instructions for the conduct of caving activities, including ascending and descending. Caving involves exploring underground caverns and subterranean passages. Caving activities are divided into horizontal caving and vertical caving activities, requiring descent and ascent techniques. This does not include cave diving. This chapter is to be read in conjunction with Annex C to Chapter 1.

SECTION 11-2. DANGERS IN CAVING

11.2 The chances of serious injury or death while caving can be reduced by being aware of the dangers involved, by having adequate knowledge of the equipment and techniques and by cultivating good judgement. Knowledge comes after many years of caving experience and association with other cavers.

11.3 Caving accidents are, statistically, mostly attributed to poor judgement, little or no caving experience, and falls. The most common accidents in caving include:

a. falling
b. being struck by falling objects
c. getting stuck
d. hypothermia
e. drowning.

11.4 Caving, however is not as dangerous as popular opinion has it. The good caver sets out not to conquer the cave but to explore it safely, using whatever equipment is necessary to do so and avoiding hazards to themselves and the group. As a UATL, it is
essential that the potential hazards of caves are understood. A UATL must develop the attitude of mind that weighs up the risk of a cave both beforehand and as it is travelled.

Types of Dangers

11.5 Flooding. Heavy rain can produce a rise in water levels that can have dire consequences to any cavers within that system within minutes. In heavy rainfall conditions, parts of caves that are normally dry can become flooded. Flood waters can move silt, rocks and other debris sealing exit routes. Flood waters tend to rise very rapidly and dissipate slowly. If rising water is detected then immediate action needs to be taken. The two choices are to head out of the cave or to retreat to a safe area. There are risks associated with undertaking either of these strategies. Heading out of the cave may place the caving group in a more dangerous situation than was previously faced. Staying in a safe area may result in a situation where the area becomes unsafe and the cave group is therefore trapped. A decision needs to be made quickly; however, the effects of a wrong decision may be very serious, potentially resulting in death.

11.6 Drowning. Drowning can occur in caves which are prone to flooding, although many of these deaths are the result of inexperienced cavers ignoring the signs of rising water or oncoming thunderstorms and entering caves which are known to flood. Check the flood risks of the chosen cave before visiting it by reading guidebooks and, if possible, obtaining local knowledge. The local Park Ranger or nearest Speleological Society will be aware of the caves that are prone to flooding. If the group is faced with a sudden rush of water through the passage they are in, the UATL will have to make the best decision possible in the circumstances. Use the emergency bag, huddle together, conserve food, keep well away from draughty places such as the bottom of pitches and use as little energy as possible. Several cavers have drowned while trying to leave a flooding cave instead of retreating to safety.

11.7 While moving through active cave streams, it is worth noting whether the activity is being conducted in a region that does or
does not flood. A passageway devoid of fragile formations or with a clean washed look may well be prone to flooding. If the walls of the passage reveal bits of twigs or mould then that is a good indication that, at times, the cave will flood. The other obvious sign is debris lodged into crevices in the walls and ceilings of the cave.

11.8 Falling. To reduce the risk of falling, the UATL should advise participants to avoid jumping and uncontrolled sliding down slopes, to wear appropriate footwear, to check and discard any faulty or worn equipment and always to use common sense. Beware of poor equipment and poor use of equipment. A UATL must ensure that all members in the group are fully trained in the care and use of all caving equipment. There is no excuse for accidents caused by poor equipment or bad techniques; they are entirely preventable.

11.9 Falling Objects. Serious head and neck injuries can be caused by falling objects. To avoid these accidents participants must always wear a helmet and stay clear of the base of pitches and climbs. Never throw stones down a shaft. Loose material is less likely in well-trodden caves; however, when exploring new or little used caves, there is a danger of disturbing rubble at the top of pitches onto unsuspecting participants below.

11.10 Avoiding dangerous areas is a good strategy for avoiding being hit by a falling rock. Personnel should not dwell directly under pitches unless absolutely necessary. If there is no other place to move then stand against a wall. If caught on a loose slope, move together so that any dislodged rock will not have time to gain speed prior to impact on participants at lower levels in the cave. Alternatively, one member of the group may proceed past the obstacle and when in a safe area the next participant can follow on, minimising the number of people exposed at one time.

11.11 Getting Trapped. This is not easily done because common sense usually stops people pressing on until return is impossible. Nevertheless, it can happen. Cavers digging through choked passages have to be particularly careful not to
be trapped by roof-fall. In tight horizontal crawls, equipment sometimes snags under the body. It is best to remove equipment such as helmets and packs and push them ahead where this could happen. Avoid round pebbles rolling under the chest by brushing them out of the way first.

11.12 Horizontal squeezes tend not to be traps but vertical ones can be more serious. It is more difficult to climb out of a tight vertical slot than to slide into it. If there is no alternative way back, a caver must be careful.

11.13 Another way of becoming trapped in a cave is by a through trip. A through trip occurs when a caver enters at the top of the cave system and exits at the bottom. The caver uses double ropes to descend each pitch and retrieves the rope at the completion of each abseil. If further progress is not possible, the caver cannot retreat as the only means of escape (the secured rope) has been removed. Furthermore, if a rope gets stuck it could mean a strenuous and dangerous climb to free the rope.

11.14 Inexperienced cavers commonly forget where exit points are. Some caves have one way in and a different way out. Inexperienced cavers forget to do the exit set up before entering the cave and are then not able to exit out of the cave. When planning a cave trip ensure that the guidebook is checked for information regarding exit points and, once set, enter the exit to ensure that the rope and/or ladder reaches the bottom to get an idea of the layout of the cave exit.

11.15 Getting Lost. Novices may well credit themselves with supernatural route finding ability, but it is actually just a matter of applied common sense. Do not try to remember the entire cave, just the junctions. Look back after each junction to note what it looks like when going the other way. If lost, never wander on regardless, but try to retrace your steps until the passage is recognised and you find the right way out again. If a group has to wait for a rescue, they should do so in the biggest and most obvious place they can find. If a group has to leave markers, remember that these must not damage the cave and should be removed on return. Piles of rocks on top of each
other to indicate the route or where to turn can make a trip easier.

11.16 **Histoplasmosis.** This is a fungal infection of the lung and sometimes of the vital internal organs. It is found in some bat breeding caves and is the most common bat-carried disease overseas. It usually has mild and curable effects, but is occasionally fatal. In Australia, even allowing the possibility that some cases are wrongly diagnosed, it is rare although not unheard of.

11.17 The microscopic fungus *Histoplasma capsulatum* grows in the dropping of bats and birds. It multiplies by forming spores that are breathed in by the victim. Occurring as an acute lung infection two or three weeks after inhaling the spores, histoplasmosis causes fever and night sweating, pain around the lungs, shortness of breath and dry coughing. Fungicidal drugs can be prescribed, but many cases clear up of their own accord within a month or so. Chronic infections are more dangerous because they may show no symptoms until internal organs are damaged.

11.18 **Foul Air.** Foul air is a life-threatening hazard which may be encountered in caves with relatively still atmospheres. Foul air, sometimes called bad air, is a cave atmosphere which has noticeable abnormal physiological effects on humans. In limestone caves, foul air can be described as containing greater than 0.5 per cent CO\textsubscript{2} and/or lower than 18 per cent O\textsubscript{2} by volume. As a comparison, normal air contains approximately 0.03 per cent CO\textsubscript{2} and 21 per cent O\textsubscript{2} by volume. However there are some isolated caves which contain atmospheres influenced by other gases such as methane, ammonia, hydrogen sulfide or carbon monoxide, but these gases are generally rare in limestone caves.

11.19 An elevated CO\textsubscript{2} concentration is usually the most life-threatening foul air scenario found within Australian limestone caves. This colourless, odourless and non-combustible gas is the body’s regulator of the breathing function. In industry the maximum safe working level recommended for an 8 hour working day is 0.5 per cent
(5000 ppm by volume). A concentration of 10 per cent or greater can cause respiratory paralysis and death within a few minutes.

11.20 Foul air concentrations are generally more common towards the bottom of a cave but pockets do appear within the cave during the year. There is a summer-winter effect for most caving regions of Australia that is driven by weather barometric pressure changes. In summer, the regular pattern of high pressure systems push air into the cave, resulting in higher concentrations of CO2. In winter the pattern of alternating high and low pressure systems force air in and out of the caves, diluting the concentrations of CO2. Temperature changes outside caves also have an effect on the concentration of foul air. During summer the above-ground air temperature rarely drops below the cave air temperature, hence the cold, dense air remains in the lower levels without circulating. However during winter the caves breathe, the warmer air rises, thus causing an expansion of the CO2 regions with a reduction in CO2 concentration.

11.21 Caution is required while descending any vertical sections inside a cave as it is possible to descend into very high concentrations of foul air. The first descending caver must be able to ascend the vertical section upon encountering foul air.

11.22 CO2 is regarded as a hot gas due to its low thermal conductivity; heat is not conducted away as rapidly as in normal air so a person standing in it feels warm. Upon entering a region of foul air, the caver may recognise the following effects:

a. laboured breathing
b. increased pulse rate
c. headache
d. nausea
e. a hot clammy feeling.

11.23 A UATL should consider withdrawing all participants from the affected part of the cave upon foul air being discovered, or
when participants appear to be suffering from symptoms of excessive CO₂ levels. A UATL may continue the organised activity with caution, using other areas of the cave system.

11.24 In the majority of foul air found in caves, the real danger is the CO₂ concentration which is the main trigger for the human body to increase the breathing rate. In the majority of cases, if a person has any of the symptoms of elevated carbon dioxide, a simple naked flame test will fail to ignite.

11.25 The naked flame test can be undertaken by igniting a match or butane cigarette lighter or carrying a lit candle into suspected foul air. If the flame is extinguished, foul air is present.

11.26 Laboratory tests have proven that combustion of a match, candle or butane cigarette lighter will cease at about 14.5 to 15 per cent concentration of O₂; 21 per cent being the oxygen concentration in normal atmosphere. Bearing in mind that humans on average breath out air containing between 15 to 16.3 per cent O₂ and this is enough to revive a person using Expired Air Resuscitation (commonly known as EAR). In fact humans can survive in an atmosphere containing 10 per cent O₂, so when the flame test just fails, the atmosphere still contains enough oxygen to survive.

11.27 Most caves have good air circulation but there are some exceptions. The best-known caves in Australia to be affected by foul air are those of Bungonia, New South Wales. Caves in this region are most affected during the warmer months of the year, but tend to have CO₂ levels many times greater than normal, even in winter. The most dangerous practice of all is to rely on the air in small air bellts between sumps. Thorough research should be done of any cave system prior to conducting an activity. Local cavers, caving clubs and National Parks and Wildlife Officers will be able to give advice if there is a foul air problem in the area.

11.28 Pitch Heads and Other Drops. In darkness, drops can be deceiving which can result in less care being taken in dangerous situations. A cave is a very hard place devoid of trees and foliage which can protect the body in a fall. It only
11.29 To protect participants from falling, it is important to go no closer than 2 m to an edge so if a trip or slip does occur the participant is a sufficient distance from the edge to prevent them from falling down the pitch. The condition of the edge needs to be taken into account and if it is crumbling or a slope is present then an extra safety distance will be required.

11.30 **Climbs and Scrambles.** Due to the dark conditions associated with caving, the exposure experienced when attempting a climb will be much less than if the same distance climb was attempted above ground. Due to the lack of exposure people will attempt to climb features which they should not attempt. The problems with attempting a free climb in a caving environment are increased due to the slippery, dusty or crumbling surfaces found in most caves.

11.31 It is important to consider that a fall of 3 m is just as potentially fatal as a fall from 30 m. If any doubt exists then a safety line should be used.

11.32 **Slippery Surfaces.** Slippery surfaces are common in the caving environment. It is important to move through the cave carefully, using multiple points of contact to prevent a fall.

11.33 **Rockfall and Talus Piles.** Piles of rocks and debris are a normal part of cave formation, navigating through these areas is a normal part of caving. Moving rock could trap a caver or block an exit point trapping a caving group. The stability of any rock pile must therefore be assessed prior to moving through or over it. Limestone can cement together creating very stable piles but rock piles made up from dolerite tend to be less stable.

11.34 In the event that a rock pile needs to be moved through, a good practice to put into place is for one member of the group to make their way across to ascertain the best and safest route. The rest of the group should then cross one at a time to avoid multiple casualties in the event of an accident.
11.35 Suspension Trauma. The likelihood of suspension trauma increases with coldness and fatigue. Refer to LWP-G 7-6-1, Experiential Learning and Adventurous Training for a complete explanation and symptoms of suspension trauma.

SECTION 11-3. CAVING INCIDENTS

Timings and Numbers

11.36 Having lots of people in a group may make a trip last much longer than anticipated due to waits at the tops and bottoms of pitches, and delays at bottlenecks. Big groups have occasionally lost one of their number simply because nobody knew how many were supposed to come out. A small group, however, should consist of no less than four people. This is an easy number to control, and, if a mishap occurs, there will be a member to stay with the casualty and two members to go for help.

11.37 Before commencing caving activities for the day, details of the group’s intentions should be left with a competent authority, for example a local Park Ranger. This will inform the Ranger or others of the group’s intentions and should include:

a. caves to be explored
b. size of party
c. time of entry
d. time of expected exit.

11.38 On completion of the day’s activities the OIC must ensure that the UATL informs the competent authority of the group’s return or leave a message to say that they have returned.

Caving Emergency

11.39 What does the UATL do when something goes wrong? If the group is not able to deal with the situation it will be necessary to bring in outside help. There are organisations close to several caving regions that can render help, but many caving regions are located in remote areas away from roads or
populated centres. To make things more complicated, the patient could be located in an area of the cave that could take hours to reach, beyond crawls and down pitches, making the evacuation of the injured person a difficult task.

11.40 In this situation the group can either wait until someone comes looking for them or they can send two people for help. Remember that the UATL may be the only person who has relevant caving experience/knows the layout of the cave. The primary objective is to prevent any further incident or injury and then to provide first aid to the casualty. If the casualty can be moved, the UATL must remove them from the caving environment as soon as possible. Extra clothing or an insulation mat should be placed under the casualty to prevent heat loss through conduction. It is essential to conduct first aid training prior to conducting any caving activity.

11.41 The best way to promote safety is to start before the caving trip. The UATL should learn all they can about the cave and pick caving groups that will have a good cross-section of skills and confidence. Do not place all the best skilled people in one group.

11.42 The environment of caves offers potential for injury to those who are ill-prepared or careless. It also presents a unique challenge for first aid and rescue. The responsibility for preparedness lies in the hands of the UATL.
CHAPTER 12
CAVE MAPS AND NAVIGATION

SECTION 12-1. CAVE MAPS

12.1 There are a variety of different types of cave maps which contain different types of information to different degrees of accuracy. Cave maps are somewhat like road maps in that they depict a geometrical arrangement of routes and features in a cave. Some maps will show a single passageway; other maps show more complex multiple interconnections resembling a network of city streets. Maps give some idea to the caver of how to travel through the cave and which routes to follow. However, only a small percentage of cave maps are made with the express purpose of displaying a route, and most of these maps have been prepared for commercial caves. Unpaid surveyors produce most cave maps for their own purposes.

12.2 Probably the greatest number of cave maps are prepared specifically for the purpose of determining the relationship of rooms and passages with each other and with surface features. Such maps will reveal potential connections between adjacent passages or even between separate caves, assuming that both caves have been mapped and the relative positions of their entrances are accurately known. Cave maps may be difficult for the inexperienced person to read, as they show a three-dimensional environment in a two-dimensional plane.

12.3 Each cave has a unique identification number that identifies the cave and the region it is in. For example, ‘B-5’ refers to a cave in the Bungonia area. In addition to the number, most caves will have a local name; for example Hogan’s Hole, which is referred to as ‘B-5 Hogan’s Hole’.

Types of Maps

12.4 Rough Sketch Map. The rough sketch map depicts only the most significant relationships in a cave. There will have been no attempt by the caver to depict dimensions and directions
the relationships, and the map is commonly distorted. This map is used primarily to decipher the sequential arrangement of rooms or other interesting features that are frequently named on it. This type of map is often accompanied by a verbal or written description, and loses some of its utility without this information.

12.5 **Detailed Sketch Map.** The detailed sketch map is similar to the rough sketch map in that it is simply a sketch and is not based on surveyed dimensions. The map is roughly to scale and has approximately the correct alignment. This map is usually intended to illustrate some particular detail or relationship.

12.6 **Compass and Pace Map.** The compass and pace map is similar to the detailed sketch map except that it incorporates a very crude survey technique that provides rough measurements of distances and directions. This type of map is used principally to find out how far and in which direction a passage extends. A relatively large amount of effort in relation to the useful data is required for a map of this type.

12.7 **Line Map.** The line map consists of a sequence of straight line segments corresponding to the surveyed distances and directions between survey points in a cave. The line map does not depict any features, such as the width of the cave, but it does give some idea as to the size of the cave and the direction and orientation of its passages. Unless specific features are named on the map, it cannot serve as a guide. The map is as dimensionally accurate as a fully detailed map, and can therefore provide directional and distance data between various cave features if they are noted on the map. Line maps are most frequently encountered at the intermediate stage of a survey of a large cave system, where they are produced by computer.

12.8 **Solid Outline Map.** The solid outline map is somewhat similar to the line map, but in addition the cave walls have been included, a solid black line of varying width representing the entire cave passage. Solid outline maps are generally prepared when the cave is large compared to the size of the passages. This type of map is superior to the line map, as the size of the
passages and rooms are readily apparent. Dimensions and directions are to scale so that significant rooms may be ascertained without additional captions. Features can be symbolically or pictorially depicted in the white region representing the interior of the cave.

12.9 Detailed Map and Symbols. The detailed cave map is the most sophisticated of all cave maps in that it depicts significant features within the cave in addition to the walls. Both the features and the walls are dimensional to scale so that anyone reading the map can obtain an accurate idea of the interior of the cave. The various features are illustrated symbolically, and some symbols are shown in Table 12–1. The cave’s walls are shown by solid, dashed, or dotted lines, depending on whether the lines portray the main passage (solid), an underlying passage (dotted) or unsurveyed passage (dashed). Numbers inside circles can show ceiling heights, generally representing height in metres. Breakdown, which includes blocks of rocks fallen from the cave ceiling or tumbled in from the entrance, is pictorially depicted with angular, block-like outlines to resemble rock. Larger blocks are usually illustrated with a blackened edge on one side, giving the block a 3D appearance. Larger blocks may be drawn to scale, while smaller rocks are more simply illustrated. Slopes, whether clay, silt or talus, are shown by sets of radiating lines with the arrow pointing in the downward direction.

12.10 Pools and streams are represented in several different ways. Probably the best depiction is one in which the pool outline is drawn to scale and the interior region is shown by finger lines at an angle to the general passage. Flowstone and speleothems, where of significant size, are depicted by a series of small circular segments arranged so that the end of one segment joins another segment partway along its length. Symbolism is used to supplement the details on the plan view and to clarify relationships not readily apparent in the outlay of the plan view.

12.11 Once the symbolism is understood, it should be possible to read a cave map with a fair degree of accuracy. Problems
arise, however, when the cave is complex. In this case, the only solution is to study the map in great detail to distinguish the different levels and sub-levels. In some complex caves the configuration has been clarified by depicting different passages in different colours. Thus all passages at a single level are shown in a single colour, overlying passages in a different colour and underlying passages in a third colour. This system is generally found in ‘one of a kind’ maps due to the cost of duplication.

Cave Map Terminology

12.12 There are a variety of map types and map projections. Cave maps may be drawn in three principal views:

a. the plan view
b. the developed long section view
c. the cross-section view.

12.13 Table 12–1 illustrates common cave map symbols.
### Table 12–1: Common Cave Map Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Symbol" /></td>
<td>Unmarked natural feature used as a survey station.</td>
</tr>
<tr>
<td><img src="image2" alt="Symbol" /></td>
<td>Outline. Various thicknesses may be used for different sections or levels. The outline should be heavier than all other lines.</td>
</tr>
<tr>
<td><img src="image3" alt="Symbol" /></td>
<td>Outlines at significantly different levels or displaced from section plane.</td>
</tr>
<tr>
<td><img src="image4" alt="Symbol" /></td>
<td>Vertical change of floor level (cliff or pit), with height. Symbol (tics) on lower side.</td>
</tr>
<tr>
<td><img src="image5" alt="Symbol" /></td>
<td>Direction of downward slope of floor with (optional) gradient in degrees.</td>
</tr>
<tr>
<td><img src="image6" alt="Symbol" /></td>
<td>Large rocks, boulders.</td>
</tr>
<tr>
<td><img src="image7" alt="Symbol" /></td>
<td>Rockfall, talus.</td>
</tr>
</tbody>
</table>

#### 12.14 Plan View. The plan view corresponds to the outline of the cave in the horizontal plane, as viewed from directly above. A cave that is largely horizontal is generally displayed as a plan. Figure 12–1 shows an example of an M27 oddity cave, plan view.
12.15 Profile View, Developed Longitudinal. The profile view is an outline of the cave in the vertical plane, as viewed from the side. This type of view is also known as a developed longitudinal. This type of map view is advantageous when the cave has multiple levels which are directly below each other. Figure 12–2 shows an example of an M27 oddity cave, developed long section.
12.16 Cross-section. A cross-section is an outline of the cave passage viewed end on. These cross-sections can be numbered or alphabetised to show different cross-sections at differing locations throughout the cave system.

Parts of a Cave Map

12.17 The main parts of the cave map are as follows:

a. Title. The title of the map gives the name and number of the cave being displayed.

b. Map Number. The map number provides a unique code to identify the map sheet.

c. Type of Map. The type of map indicates the type of projection used.

d. Survey Grade. The survey grade indicates the accuracy of the instruments used to create the survey, and this...
provides information on how accurate the survey is. Sometimes the person who drafted the map may not have allocated a survey grade to it, but in this case information regarding the type of instruments used and the precision to which measurements were made during the survey should be indicated.

e.  **North Point Arrow.** The north point arrow indicates the direction of true or magnetic north.

f.  **Scale Bar.** The scale bar indicates the size of the cave’s passages.

g.  **Legend.** The legend contains the symbols used to indicate the types of conditions found in the different parts of the cave. Generally, standard symbols are not shown; however, any non-standard symbols are detailed.

h.  **Labels.** Labels indicate features of note, the size of avens or pitches.

**SECTION 12-2. CAVE NAVIGATION**

**12.18** Navigation in a cave is no different from the standard navigation principles taught by the Army. However, the following basic guidelines will assist movement through a cave:

a.  Always have a person nominated as check navigator to assist the main navigator.

b.  Ensure that it is possible to backtrack to the last known location, which is essential if a group has taken a wrong passage which may not be on the map.

c.  Ensure that familiarity with the cave is gained prior to taking novices into the cave.

d.  Remember that maps can depict information both above and below the current location.

e.  Conduct constant navigation checks and, if unsure of the direction of passage to take, send a person ahead to
Hints for Reading Cave Maps

12.19 When a caver is trying to determine their location on a cave map, they cannot just stand still and expect to work it out. Move around, try to identify the walls, any identifiable features, speleothems, pitches and so forth. To aid in cave navigation a caver should adhere to the following:

a. Use members of the group to scout ahead, down side passages, down holes and so on.

b. When using the compass, identify the passage trend and shoot a bearing that way.

c. Hold the compass flat and keep metal objects away from it.

d. If possible use a highlighter to identify the different levels on the map.

e. If unsure of the current location, use a group consensus.

f. As movement is undertaken through the cave, regularly turn around and look back, taking a mental image of the passage, as this helps on the way out.

Compass

12.20 Any type of compass can be used to navigate within a cave; however, purpose-built caving compasses are the most suitable. There are a number of important points to remember when using a compass in a cave system, as follows:

a. Always hold the compass level. Some cave passages are on inclines and there is a tendency to hold the compass in orientation to the passageway, which will give a false reading.

b. Keep metal objects away from the compass. Spectacles, headlamps, torches and some helmets have metal components that can affect compass readings.
c. Be aware of the surrounding rock. Some may be made of iron, which can affect the compass.

12.21 To use a compass effectively in a cave, the caver should adhere to the following:
   a. Identify the trend of the passageway.
   b. If space permits, get someone else to illuminate the compass.
   c. Take the bearing twice.
CHAPTER 13

CAVING TECHNIQUES

SECTION 13-1. INTRODUCTION

13.1 Caving can be very strenuous and tiring. The use of correct techniques and employing a positive mental attitude when moving through a cave can achieve the following:
   a. conserve energy for an emergency if one arises
   b. enable movement through a cave with maximum safety.

13.2 Conserve energy by using only what is needed or by replacing it with food.

Caving and Climbing Techniques

13.3 When moving through a cave, a caver’s body can adopt many different positions. Experience and regular practice make caving easier and more enjoyable, so inexperienced cavers should not be disgruntled at first when they keep getting stuck. In time, if they persist, the necessary moves will become second nature.

13.4 The following are some basic techniques for moving through a cave:
   a. *Keep the Head Up*. Looking where you are going is much easier than looking at the ground and walking into things. Keeping your head up also improves your posture and reduces the strain on your back from crouching. Even when on your knees, or your hands and knees, keep your head up and look ahead. If during a belly crawl the height of the cave forces you to look sideways, remove your helmet and slide it in front of you. The extra inch or two of headroom this provides makes a big difference to the ease of moving.
b. **Keep Your Balance.** Most cavers carry small packs containing all their supplies. In some parts of the caves you may be required to rest but will not be balanced to do this. A balanced distribution of your own weight and the weight of your pack can relieve the weight on your back, shoulders and hips.

c. **Layback Method.** This is the use of counter forces, with the hands pulling and the legs pushing in opposition. Laybacking is strenuous, making it necessary to move quickly. The arms must be extended, making use of the bone structure. The feet must be kept high to maintain friction on the rock.

d. **Chimneying.** The term ‘chimney’ refers to cracks ranging from those that will barely admit the body to those where the caver’s length will not span the width. Depending on the width of the crack, the chimney is climbed using various combinations of feet, hands, back, buttock, toes and elbows. Pressure is applied with the upper parts of the body while the lower parts of the body just fit. This restricts movement and is extremely awkward until perfected. Wide chimneys are easier to ascend/descend, as they allow free movement of the body parts to provide friction against the rock. This is sometimes referred to as ‘bridging’.

e. **Stay Level.** When you walk along a passage or into a cavern, there may be many routes ahead. You could climb to the bottom, go to the top and so on. The energy-saving technique is to sight a level line from yourself to your next destination. It may take you over fallen rocks or swing you off the direct line, but the level route will require less energy to traverse. Pick out intermediate landmarks to head for.

f. **Look Where You Go.** Effortless movement through a cave depends on seeing the cave and being able to pick the correct route. Watch the caver in front of you. Their headlamp will illuminate the route a good distance ahead. Turn around frequently and look behind you.
Passages often look entirely different when you are heading in the opposite direction. If you have to lead the party out the same way you came in, it helps to be able to identify particular landmarks within the cave.

g. *Use Your Legs.* As the thigh muscles are the largest muscles in the body, it makes sense to use them to your advantage. When you are in a cave that requires a great deal of climbing, you should do most of the climbing by driving upwards with your legs as opposed to pulling upwards with your arms. This will prevent muscle fatigue in your arms and allow you to climb for a longer period. Of course, there will be times when you will have to use your arms; however, one should hope that these are few and far between.

13.5 Various other methods can be used for moving through a cave, such as bear walking, duck walking, crawling, belly crawling, squeezing and crouching. Figure 13–1 shows the different methods of cave movement.
Figure 13–1: Methods of Cave Movement
Getting Back Out

13.6 It is highly likely that you will be able to move through a cave with ease; however, the ultimate aim is to be able to exit the cave. Remember never to get into a situation where help cannot be obtained. A caver should not move into any area that they cannot get themselves out of and especially places where nobody can rescue them.

13.7 A caver who comes across a pit and can see a passage leading off it at the bottom should not plunge into it but should ask, ‘How will I get out?’ Assess the risks by considering the worst case scenario. Always apply common sense and maintain a healthy respect for the risks involved in caving.

SECTION 13-1. LADDER TECHNIQUES

13.8 Generally, even in these days of modern equipment, caving ladders still have their uses. They are particularly good on small isolated pitches where it would otherwise be necessary to rig descending and ascending gear.

Techniques

13.9 For information on ladder climbing techniques see Section 8-4.
CHAPTER 14
GUIDEBOOKS, GRADES, STYLE AND ETHICS

SECTION 14-1. INTRODUCTION

14.1 Guidebooks, which cover most popular climbing areas, allow climbers to identify and climb established routes within their skill level and experience. For UATLs, guidebooks provide information that will help in the selection of climbing routes suitable for the skill level of participants, and in the selection of climbing areas that will assist in achieving the objectives of the activity.

14.2 Guidebooks vary according to the purpose for which they were written. Some guidebooks are limited to a selected cliff and others cover a number of cliffs in an area, while others again are limited to a number of selected climbs (usually of the best quality) in a selected area.

14.3 Popular climbing areas may be covered by a number of different guidebooks. Generally, each popular climbing area will have a guidebook that describes all of its climbs. Local climbing guides are also available on the internet.

14.4 Guidebooks provide climbers with the following information:

a. the geographic location of an area
b. the approaches, facilities and camping areas near a climbing site
c. a brief on local climbing history and climbing ethics at a climbing site
d. the location of a climbing site and its name, a description of, and grading of routes
e. first ascent details.
14.5 The use of a guidebook is recommended for the conduct of an AT activity. If a local guidebook is not available, local knowledge can be sought from other climbers.

**SECTION 14-2. GUIDEBOOK CONTENTS**

14.6 The guidebooks for all climbing areas are laid out in logical sequence. The climbs are usually described from left to right when facing the cliff face from the base. In addition to this information, when describing climbs, the guidebook will often detail an obvious feature in the area in question that can be used as a reference point. If no reference point is given, a diagram or photograph showing the routes of obvious climbs may be provided.

14.7 **Description.** The descriptions of climbs may vary, according to the guidebook author's style, from sparse prosaic notes to eloquent tales of near poetical fancy.

14.8 All guidebooks will describe how hard and how long a climb is for the climber, as well as where to belay if the climb is multi-pitch. Tradition states that a climb is named and graded by the person who first climbed the route.

14.9 **Guidebook Language.** To understand a guidebook, a climber needs to know the language used by guidebook authors and its meanings. The following is a list of useful terms, and their meanings, relating to cliff features:

a. **Amphitheatre.** A very large recess in the cliff face is known as an amphitheatre.

b. **Arête.** This is a sharp rock feature rather like the outside corner of a building; a steep ridge.

c. **Block.** A squarish lump of rock that may or may not be attached to the cliff is known as a block.

d. **Bulge.** This is the term for a rounded, protrusion of rock.

e. **Buttress.** A very prominent section of the cliff is called a buttress.
f. **Chimney.** A crack large enough to contain the entire body is known as a chimney.

g. **Chockstone.** A chockstone is a rock jammed in a crack.

h. **Corner.** This is the term for a feature rather like the inside corner of a building.

i. **Crack.** This term indicates a generally horizontal or vertical crack in the rock face. It can vary from finger width to almost body width. At body width it is known as a chimney.

j. **Crag.** This is a cliff line or steep rock face.

k. ** Flake.** A thin, flat piece of rock that has peeled away or detached from the main face, a flake may vary in size from that of a thumbnail to a feature as big as the side of a house.

l. **Groove.** This is the term for a shallow corner or furrow in the rock.

m. **Gully.** A small ravine or deep chasm, formed by water.

n. **Ledge.** A flat area on the face, a ledge can range from a few centimetres to a few metres in width.

o. **Niche.** A shallow hollow, or crevice feature is known as a niche.

p. **Off Width.** A crack or chimney that is wider than a fist jam-width but not wide enough to chimney effectively.

q. **Overhang.** This is a roof of rock.

r. **Overlap.** A small downwards facing step in the continuity of the face is termed an overlap.

s. **Pedestal.** A pedestal is a flat-topped, detached pinnacle.

t. **Pinnacle.** This is a detached feature rather like a church steeple.

u. **Pocket.** A pocket is a feature that can range from shallow, one-finger dents to mini-caves.
v. *Prow.* This is a feature rather like the prow of a ship.

w. *Rib.* A prominent, slender feature more rounded than an arête is known as a rib.

x. *Roof.* This refers to a very large overhang, usually extending a metre or more from the cliff face.

y. *Scoop.* A scoop is an indentation in the rock face, not as pronounced as a niche.

z. *Spike.* A finger of rock is called a spike.

**Climbers’ Terminology**

14.10 Climbers use a language that describes the type of handhold, foothold or body position they use, and equipment that may be encountered throughout a climb. Some common examples are as follows:

a. *Bolt.* This describes the artificial protection placed by drilling a hole in the rock and inserting a bolt into the hole.

b. *Bolt Hanger.* A metal plate that is permanently attached to the bolt is known as a bolt hanger.

c. *Bolt Plate.* This is a metal plate that is placed over the bolt for attaching a karabiner. The plate can be removed from the bolt.

d. *Bucket.* Large, solid handholds that give positive security.

e. *Chimney.* This describes the climbing style used to climb a chimney.

f. *Cling Hold.* This describes a hold on the rock gained by clinging with the fingers. A climber pulls sideways on a side cling and upwards for an under-cling.

g. *Crux.* The most difficult section of a climb on the pitch is known as the crux. A pitch or route is rated by the difficulty of the crux.
h. Cut Loose. To hang with only one or two points of contact is to ‘cut loose’.

i. Dead Point. Draw body close into the rock, at the point of equilibrium shoot a hand out to the next hold. Can be used for vertical and lateral moves.

j. Dynamic Move (or Dyno). Push off a foothold around knee height, spring upwards with an explosive action keeping hips close to wall, and slap hands onto the jug.

k. Edge. A very small horizontal or vertical ledge is known as an edge.

l. Edging. This refers to climbing by precise placement of the edge of the climbing boot sole on tiny ledges.

m. Exposed/Exposure. The psychological difficulty is increased due to the height and unprotected nature of the climb.

n. Finger Lock. This is a hold in a crack obtained by wedging one finger against the other.

o. Fixed Hanger. This is the same as a bolt hanger.

p. Gaston. A gaston is achieved by grabbing a sideways hold on the edge of a crack, thumb down, and pressing sideways on it.

q. Heel Hook. A foothold using the back of the climber’s heel is known as a heel hook.

r. Jam. This indicates that part of the body is jammed into the rock.

s. Jugs. Same as a bucket.

t. Layback. A layback is a climbing manoeuvre that consists of pulling with the hands and pushing with the feet.

u. Mantle. Mantles are flat ledges that the climber must pull up onto with the arms, then locking the arms so that a foot can be placed on the ledge.
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| v.       | Pitch. This is the term for the section of rock between belay points. |
| w.       | Piton. This is a metal spike with an eye through which a karabiner may be passed. |
| x.       | Piton Runner. An old piton left in the rock is called a piton runner. |
| y.       | Protection. The anchors and intermediate points used to protect the leader are known as protection, or ‘pro’. |
| z.       | Rope Drag. This describes the frictional resistance of the rock and change of direction against the rope. |
| aa.      | Run Out. This is the term for a considerable distance between protection points. |
| ab.      | Smearing. The boot sole is placed on the rock so that friction holds the boot to the rock. |
| ac.      | Stem/Bridge. The climber takes a stance with the feet wide apart. |
| ad.      | Traverse. To move sideways is to traverse. |

### Grading

**14.11** There are many grading systems developed by different countries. The grade of difficulty of a climb is firstly a matter of opinion of the person who first climbed it and, subsequently, a matter of consensus among all who follow. Grades are subjective and, while the majority of climbers may agree on a grade, some climbers may find the route easier or harder, depending on their level of skill, experience and climbing style.

**14.12** The grading system in use in Australia, New Zealand and South Africa is the Ewbank system, developed by John Ewbank, a New South Wales climber, in the 1960s. The Ewbank grading system generally grades each route with a single number from 2 through to 35 on an open-ended scale.

**14.13** In general, participants taking part in an AT climbing activity, with a moderate level of fitness, should be able to climb routes of Grade 11 to Grade 14. Particularly fit or strong individuals...
should be able to climb routes of Grade 15 to Grade 18. Routes of Grade 19 and above usually require climbing experience or climbing-specific training.

14.14 The grading of a climb is based on a combination of the following:

a. the difficulty of the move
b. the amount of protection
c. the type of protection
d. the run out between protection
e. exposure
f. the length of the climb.

14.15 A Grade 12 climb of only 30 m starting from the ground may become a Grade 14 if the climb starts 200 m up a cliff face.

14.16 Symbols. Some guidebooks contain a number of symbols that provide the reader with quick information about a climb without having to read the whole description. Symbols such as those that designate sport climbing routes (which only use placed bolts as protection), dangerous climbs and climbs with abseil chains may be found. Most guidebooks also have a system of stars that show the quality of a particular route. While quality is subjective, the best climbs at a cliff will be awarded three stars (eg, ‘must-do’ climbs), climbs of good quality will be awarded two stars, and climbs of above-average quality will be awarded a single star. As the quality is subjective, it is also regional and, while a climb may be awarded two stars on a cliff of generally poor quality, a similar climb may be awarded only a single star if on a cliff with many good climbs.

14.17 Guidebooks are an important part of climbing. Some guidebooks are written poorly and some are very comprehensive, but all act as a basic reference and require some common sense in the interpretation. For UATLs, they are a good source of information to assist in selecting a climbing area and specific routes suited to the skill and fitness level of the activity participants, and suitable for the achievement of the
objectives of the activity. A rough comparison on climbing grading systems is made in Figure 14–1.

Figure 14–1: Grading Comparison Chart

SECTION 14-3. STYLE AND ETHICS

Style

14.18 The topic of climbing styles can be controversial, especially among the international climbing fraternity. Culturally, climbers across the world view different styles of climbing as more elite than others. A UATL needs to be cognisant of the other climbers and either negotiate or adjust to suit. Courtesy will go a long way when sharing a climbing area.

14.19 There are a number of differing forms of climbing, each of which has its own rules in order to maintain the challenge to climbers. In general, the higher the risk, the stricter the rules.
The different forms of climbing, in ascending order of risk, are as follows:

a. **Bouldering.** Bouldering involves the vertical or horizontal progress on or along a boulder or a small section of cliff. Climbers undertaking bouldering use only the bare minimum of equipment: generally only friction boots, chalk, helmet and possibly a bouldering pad. Bouldering is a highly specialised form of climbing.

b. **Top Rope Climbing.** Top rope climbing uses a rope to belay and safeguard a participant from above, where the belayer may be positioned above or below the climber. Climbers should not weight the rope until they have successfully completed their climb. Top rope climbing is the most common form of climbing conducted during AT activities.

c. **Lead Climbing.** Lead climbing has two separate disciplines – Traditional and Sport – and these may both be conducted on single-pitch or multi-pitch routes. Lead climbing consists of climbing a route from the ground up and placing protection in the rock in case of a fall while being belayed on a rope. The rope and protection is not used to assist in the climb, but only as a safety mechanism in case of a fall. The traditional climber must place artificial, temporary protection to protect the climber, whereas the sport climber is protected by clipping fixed protection (bolts). Lead climbing also has a number of styles of ascent, as follows:

   (1) **On-sight.** The climber basically identifies a climb from a guidebook and climbs it from the ground up without falling, on the first attempt, with no further knowledge of the climb. The climber places protection or clips fixed protection as they climb.

   (2) **Flash.** This is climbing a route on the first attempt without falling, with some knowledge (‘beta’) of the route. Climbers place protection or clip fixed
protection as they climb. Watching another climber attempt the route constitutes beta.

(3) **Red Point.** This is climbing a route on any subsequent attempt, from the ground up, placing protection on ascent.

(4) **Pink Point.** This is climbing a route from the ground up, having previously placed protection either on previous attempts or by abseil.

(5) **Working a Route, also known as Dogging a Climb.** This is climbing a route after hanging or resting on the rope or protection. Climbers will often use this method to practise sequences for a later ascent.

d. **Aid Climbing.** Aid climbing differs from lead climbing in that the protection and rope are used as direct aids to ascend the route.

e. **Ice Climbing.** Ice climbing is the ascent of frozen waterfalls or glacial ice cliffs using ice climbing techniques. Ice climbing, like rock climbing, may be conducted by top rope climbing methods or through single-pitch or multi-pitch lead climbing styles.

f. **Mountaineering.** Mountaineering is the sport of mountain climbing; it requires technical knowledge, experience, and athletic ability to maintain safety. There are generally two styles of mountaineering, Alpine and Expedition:

(1) **Alpine Style.** Alpine style is a ground up single ascent and descent of multi-pitch routes on snow, ice or rocks (most often a combination) in alpine areas. Alpine climbs may be single- or multi-day routes exposed to the mountain environment with minimal gear, fuel and food. An Alpinist will sacrifice comfort for speed.

(2) **Expedition Style.** This style of mountaineering involves multiple ascents and descents of a route on a particular mountain using a variety of
different skills including lead climbing and ice climbing. Expedition mountaineering can be extremely dangerous and due to the need for base camps and specialist equipment expedition mountaineering is very expensive.

14.20 For novices being introduced to climbing, like the participants in AT activities, it would be unacceptable to expose them to high levels of real risk. This is what makes top rope climbing a good medium for skills development, as it has initially a high perceived risk but low real risk. A UATL, however, should constantly pursue higher levels of personal development.

Ethics

14.21 Climbing ethics are, after safety, one of the most important parts of climbing. While there has been a general softening of the attitude to once radical innovations such as friction boots, gymnast’s chalk and fixed protection, ethics continue to vary between climbers and climbing areas. A UATL or activity organiser should attempt to find out as much as possible about local area ethics before commencing an activity. Environmental issues are an increasing source of concern at climbing areas, and every effort should be made to minimise impact.

14.22 Ethical beliefs are consistently evolving. To deal with this, a UATL is expected to understand the culture of the climbing community in the area where they are running their activity.

14.23 To ascertain the ethics for an area seek information from locals, adventure businesses in the area, read the climbing guide and research on the internet. A general code of conduct for AT activities should consider the following factors:

a. Group size should be kept to a minimum.

b. Courtesy should be shown to other climbing area users. Activities at popular areas should be restricted to weekdays if possible.

c. Only the minimum number of vehicles required should be taken to climbing areas, and vehicles should be parked only in designated parking areas.
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d. Climbing routes and areas should not be monopolised.

e. Consideration should be given to other users in close proximity: noise, music and bad language should be kept to a minimum.

f. All rubbish and human waste must be removed from the area.

g. Ensure that the area is suitable and can sustain your activity. For example ensure cliff top stability when conducting a top rope activity.

h. Established tracks and routes around the climbing area should be used.

i. Do not cause unnecessary damage to fauna or flora. Use supplied fixed protection where possible. Vegetation should not be removed from cracks or pockets.

j. The rock itself must never be vandalised or disfigured.

k. Closures due to environmental reasons such as bushfire regeneration and bird nesting must be observed.
CHAPTER 15

MOVEMENT ON ROCK

SECTION 15-1. PRINCIPLES OF MOVEMENT ON ROCK

15.1 The aim of all climbing is to choreograph the different moves into a fluid and efficient upwards movement. To choreograph these moves, the climber needs to link a combination of holds and techniques. It is not proposed to lay down any exact method of rock climbing. Each instructor will vary in their instructional technique and individual participants will require different coaching techniques. As a rule of thumb, and to ensure doctrine for teaching is consistent, the following nine principles of climbing have been laid down:

a. conserve energy, find rest positions
b. test holds, where possible
c. move the limbs then shift the body weight
d. vary your hip and body position to the angle of the wall
e. watch your feet
f. weight your feet
g. use smooth, rhythmic, and dynamic movement
h. preview the route and think first
i. use the skeletal system
j. use the climbing cycle.

15.2 Conserve Energy, Find Rest Positions. Walking up hills and climbing rocks involves lifting the body through a considerable distance of vertical height. This involves a great expenditure of energy – this energy is precious and must be conserved for possible future difficulties. Instead of trying to muscle their way to the top, a climber should look for opportunities to rest on the
climb. These rest spots can be chosen from the ground. Pace yourself between these rests – this will avoid unnecessary expenditure of energy and give you time to look at what is ahead of you. Climbers who look for rest positions will do better than those who do not. Conserving energy is mainly achieved using balance. Whether standing still or moving, climbers balance themselves on their feet. In rock climbing, the hands and arms are used to aid in balancing the body. The legs and feet must always do the bulk of the work. If a climber is off-balance, unnecessary weight is put on the arms, causing the use of excess energy. The object of climbing is to keep the body weight directly over the point of support. Movement then becomes a manner of moving from one point of support to the next. Support is achieved by using the bone structure of the body and not the muscles.

15.3 **Test Holds Where Possible.** Climbers should aim to make a move once the new hold has been tested, found to be suitable, solid and safe. This is carried out to both, prevent holds breaking off in a climber’s hands and to find the most efficient position on that particular hold.

15.4 **Move the Limbs then Shift the Body Weight.** There is a natural tendency is to use the arms to do the heavy lifting but by the simple sequence of moving the limbs and then shifting the body weight you can ensure that the lower body is doing the majority of the lifting. This is completed by moving the hands to suitable holds, then moving both the feet to suitable footholds before shifting the weight and pressing upward or balancing over the new footholds.

15.5 **Vary Your Hip and Body Position to the Angle of the Wall.** Body position is crucial to where your centre of gravity is located; you must aim for it to remain over the feet. On face climbs and steep climbing your hips and weight should ideally remain close to the wall to reduce weight on the upper body. On lower angled climbs such as slabs you need the weight out vertically directly above the feet to retain friction.

15.6 **Watch your Feet.** Good footwork is the key to efficient climbing and experienced climbers will place a foot on a hold and shift
15.3 weight onto it accurately. You should always watch your foot movements, since it is impossible to feel whether or not a boot is placed correctly on a hold. The boot should be hovered over a hold and then placed exactly as required; the whole weight of the body is then transferred completely onto the hold. This is most important, as this technique ensures an efficient movement with no dragging of the moving foot. It is important to strive for fluidity to conserve time and energy. Often the first foothold looked at is the best or most efficient option as the body is trying to balance you intuitively with your handholds and footholds.

15.7 **Weight your Feet.** The centre of gravity must be kept over the feet so that the body weight is off the arms and concentrated on the feet, efficient climbers will do this by pulling and pushing. A move in climbing is made by moving the body’s weight over the new footholds before committing weight to it, in turn shifting the centre of gravity. Leaning over to the right and pulling the body across with the arms does not make a lateral move to the right and can cause a loss of energy. The correct use of footholds and other holds will ensure that the transfer of the centre of gravity will be progressive, with minimal loss of strength and will result in the maintenance of balance throughout the movement. The centre of gravity is used to keep the body in a balanced rest position. This is known as the ‘relaxed X position’ where your weight is centred over the feet and a slight shift of the hips and your centre of gravity will allow a resting of arms one at a time.

15.8 **Smooth, Rhythmic and Dynamic Movement.** Quick jerky movements can lead to a momentary loss of balance, with a consequent loss of energy in the effort to regain balance. All movements should be smooth, deliberate and unhurried whenever moving from one hold to another on a rock face.

15.9 **Preview the Route and Think First.** Climbers should consider very carefully whether the proposed route is possible, then work out where to go and how to make use of the available holds before starting to climb. Spend time looking at the route, consider the hand movements, the foot movements required, the rest positions, give yourself multiple options and the
protection required if leading. Time spent on the ground or belay looking at your options and feeding yourself information on what is coming up will save precious physical and mental energy trying to do the same on the climb.

15.10 Use the Skeletal System. There is a natural tendency to muscle for the next set of handholds. Unless it is unavoidable, this is not recommended as it generally means using precious energy and strength. Climbers should try to keep straight arms while in rest positions and twist through the hips and shoulders using their legs and core to gain height. By standing up and twisting in a move instead of pulling directly up with their arms the strong muscles of the core and legs do the work.

15.11 Climbing Cycle. The process of climbing and the movement on the rock can be defined as a three-part cycle. This three-part cycle involves the following:

a. **Balanced Rest Position.** The body is balanced over the feet and in the relaxed X position, resting where possible.

b. **Moving the Limbs.** Hands are moved to suitable handholds, followed by the feet to suitable footholds. Ideally legs are kept in the bent position and weight shifted onto the new footholds.

c. **Moving to a New Position.** Look for the next hold before moving to the new position and then complete the cycle by standing from the compressed squat position to move to the new hold and rest position.

### SECTION 15-2. FOOTWORK

15.12 Footwork is the essence of climbing, as the body weight is driven upward using the legs, the strongest muscles in the body. Even once a rock face becomes so steep that it is beyond vertical, even horizontal, ascent is still gained by using the powerful muscles of the legs. Arms and hands are used mainly for balance. Good footwork is one of a climber’s best assets. The feet must be secure on the rock, and this is achieved by
visually placing the feet onto the rock using different techniques such as edging, friction, smearing or jamming.

Edging

15.13 Edging involves placing the boot edge on any hold be it the smallest edge to a fist-sized hold (see Figure 15–1). Either the inside or outside edge may be used, but the inside is usually preferred as it is easier and more secure. A hold is gained by positioning the edge of the boot on the hold and weighting it, so that the boot’s edge conforms to the hold. The inside edge of the boot, near the big toe, is normally used, but in some cases the outside edge may be used. Toe-in edging is when the toe of the boot is placed on the hold; it is very tiring and places strain on the leg muscles.

15.14 Once an edge is gained, it is essential not to move the foot around, as it will most likely come away from the edge, especially if the edge is only marginal.
Figure 15–1: Edging
Friction

15.15 Friction is achieved by having as much of the climbing shoe sole surface area as possible in contact with the hold (see Figure 15–2). The hold may be a ledge, step or obvious foothold, or even any irregularity such as a rough spot. The foot must be positioned to gain maximum contact and friction. Friction is important when applying the technique called smearing.
Figure 15–2: Application of Friction
Smearing

15.16 Smearing is used when there is no ledge or obvious foothold and makes use of the characteristics of the sticky rubber friction boot (see Figure 15–3). Smearing holds are gained using the friction of the sole and can be more secure than edge holds, especially when the edge hold is not well defined. Smearing can be described as pasting the boot onto the rock.
Figure 15–3: Smearing
15.17 Flagging is a balance technique where a limb, usually a leg, is used as a counterbalance to prevent swinging out from the rock and is useful for off-balance moves that require more reach or where the holds are consistently facing the same direction.

Heel Hook

15.18 A heel hook is often used in steep terrain to reduce the weight on the upper body by using the cup of the heel as a hook on a prominent or positive feature. It can be used to pull against or act statically. To conduct a heel hook the heel needs to be placed on a hold that is generally not below waist height. This assists with balance and leverage to allow the body to move back in line with its centre of gravity. A similar technique can be applied in the form of a toe hook.

Knee Bar

15.19 The knee bar is performed by placing the foot against a solid foothold and using opposing pressure to lock the knee or lower thigh against a feature. A successful knee bar can often offer a solid hands free rest, or to allow the use of marginal holds.

15.20 Technique. The main technique with footwork is that climbers must watch their feet when placing them, be accurate and use the skeletal system of the body to avoid placing too much strain on the calf muscles. Strain on calf muscles can result in ‘Sewing Machine Leg’ or ‘Elvis Rock’ (uncontrolled shaking), which is annoying and can result in a fall. The way to rectify this is to remove the strain from the offending leg by changing the position of the ankle or dropping the heels.

SECTION 15-3. HANDHOLDS

15.21 There are many different ways in which hands can grasp holds used for climbing. The following are some of the basic methods:

a. open hand grip
Open

15.22 With the open hand grip, the fingers of the hand conform to the natural curvature of the hold and the hand functions like a claw (see Figure 15–4). The forearm must resist the tendency of the fingers to straighten out. This grip is the technique used on heaving beams when doing chin-ups. Large, open grip holds, when the entire hand can be placed on the hold, are often referred to as ‘jugs’. On smaller holds, when only the tips of the fingers can be placed, the friction created by the finger pads on the hold achieves the purchase.
Figure 15–4: Open Hand Grip
Crimp

15.23 The crimp (see Figure 15–5) is used on small flat-topped holds; whether they are small edges or slightly larger shelves. The fingers are bent at the second knuckle and the thumb can be wrapped over the index and second fingers for extra support. The position of the thumb is important, as it adds considerable strength to the hold and is very strong.
Figure 15–5: Crimp
Pocket

15.24 Pockets are holes in the rock that come in a large variety of sizes from single finger (mono digit) to large hand-sized holes. The size will determine how many fingers can fit in the pocket and in smaller ones it may be possible to stack fingers on top of each other. If possible it is best to maintain a relaxed open hand style grip with these holds and use the hook of the hand to maintain the grip.

Pinch

15.25 The pinch (see Figure 15–6) involves squeezing the rock between the thumb and the finger. The most effective pinch combines the thumb with the side of the index finger.

Figure 15–6: Pinch Grip
15.26 Under-clings (see Figure 15–7) are downward facing types of holds found under overhangs or flakes and are often overlooked by climbers. They are usually not suitable to pull directly up with but do assist a climber to maintain balance while moving to a higher hold. An under-cling is gripped with the palm up in an upwards and outwards pull. The under-cling technique is best conducted with straight arms and uses as much of the hand as possible, not just the fingertips. In general, bracing with your feet against the wall will create a counter pressure and if there are no footholds, the closer the feet are to the hands, the easier the position is to maintain. Often rotating a hip on the reaching side closer to the wall will provide extra distance in your reach.

Figure 15–7: Under-cling
Layback

15.27 The layback technique (see Figure 15–8) is used to climb arêtes, cracks in right-angled corners or cracks that are too shallow for jamming. This technique uses counterforce, with the hands pulling and legs pushing in opposition. Laybacking is often strenuous, so it is necessary to move quickly. The arms must be extended, making use of the bone structure. The feet must be kept high to maintain friction on the rock.
Figure 15–8: Laybacking
Side-pull

15.28 Similar to a layback, a side-pull is conducted on a vertical or diagonally angled hold that cannot be pulled directly down on. Like the layback, they can be used by leaning away from the hold counterbalancing with the body and if required the feet can be used in opposition. Side-pulls will often allow a considerable reach to be performed.

Mantling

15.29 Mantling (see Figure 15–9) refers to gaining a ledge using downward pressure on the hands and placing a foot on the ledge. The mantling technique is used to get the feet as high as possible, and then straighten the arms, balance, and place a foot on the ledge. The body weight is then moved over this foot and weighted. Balance is an important aspect of this technique. The use of the knees can place the climber in the difficult position of being unable to stand. A well-executed mantel is often conducted dynamically and fluidly and considerable height can be gained using this technique even on very small ledges.
Figure 15–9: Mantling
15.30 Palming holds make use of the pressure, in any direction, applied through parts of the hand. The climber, instead of reaching up and pulling, pushes down or away on the hold and straightens the arm (see Figure 15–10), placing the climber in a position of balance to move the other hand to a higher hold. This technique is useful when climbing slabs and corner systems.
Figure 15–10: Palming
SECTION 15-4. CRACK CLIMBING

15.31 Crack climbing can be a mixture of finger- to fist-sized jams, chimneying, laybacking, opposing pressure and off-width cracks requiring many different techniques and skills.

Jamming

15.32 Jamming is the main technique used for climbing cracks. Parts of the body are jammed into the cracks in various configurations, lodging them securely enough to bear weight. Each movement must be deliberate as the body part is moved to the new position and locked in place.

Foot Jams

15.33 Foot Jams. The foot is jammed by placing the toe of the foot into the crack as far as the ball of the foot, with the sole of the boot facing to the edge of the crack and then twisting the boot (see Figure 15–11). The most common and most efficient foot jam is conducted by pushing the foot into the crack on the side with the knee facing out. Then, as the climber stands on that leg, the knee rotates back under the body and the foot rotates and cams into the crack, effectively jamming. The entire boot can also be jammed from heel to toe. If the boot is too long for the crack, it can be jammed diagonally.
Figure 15–11: Foot and Toe Jam
Finger Jams

15.34 Fingers are inserted into narrow cracks and a twisting action of the hand is used to lock the fingers in place often called finger locks. These can be made with the thumb pointing up the crack or down. See Figure 15–12.
Figure 15–12: Finger Jamming
Fingertip Jamming

15.35 In very narrow vertical cracks, the fingertips of the index and middle finger are wedged with the thumbs down and the wrist low and torqued to lock (see Figure 15–13).
Figure 15–13: Fingertip Jamming
15.36 In slightly wider cracks (those too large for fingertips but too small for hands – known as ‘off-hands width’), all fingers are jammed as far as possible (thumb down for holds above eye level and thumb up for holds below eye level), and the hand is torqued to lock.

15.37 The thumb can also be used. The thumb is placed into the crack vertically and then the index finger slides down onto the knuckle of the thumb to create the lock, known as a ring lock.

**Hand Jams**

15.38 With wider cracks the whole hand can be placed into the crack and pressure can be extended between the back of the hand and the heel and fingertips. This is achieved by tucking the thumb across the palm. The hand may be required to twist or be clenched to complete the lock.

15.39 In vertical cracks, the hands are jammed with the thumb down for holds above eye level and thumb up for holds below eye level. The thumb-down position for the hand jam can be used for pulling down, as this can add more power to the jam through the torque action of the wrist.

15.40 For slanting or diagonal cracks, hand jams are generally placed with the thumb down for the upper hand and thumb up for the lower hand.

**Fist Jams**

15.41 Placing the fist in a wide part of a crack and pulling it down into constriction is the best way to jam fists. Expansion of the fist can be achieved by flexing hand muscles and changing the position of fingers and thumb (see Figure 15–14).
Figure 15–14: Fist Jam
Arm-bar

15.42 An arm-bar is conducted by orientating the body sideways to the crack. The arm closest to the crack is manoeuvred deep into the crack and the palm is pushed against the wall of the crack with thumb up and the elbow or shoulder is forced against the other side of the crack. The outside hand can be pressed down on the outer edge of the crack to add more opposing pressure. This hold should hold the upper body in the crack to allow for the feet to be moved.

Body Jam

15.43 A body jam can be used in an off-width crack to wedge or jam the body into the crack to prevent downward movement. It is not an elegant or comfortable move as it is the process of forcing the body to be held between rocks by locking on the core muscles. This then allows the hands or feet to be freed up for the next move. It is important to make an informed decision on which side of the body to jam to enable the next handholds or footholds to be accessible. It can be used as a rest position.

Opposing Pressure

15.44 Both hands can be placed in a crack or cracks and pulled against in opposition to each other (see Figure 15–15).
Figure 15–15: Opposing Pressure
15.45 Widely spaced double cracks may be climbed by ‘pulling the arms together’. A climber leans out to smear the feet onto the rock and, by shifting their weight from one side to the other, can move their hands, one at a time, alternately up both cracks. This can be strenuous, so it is necessary to move quickly. The arms must be extended, making use of the bone structure. The feet must be kept high to maintain friction on the rock.

Off-width Crack

15.46 These are cracks too large for hand and foot jams but too narrow to climb with the chimney method (see paragraph 15.48). These cracks are climbed using jams of the arms, legs, hips and shoulders. The off-width crack requires practice, technique and strength to climb. Many climbers fear them because the climber is in no-man’s-land – never in the crack and never out of the crack.

Bridging or Stemming

15.47 This is the spanning of a gap, corner or two features using the body. The feet are placed on opposing faces and the weight of the body forces the feet against the opposing face. Bridging can be used in corners, chimneys or on the face. The bridging position provides a good, balanced position. Good footwork is essential to maintain balance (see Figure 15–16).
Chimneying

15.48 The term ‘chimney’ refers to wide cracks that vary in width from those that will admit the body, to those in which the climber’s arm length will not span the width. The chimney, depending on the width, is climbed using various combinations of feet, hands, back, buttocks, toes and elbows. Pressure is applied with the upper parts of the body while the lower parts are moved and vice versa. Narrow chimneys where the body just fits are extremely awkward and restrict movement. Wide chimneys allow free movement because the bridging technique and more parts of the body are used (see Figure 15–17).

Figure 15–16: Bridging or Stemming
Figure 15–17: Chimneying
15.49 When bouldering, either indoors or outdoors, participants are not to climb more than 2 m from the ground. Supervisors are to ensure that specific bouldering mats and spotters are used as required by the situation to ensure that personnel who are bouldering land safely. A spotter is an assistant that provides a measure of safety for a climber. It is not the role of the spotter to catch a falling climber, but to break the climber’s fall, ensuring that the climber lands on their feet or away from dangerous obstacles.

15.50 The following are the specific techniques used by a spotter for a climber when bouldering:

a. When climbing a vertical rock, the climber is most likely to land feet first, and therefore the spotter will be close to the climber and aim to catch them by the hips to steer them to a safe landing. Spotters should bend their legs to absorb the shock (see Figure 15–18).

b. When the climber falls off an overhang, the spotter is to be in a position that enables the climber to be grasped by the shoulders, grabbing them above the centre of gravity (by the underarms) so that the climber rotates feet down (see Figure 15–19).

c. A spotter standing on the ground may not be able to safely spot a climber due to the presence of an obstacle such as a rock. Therefore, a spotter may find it best to spot from on top of the obstacle, and push a falling climber away from the edge of the danger toward a safe landing on a mat or mats. The spotter should be cautious of the boulderer’s feet and where they will swing if they come free (see Figure 15–20).
Figure 15–18: Spotting a Climber on Vertical Rock
Figure 15–19: Spotting a Climber on an Overhang
Figure 15–20: Avoiding Obstacles
15.51 Climbers and spotters must adhere to the following safety points:

a. Scope the climber’s landing well, and use a bouldering mat or spotter.

b. The highest priority is to protect the head or spine.

c. The spotter is responsible for the climber, and therefore:
   (1) the spotter must steer the climber towards a good landing
   (2) if possible, the spotter may reduce the force of the climber’s fall by absorbing some of the weight.

d. The climber and spotter must also check around bouldering areas for tree roots and other dangers to the climber in the event of a fall, and anticipate the consequences of them.

e. Spotters must ensure that they are in a stable spot to assist in case of a fall.
CHAPTER 16

BELAYING

SECTION 16-1. HISTORY

16.1 Belaying is a method of protecting a climber from a fall; it must be able to resist the large forces generated by a fall. Ropes act as a shock absorber and the belayer’s job is to quickly stop the rope from running. Rope that runs through the belay system as the fall is caught has two related effects: softening the impact forces and lengthen the distance fallen.

Definitions

16.2 The following definitions apply to the belay and the process of climbing as these are pertinent to the remainder of the chapter:

a. Active Rope. The rope between the climber and the belay device is called the active rope.

b. Backup Belayer. The second person belaying behind the first belayer on the same rope is called the backup belayer.

c. Belay. This is the technique of managing the rope to safeguard a climber against a fall.

d. Belay Device. This is a mechanical object that the rope attached to the belayer is passed around or through. The device allows a climber’s fall to be arrested by the friction of the belay device.

e. Belayer. The person who safeguards a climber and controls the rope that is attached to the climber is the belayer.

f. Belay Point. This is an anchor point attached to a belay device and a person (belayer) who operates the belay device.
SECTION 16-2. CONSTRUCTION OF THE BELAY

16.3 Components of a Belay Point. The components of a belay point are as follows:
   a. the anchor point
   b. the belayer
   c. the belay device
   d. the climbing rope.

16.4 Employment of a Belay Device. The following are the two ways to employ a belay device:
   a. Direct. The direct technique is where the belay device is connected to the anchor point and there is no slack in the tape or rope. All the force of the fall goes to the anchor and no forces are exerted on the belayer.
   b. Indirect. The indirect technique is where the belay device is connected to the belayer who is, in turn, connected to the anchor point. Using this technique transfers some of the forces created from a climber’s fall onto the belayer. Indirect belays are used when the forces exerted on an anchor point during a fall are going to be considerable.

16.5 Belay Method. The method used to belay allows no running of the rope through the belay device. Static belaying reduces the length of the fall of a climber but produces high impact forces that must be absorbed by the climbing rope. Static belaying is commonly used in rock climbing where the length of fall needs to be short so that a climber does not hit the ground or a ledge. Dynamic climbing ropes are used to reduce the impact forces in rock climbing which are produced through the static belaying technique.
16.6 The Belay Stance. Each stance and belay will be different. Selection and use of the belay stance usually requires some compromise, and with the application of the following basic rules they can be made more secure:

a. An anchor point that is fail-safe must be used. If doubt exists then an anchor system must be constructed.

b. The belay stance chosen must be:
   (1) comfortable
   (2) stable.

c. A long connection from anchor point to belay device should be used with care and avoided where possible as this is prone to sideways instability (top belay) and stretching (bottom belay).

d. For top rope – top belay systems, the belayer must be able to maintain visual contact with the climber, where possible.

e. Stretch in the rope must be considered.

f. The anchor, belayer and climber should be in a straight line in the direction of anticipated force.

Top Rope – Bottom Belay Point

16.7 The sequence for establishing a bottom belay point is as follows:

a. Secure the end of the climbing rope or sling to an anchor point.

b. Isolate, if necessary, or attach the climbing rope to the sling. Measure a length of rope to allow for a clove hitch and figure-eight knot or bunny ears to be tied to create an adjustable anchor point.

c. Using a locking karabiner, attach the belay device to the anchor point ready for use.

d. A belayer, wearing a harness with an attached locking karabiner, clips their karabiner into the figure-eight knot.
eye that is attaching the locking karabiner and belay device to the anchor. Secure the locking karabiner. Figure 16–1 shows an example of a bottom belay point.

e. A backup belayer can be used for novice or nervous participants. A backup belayer holds the running end of the rope 1 to 2 m from the belayer’s belay device and is expected to apply the brake by holding onto the rope, in the event that the belayer accidently lets go. The backup belayer is to constantly maintain their position on the rope and can also deal with the rope management. The backup belayer in a top rope – bottom belay does not need to be secured to the belay point.

f. If an anchor point is not available at the base of a top rope climb then a backup belayer must be used.
Figure 16–1: Belay Set-up
Top Rope – Top Belay System

16.8 During top rope – top belay, the belayer is attached to the anchor system constructed for the safety of the climber. The sequence for construction of this system is as follows:

a. Construct an anchor system.
b. The belayer is attached to a safety line.
c. Ensure that the rope to the climber is taut.
d. Connect the belaying device, as appropriate.
e. Using a locking karabiner, attach the belay device to the anchor point.
f. The belayer, who is wearing a harness with an attached locking karabiner, now clips the karabiner into the loop of rope at the bight, at the culminating point of the anchor system. Secure the locking karabiner. A safety line will need to be used to keep the belayer secure while moving into position or if the belayer needs to escape the system.
g. A backup belayer can be used for novice or nervous participants. A backup belayer holds the running end of the rope 1 to 2 m from the belayer’s belay device and is expected to apply the brake by holding onto the rope, in the event that the belayer accidently lets go. The backup belayer is to constantly maintain their position on the rope and can also deal with the rope management. The backup belayer in a top rope – top belay must be secured to at least an anchor point and should be back from the edge.

16.9 While using the top rope – top belay system, the climber can begin at the top of the climb and be lowered carefully by the belayer to the ground to begin the climb.

16.10 Escaping the Belay. The belay systems described in this section are escaped by tying off the belay device and then undoing the karabiner attached to the belayer’s harness. The belayer is thus released from the belay system. For the belayer
to escape the system in the top rope – top belay, they must have a safety line attached.

SECTION 16-3. BELAYING PROCEDURE

Rope Handling

16.11 Belaying involves the letting out or taking in of rope to ensure that a climber is safeguarded against a fall. The hand on the rope between the belayer and the climber is called the feeding hand and its function is to feed in the rope to the device and feel the amount of tension or slack in the rope. The other hand is the braking hand. This hand does the work of arresting the falling climber by placing the rope into a braking position. Under no circumstances is the braking hand to be removed from the rope.

Letting out Rope

16.12 To let out rope, the belayer pulls slack through the braking hand with the feeding hand.

Taking in Rope

16.13 While there are a few variations of the belaying process, the four-stage belaying process is suitable for all mechanical belay devices. The four-stage belaying process is to be used for all AT and climbing activities and is conducted as follows:

a. **Start Position.** The feeding hand grasps the active end of the rope with an underhand grip. The braking hand grasps the inactive end of the rope near the belay device with an overhand grip close to the belay device.

b. **Stage 1.** The rope is fed into the belay device by the feeding hand and pulled through with the braking hand. Immediately, the braking hand is brought around the belayer’s hips into the brake position (see Figure 16–2).
Figure 16–2: Four-stage Belaying Process – Stage 1

c. **Stage 2.** The feeding hand is removed from the active end of the rope and firmly grasps the inactive end of the rope with an overhand grip next to the belay device. A space must be left between the belay device and the feeding hand to prevent the hand from being jammed into the belay device (see Figure 16–3).

d. **Stage 3.** The braking hand slides up the inactive end of the rope until both hands meet (see Figure 16–4).

e. **Stage 4.** The feeding hand is removed from the inactive end of the rope and grasps the active end of the rope with an underhand grip. This now becomes the start position and the belay sequence can begin again (see Figure 16–5).
Figure 16–3: Four-stage Belaying Process – Stage 2
Figure 16–4: Four-stage Belaying Process – Stage 3
Figure 16–5: Four-stage Belaying Process – Stage 4
Belay Devices and Methods

16.14 Belay Plates or Tubes – Passive Method. This method can be used in both top-belay and bottom-belay. A bight of rope is passed through one of the slots, clipped through a locking karabiner and attached to the belayer’s harness or anchor (see Figure 16–6).

![Figure 16–6: Belay Plates and Tubes](image)

16.15 Belay Tubes – Active (Guide) Method. This method is used in top-belay only. A locking karabiner is connected to the full-strength, clip-in point and connected to the anchor point, usually above the belay stance. A bight of rope is passed...
through one of the slots and a locking karabiner is connected to the bight, the active rope must be above the inactive rope when passed through the slot. This method is not an automatic belay, and requires the full attention of the belayer. Different brands of belay devices with guide mode have different requirements to lower, and must be clearly understood before use. The use of a belay tube in guide mode is show in Figure 16–7.
16.16 Figure 8 Descending Device (Threaded Normally). The figure 8 descending device can be used as a belay device. This method is tedious to use because of the large amount of friction placed on the rope being pulled through the device. This method can be improved by not placing the bight of rope over the neck of the figure 8 descender but instead directly through the locking karabiner, this is known as the 'sport' method. Be aware that friction is drastically reduced but practice is needed. The use of a figure 8 descender threaded normally for belaying is shown in Figure 16–8.

![Figure 16–8: Figure 8 Belay](image)

16.17 Figure 8 Descending Device (Small Eye). Some figure 8 descenders can be used in a belay plate configuration by threading the rope through the small eye (see Figure 16–9).
16.18 Münter Hitch. The Münter hitch or Italian hitch (see Figure 16–10) is a simple running hitch. It is true that the two nylon surfaces do rub, but due to the constant movement of both ropes there is very little possibility of the rope cutting from this friction. However, it will still place wear on the rope. The knot is two-directional, simple to tie and possesses the strongest holding and arresting force of all the methods discussed. It is important to use a karabiner large enough to allow the knot to flip through. Further details are in contained Chapter 4.
16.19 **Active Belay Devices.** These devices display a diagram of the correct threading method imprinted on the device itself. Threading is usually by way of moving a sliding side panel and looping the rope around a shaped cam. This method is not an automatic belay, and requires the full attention of the belayer. These devices are suitable for both top-belay and bottom-belay.

16.20 **Supervision.** There are many types of belay devices and methods of belaying. The act of belaying during top rope climbing is the most important area for the wellbeing of the
climber. During the conduct of AT activities, belaying should be the main area of supervision rather than the climber because an injury is more likely to occur through poor belaying technique as opposed to poor climbing technique. It also important to ensure that the climber’s rope is kept taut for the first 3 m to prevent a ground strike. It is also important to observe the speed of the climber does not get ahead of the belayer.

**WARNING**

Whenever a rope is live (ie, the rope is protecting a climber) the belayer must never remove the braking hand from the rope, regardless of the belay device used. Failing to maintain hold of the brake may result in serious injury to personnel, or death, in event of a fall.
CHAPTER 17

TOP ROPE CLIMBING

SECTION 17-1. INTRODUCTION

17.1 Top rope climbing is a method of climbing that does not require climbers to place protection on the ascent to safeguard themselves from a fall. This is because a climber is on a rope anchored to the top of the climb. Top rope climbing is normally used for beginner climbers and large groups of participants who require constant supervision. It can also be used to practise difficult climbs without the risk of taking a large fall, with the intent to later lead the climb. Top rope climbing can be used in the following two methods:

a. Top Rope – Bottom Belay. The top rope – bottom belay method (see Figure 17–1) safeguards the climber from above, with the belayer below the climber. This method involves establishing an anchor system on top of the cliff where the culminating point hangs over the cliff’s edge. The climbing rope is passed through two karabiners that are at the culminating point of the anchor system. This acts in a pulley-like fashion by folding the rope in half. As the climber ascends the route, the rope is taken in at the base of the climb, reducing the chance of a long fall. In addition, a belay point is established at the bottom of the cliff to safeguard the belayer. With top rope – bottom belay, the length of the climb must be no longer than half the length of the rope being used.
Figure 17–1: Top Rope – Bottom Belay
b. *Top Rope – Top Belay.* The top rope – top belay method (see [Figure 17–2](#)) safeguards the climber from above, with the belayer above the climber. This involves the belayer going to the top of a cliff, establishing a top belay anchor system and then dropping the rope down to the person who is going to climb the route. The climber can approach the climb from the bottom or could also be lowered carefully by the belayer from the top of the climb to the bottom of the climb to ascend the route. With the top rope – top belay method, the climb may be as long as the rope being used.

c. *Multi-pitch Top Rope.* The multi-pitch top rope method is where a multi-pitch climb has been selected and the top ropes on each pitch are set up from above by abseil.

17.2 **Tying to the Rope.** A rethreaded figure-eight knot is always used to tie into the rope. To tie in, the climber feeds the rope through the climber’s harness, ensuring that both the waist belt and the crutch strap are picked up. The figure-eight knot must not have an excessive tail and that tail is not to be tied to the rope by any method.
Figure 17–2: Top Rope – Top Belay
SECTION 17-2. TOP ROPE CLIMBING SEQUENCE

17.3 The sequence detailed in Table 17–1 is used in top rope climbing.

17.4 Table 17–2 explains climbing calls.

Table 17–1: Top Rope Climbing Procedure

<table>
<thead>
<tr>
<th>The Member</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminaries</td>
<td></td>
</tr>
<tr>
<td>Belayer and climber</td>
<td>Identify the climb (using the guidebook). Things to look for are as follows:</td>
</tr>
<tr>
<td></td>
<td>a. <em>Length of Climb.</em> Is the rope going to be long enough?</td>
</tr>
<tr>
<td></td>
<td>b. <em>Grade of Climb.</em> Is it within the climber’s ability?</td>
</tr>
<tr>
<td>Belayer and climber</td>
<td>Establish top rope – top belay or top rope – bottom belay anchor system.</td>
</tr>
<tr>
<td>Base Procedures</td>
<td></td>
</tr>
<tr>
<td>Belayer</td>
<td>Establishes a belay point.</td>
</tr>
<tr>
<td>Belayer</td>
<td>Rope management – checks the rope for:</td>
</tr>
<tr>
<td></td>
<td>a. knots</td>
</tr>
<tr>
<td></td>
<td>b. kinks</td>
</tr>
<tr>
<td></td>
<td>c. serviceability</td>
</tr>
<tr>
<td></td>
<td>d. cuts</td>
</tr>
<tr>
<td></td>
<td>e. local abrasions</td>
</tr>
<tr>
<td>Belayer and climber</td>
<td>Ties in.</td>
</tr>
<tr>
<td>The Member</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Belayer and climber</td>
<td>Checks equipment:</td>
</tr>
<tr>
<td></td>
<td>a. that the helmet is worn</td>
</tr>
<tr>
<td></td>
<td>b. the rope is tied into the harness correctly</td>
</tr>
<tr>
<td></td>
<td>c. all the karabiners are locked</td>
</tr>
<tr>
<td></td>
<td>d. all the buckles back-threaded</td>
</tr>
<tr>
<td></td>
<td>e. the belay is connected correctly.</td>
</tr>
<tr>
<td>Climbing Calls</td>
<td></td>
</tr>
<tr>
<td>Belayer calls</td>
<td>‘ON BELAY, CLIMB WHEN READY.’</td>
</tr>
<tr>
<td>Climber</td>
<td>Checks the belay point and the belayer.</td>
</tr>
<tr>
<td>Climber calls</td>
<td>‘OK.’</td>
</tr>
<tr>
<td>Belayer</td>
<td>Checks the climber’s harness</td>
</tr>
<tr>
<td></td>
<td>Checks that the climber is tied in correctly</td>
</tr>
<tr>
<td></td>
<td>Checks all buckles and helmet.</td>
</tr>
<tr>
<td>Belayer and climber</td>
<td>If the rope between the climber and the belayer is slack then the climber will say to the belayer: ‘TAKE IN.’</td>
</tr>
<tr>
<td></td>
<td>The belayer takes in rope. When enough rope has been taken in, the climber says: ‘THAT’S ME.’</td>
</tr>
<tr>
<td>Climber calls</td>
<td>‘CLIMBING.’</td>
</tr>
<tr>
<td>Belayer</td>
<td>Double-checks belay.</td>
</tr>
<tr>
<td>Belayer calls</td>
<td>‘OK.’</td>
</tr>
<tr>
<td>Climber</td>
<td>Begins climbing.</td>
</tr>
</tbody>
</table>
### During the Climb

<table>
<thead>
<tr>
<th>The Member</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belayer</td>
<td>Tries to keep visual contact with the climber.</td>
</tr>
<tr>
<td></td>
<td>The belayer should try to belay from a point where the climb can be seen.</td>
</tr>
<tr>
<td>Belayer and climber</td>
<td>Hold general conversation.</td>
</tr>
</tbody>
</table>

### Safety

<table>
<thead>
<tr>
<th>The Member</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belayer and climber</td>
<td>Always remain alert.</td>
</tr>
<tr>
<td>Belayer</td>
<td>Brake hand always remains on the rope.</td>
</tr>
</tbody>
</table>

### Top of the Climb for Top Rope – Bottom Belay

<table>
<thead>
<tr>
<th>The Member</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climber calls</td>
<td>‘TAKE IN.’</td>
</tr>
<tr>
<td>Belayer and climber</td>
<td>Belayer takes in rope until the climber says: ‘THAT’S ME.’</td>
</tr>
<tr>
<td>Climber calls</td>
<td>‘HOLD.’</td>
</tr>
<tr>
<td>Belayer</td>
<td>Holds climber and says: ‘OK.’</td>
</tr>
<tr>
<td>Climber</td>
<td>Leans back and takes all the weight in the rope.</td>
</tr>
<tr>
<td>Climber calls</td>
<td>‘LOWER.’</td>
</tr>
<tr>
<td>Belayer</td>
<td>Lowers the climber back to the ground under control.</td>
</tr>
</tbody>
</table>

**Note:**

On completion of the climb (once the climb is no longer required to be in use) the system can be dismantled.
<table>
<thead>
<tr>
<th>Belayer</th>
<th>Climber</th>
<th>Meaning</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘THAT’S ME.’</td>
<td>‘THAT’S ME.’</td>
<td>Rope between the climber and the belayer is taut.</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>‘OK.’</td>
<td>The climber is attached to the climbing rope.</td>
<td>Belayer checks that the climber has tied into the harness correctly, has back-threaded all buckles, is wearing a helmet and is ready to climb.</td>
</tr>
<tr>
<td></td>
<td>‘CLIMBING.’</td>
<td>Belayer is secured to an anchor point and is ready to belay the climber.</td>
<td>Climber checks belay and belayer. Belayer double-checks climber.</td>
</tr>
<tr>
<td>‘ON BELAY, CLIMB WHEN READY.’</td>
<td></td>
<td>Belayer is secured to an anchor point and is ready to belay the climber.</td>
<td>Belayer double-checks belay and themselves.</td>
</tr>
<tr>
<td></td>
<td>‘OK.’</td>
<td>Climber ready to climb.</td>
<td>Climber starts climbing and the belayer begins belaying.</td>
</tr>
<tr>
<td></td>
<td>‘SLACK.’</td>
<td>Feed some rope.</td>
<td>Belayer gives rope until the climber says: ‘OK.’.</td>
</tr>
</tbody>
</table>

Table 17–2: Top Rope Climbing Calls
<table>
<thead>
<tr>
<th>Belayer</th>
<th>Climber</th>
<th>Meaning</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>‘TAKE IN.’</td>
<td>Take in some rope.</td>
<td>Belayer takes in rope until the climber says: ‘THAT’S ME.’</td>
</tr>
<tr>
<td>-</td>
<td>‘HOLD’ or ‘WATCH ME.’</td>
<td>Climber is about to fall.</td>
<td>Belayer applies the friction brake and holds until the climber says ‘CLIMBING’.</td>
</tr>
<tr>
<td>-</td>
<td>‘FALLING.’</td>
<td>Climber is falling.</td>
<td>Belayer applies the friction brake quickly and braces.</td>
</tr>
<tr>
<td>-</td>
<td>‘LOWER.’</td>
<td>Climber has finished the climb and is ready to return to the ground.</td>
<td>Belayer lowers climber under control.</td>
</tr>
</tbody>
</table>
CHAPTER 18

FALL FACTORS

SECTION 18-1. INTRODUCTION

18.1 An important facet of lead climbing is understanding what will happen in the event of a fall in relation to the amount of force exerted from the climber to the belay. The standard of climbing equipment has experienced vast improvements and this has seen advancements in strength, robustness, ingenuity, and the standard of safety of equipment. Nevertheless, in the event of a fall by a climber, an enormous force of energy is applied not only on the belay system, but on the equipment and climber.

18.2 Many years ago, the climber’s main fear in a fall was the very real possibility that the rope would break. Ropes were made of natural fibres such as manila or hemp and, if a belayer held on too strongly, the rope would snap even in a small fall. To prevent this, climbers needed to use a dynamic belay technique to hold a climber’s fall (see Chapter 16). Today this is no longer necessary with the invention of dynamic ropes and suitable belay devices. Today the climber’s main fear in a fall is the failure of the protection used and the fall factor generated. If a piece of protection is pulled out then this increases the length of fall and, therefore, will increase the amount of energy and force placed on all equipment and the climber.

SECTION 18-2. CALCULATING FALL FACTORS

18.3 To assist in understanding forces and calculating them effectively, the following terms and definitions apply:

a. Fall Factor. Fall factor is simply an equation used to calculate the amount of force that can be expected by a climber on a particular fall. The fall factor is the length of the fall divided by the length of rope from the falling climber to the belay.
b. **Impact Force (Shock Load).** This is the amount of force the belayer has to exert on a falling climber through the rope, anchor and belay device to stop or arrest the climber’s fall. The amount of impact force needed to stop the climber’s fall is determined by the fall factor. Shock load is the result of three factors:

1. the nature of the rope
2. the fall factor
3. the weight of the falling object (i.e., the climber).

**18.4** When using a static belay, the fall factor forces are determined by the distance of the fall divided by the length of rope between the climber and the belayer. The rope characteristics are crucial because in a static belay the rope absorbs nearly all of the energy of the fall. The climber’s fall is determined by measuring the distance above and below the piece of protection that holds the climber.

**18.5** The fall factor is a number that can be determined theoretically. However, there are many different variables that affect an actual climbing situation, such as the angle of the rock, the protection used and the set-up of the belay. It is difficult to accurately determine a climbing fall. The considerations concerning the calculation of fall factors are as follows:

a. The fall factor will always be below Fall Factor 1 unless the climber falls to or beyond the belay, which only occurs on a multi-pitch climb. A fall that goes past the belay will always have a fall factor greater than 1.

b. Fall Factor 2 is the maximum a climber will encounter in a climbing fall, as the height of a fall cannot exceed two times the length of the rope. A fall factor of 2 can only occur when a leader has passed the belay and has placed no protection. As soon as protection is placed, the distance the climber will fall is reduced and the fall factor drops below 2. If a climber has a fall greater than Fall Factor 1 then the rope that has been used needs to be retired. Even falls greater than Fall Factor 0.5 is
serious and the rope used should be rested overnight. Falls approaching Fall Factor 2 place enormous forces on equipment and may result in equipment failure.

18.6 It is important to be aware of the difference between a fall factor and the length of fall. This is because comparatively small Fall Factor 2 falls (as might occur when leaving the belay on multi-pitch climbs) can give high impact forces, potentially more dangerous than a climber taking a 20 m fall at the end of a 60 m pitch. Placing protection as early as possible after leaving the belay prevents this from occurring.

18.7 Any fall which occurs will create energy and force that is dispersed throughout the climbing system. Another consideration is the fact that more rope means more stretch to absorb a fall; for example, a Fall Factor 2 drop of 4 m develops the same shock force as a fall of 20 m using an UIAA-approved dynamic rope.

SECTION 18-3. FALL FACTOR EXAMPLES

18.8 The illustrations in this section provide a representation of various types of falls and the fall factors generated.

18.9 Figure 18–1 represents a lead climber taking a fall of 5 m, with 7.5 m of rope out from the belayer to the climber. The fall factor is 5 divided by 7.5 which calculates as a fall factor of 0.66. This is a reasonably serious fall factor and the rope used in the fall should be rested overnight if possible.
Figure 18–1: Fall Factor 0.66 Example
18.10 Figure 18–2 represents a lead climber taking a fall of 10 m, with 6.6 m of rope out from the belay to the climber. The fall factor is 10 divided by 6.6 which calculates as a fall factor of 1.5. In this example, the belayer is located further up the pitch of the climb. As such, the climber will fall, clearing the ground. If the climber had not placed protection after leaving the belay point, as illustrated, the fall would have been much more serious, increasing the amount of force and energy generated on the belay stance. Regardless, this is a very serious fall factor. The equipment used in the climb should be inspected (karabiners may be bent from the force generated) and the climbing rope should be retired.
Figure 18–2: Fall Factor 1.5 Example
18.11 Figure 18–3 represents a lead climber taking a fall of 5 m, with 2.5 m of rope out from the belay to the climber. The fall factor is 5 divided by 2.5 which calculates as a fall factor of 2. As discussed for Figure 18–2, the fall factor is generating a dangerous amount of force which is being transferred directly onto the belay stance. Should the fall have been over a greater distance, the force placed on this system would have been even greater. In this example, it should be noted that this fall would have been much more serious if the belayer was located at the base of the climb. In this case, the main concern would be the climber striking the ground. Climbing protection in this fall may be destroyed or damaged by the fall and will require inspection. The climbing rope should also be retired.
Figure 18–3: Fall Factor 2 Example
18.12 Equipment Considerations. It is necessary to understand fall factors because they can be a determining factor in deciding to retire a rope, especially after a number of falls have been taken. All dynamic ropes must meet minimum standards as specified by the UIAA. Unlike static ropes, which must meet minimum static breaking strains, the tests for dynamic ropes are quite extensive. The tests of most relevance are the fall test and the impact force test. For the fall test, a number of sections of a rope are subjected to a fall factor of 1.7 with an 80 kg weight through a purely static belay. A rope must survive five such falls to pass the test. The impact force of the fall is also measured. Ropes with a better force-diminishing capacity have a lower impact force and are generally preferred.

18.13 Fall Factor Risk Reduction. To reduce the risk of creating large fall factors, and the resulting force applied to the climber, rope and equipment, it is necessary to place protection in the appropriate positions and at regular intervals. At the start of a climb, pieces of protection should be placed closer together to prevent a long fall. As the climber ascends higher up the pitch then protection can be spaced further apart. This is because of the length of rope connecting the climber to the belayer and the transfer of energy and force generated along its length.
CHAPTER 19

SINGLE-PITCH LEAD CLIMBING

SECTION 19-1. INTRODUCTION

19.1 Single-pitch lead climbing is classed as any climb led from the ground up using protection to safeguard the climber from a fall. Lead climbing is generally conducted by a pair of climbers. Normally, the pair are broken up into the No. 1 (or leader) and a No. 2 (or second). The No. 1 is always the leader and climber and the No. 2 is the second and belayer. When conducting single-pitch climbing, the procedure is similar to top rope – top belay, except the leader actually climbs to the top of the pitch. The second belays from the ground as the leader climbs the route. The leader then belays the second to the top of the climb.

19.2 If the second is not an experienced lead climber and cannot perform a leader rescue (see Chapter 9), then the length of a single-pitch lead climb must not exceed half the length of the rope being used. This length allows the leader to be lowered at any time by the second.

19.3 Planning a Route. Leading a climb is a serious activity. The leader must plan the route by first studying a guidebook that will give the details about the climb. Once the route has been located, both the leader and the second (also the belayer) study the climb from the ground. From the ground, the crux of the climb, rest positions and places for protection should be identified. The leader should spend as much time as needed on the ground studying the climb to make the lead as efficient as possible.

19.4 Leading. After leaving the ground, the leader must start selecting places for protection that will safeguard them in case of a fall. When the leader reaches a point where they would prefer not to continue without protection, they should stop and place protection. The leader must identify a suitable place in the rock for protection, get a good stance, place the protection
and continue. Sometimes this may not be possible and the leader may be faced with retreat, falling or going on without placing protection, which can be dangerous. This problem can be avoided by planning and looking ahead.

19.5 Lead climbers must have a good understanding of their ability and skill level. More importantly, they must have a clear understanding of the effect that anxiety and stress levels will have on their ability and performance.

19.6 **Frequency of Protection.** Protection should be placed as soon as possible after leaving the belay. The first piece of protection must be a piece that is multi-directional. As the leader ascends the climb, a piece of protection needs to be placed at, approximately, every body length. As the height increases, the protection can be spaced further apart. If there is no possibility of placing a piece at every body length then protection should be placed wherever possible.

19.7 The whole process of lead climbing is a practice in risk management. Not placing enough protection may expose the leader to danger in the event of a fall, while placing too much protection may tire the leader and make a fall more likely. Placing too much protection too early may also use up valuable protection, meaning that the leader may not have the appropriate pieces of the required sizes when needed. The stress and fear leaders feel while lead climbing may also determine how often they place protection.

19.8 When placing protection, the leader should consider the following points:

a. The leader should always protect the crux. Placing a good, solid piece (or two) of protection below the crux will usually provide adequate protection.

b. Protection is most easily placed when the leader is stable and relaxed. A leader should try to avoid placing protection from physically stressful positions, as the placement may not be optimal.
c. Leaders must consider where they will fall. Protection should be placed to prevent the leader from hitting ledges or other rock features if they fall.

d. The leader must also consider the second. Protection should be placed so that it also protects the second (such as on traverses) and is easily retrievable.

e. If good quality placement exists, one piece of protection will be sufficient. If the placement is poor, then it may be backed up by another piece of protection. The leader must always consider the quality of the piece of protection below the last piece.

19.9 Falling. Falling is a part of lead climbing and all leaders must be prepared to take a fall. The old saying – 'the leader must not fall' was true 50 years ago when ropes and protection were barely adequate, but modern gear has allowed the ability to push harder and fall relatively safely. All lead climbers must learn how to fall and how to assess the situation and decide whether to take a fall or continue. A lead climber must be prepared to commit to a fall if the need arises. No fall should be taken lightly and the leader must consider the protection, the position of the belayer and the rock features that may be hit on the way down, before committing to a fall.

19.10 Falling is a technique that must be taught to all climbers in a controlled situation if they are to progress as leaders. During a fall, the leader must do the following:

a. maintain body control
b. stay facing the rock
c. stay upright
d. slide with feet apart and hands high when on slabs
e. push away clearly and plummet when on vertical or overhanging rock.

19.11 If a fall is likely, the leader must alert the belayer by yelling ‘WATCH ME!’ or ‘FALLING!’
SECTION 19-2. PLACING PROTECTION

19.12 Establishing a Climbing Rack. The racking of gear is a process the leader goes through before ascending the climb. Things to consider before racking up are as follows:
   a. the length of the climb
   b. the type of protection required
   c. the belay at the top of the climb.

19.13 A number of different methods of racking up may be used. The leader can rack all the gear onto the harness or the gear may be placed on a sling that is slung across the shoulder. With either method, the rack should be arranged in a logical and comfortable manner. The gear that would be used often (normally the climbing protection) should be placed at the front of the harness or sling. The gear that would be used the least should be placed at the rear of the harness or sling (normally all the gear that would make up the belay). When racking such things as SLCDs that come in sizes, they should be arranged so that the smallest SLCD are at the front and the largest at the rear of the harness or sling.

19.14 Chocks can be racked in a number of ways. If the leader is using two sets of chocks, one set can be placed on each side of the harness. If they are split into small and large sizes (normally sizes 1 to 5 and sizes 6 to 10), they may be placed with the small sizes on one side and the large sizes on the other.

19.15 Quickdraws are normally placed behind the protection due to their less frequent individual use. This method would change if the leader were climbing a route that consisted of a number of bolts. Bolt plates can be racked on a clip gate karabiner that is clipped onto the harness or sling, or they may be placed in the chalk bag the leader is carrying for easy access. Either way, the leader needs to find the most efficient method.

19.16 The leader may carry slings in two ways. The slings may be slung across the body, or they may be daisy-chained and
clipped to the rear of the harness or gear sling. When daisy chaining slings, it is important to keep the length of the daisy chain short. This prevents the daisy chain from being caught on gear racked onto the harness. It also prevents the daisy chain getting in the way when climbing. Different methods of racking protection are shown in Figure 19–1.

Figure 19–1: Racking Protection

19.17 All protection should be placed as detailed in Chapter 6. Once a piece of protection is placed, the rope must be clipped to that piece of protection. The way in which the rope is clipped will depend on the protection used.

19.18 Wired Chocks. Wired chocks should always be extended with quickdraws or slings (see Figure 19–2), so that the action of the rope will not cause the chock to shake itself out of placement. Chocks that are not extended may be pulled out after clipping. This may occur when the leader moves past the chock, as the leader’s foot or knee could lift the chock out of the placement. At no time should a sling be used to extend the wire chock by using a girth hitch through the wire loop of the chock.
19.19 **Hexentrics.** Hexes may be extended by clipping a quickdraw to the accessory cord tied through the hex. The rope may also be clipped directly to the accessory cord tied through the hex with a clip gate karabiner.

19.20 **Spring-loaded Camming Devices.** The SLCD usually has a sewn sling attached to the stem. Clipping the rope to this sling with a clip gate karabiner may extend the SLCD. If further extension is required, a quickdraw may be clipped into the sewn sling. The rope must never be clipped into a clip gate karabiner clipped directly to the SLCD stem.

**Protection Extension**

19.21 If a piece of protection is questionable but used out of necessity, it may hold a direct downward force. To help the protection hold an outward force, it should be extended with a sling, allowing the force of a fall to pull the piece down into the constriction before pulling outwards.

19.22 Protection should be extended so that the climbing rope will follow a straight line. If the protection is not in line and the rope is connected directly to the piece of protection, it will zigzag and cause rope drag making it impossible to pull the rope through. **Rope drag** is the term that describes the friction placed on the
rope when running through the protection. Figure 19–3 demonstrates the extension of protection to eliminate rope drag.

Figure 19–3: Rope Drag

19.23 Protection is normally placed for a downward force. A climbing rope zigzagging will place sideways and upwards force on the protection and may dislodge it. In a fall, failure of the highest protection placement may result in total failure of the entire system if other protection placements are poor. If all placements are correct and in a straight line, the rope should place a force only on the highest piece of protection in a fall.

19.24 Overhangs and Roofs. If a climbing route goes under a roof or an overhang and protection is placed under the roof or overhang, then it must be extended (see Figure 19–4). This is to allow it to clear the roof or overhang without bending the rope and thereby avoiding rope drag.
Another consideration is that, when extending a piece of protection, using slings that are too long will increase the length of the fall of the leader. For example a 2 m sling will cause a leader to fall an extra 4 m if the fall is from above the protection.

**Zippering**

The zipper effect (see Figure 19–5) occurs when the rope between the belayer and the leader wants to go in a straight line during a leader fall. If the belayer is not directly below and in line with the leader, this will greatly increase the chance of a zipper effect. To avoid this effect, the first piece of protection is placed to take an upward and outward force or, ideally, a multi-directional force (an SLCD is the best for this). If the first piece of protection is not placed to take an upward and outward force and the leader falls, the lowest piece of protection will be pulled upward and most likely pulled out. This in turn will cause a chain reaction and pull out all the protection from the bottom up, as the rope attempts to straighten from belayer to leader. When the last piece of protection is reached, the force on that piece remains downwards but may leave the leader hanging by the rope with only the last piece of protection still attached to the rock.
Clipping the Rope

19.27 When lead climbing, on most occasions, it is necessary to clip the rope to the piece of protection with one hand while the other hand is holding onto the rock. There are a number of different ways to clip the rope to the piece of protection and they all work on the same principle.

19.28 To clip the rope, the leader reaches down and takes up a bight of the rope with one hand. The bight is then pulled up and placed between the teeth. The leader then reaches down again taking up another bight of the rope, and reaches up, clipping the bight into the piece of protection.

19.29 Once the rope is clipped into the protection, the rope that is in the mouth can be released. If the piece of protection is between waist and head height, the bight may not need to be placed into the mouth and may be pulled up and placed directly into the piece of protection.
19.30 To clip the rope with one hand, the karabiner gate must face the thumb.

19.31 A bight of rope is taken up in between the thumb and forefinger and pulled up toward the karabiner. The tip of the middle finger is placed in the bottom of the karabiner and pulled down to stabilise it.

19.32 Using the thumb and forefinger, the rope is rolled through the karabiner gate, clipping the rope into the karabiner. It is easier to clip the rope with bent-gate karabiners than with straight-gate karabiners, as they help channel the rope into the karabiner.

19.33 Alternatively, once a piece of protection has been placed, a quickdraw can be clipped into the rope near the harness, and the quickdraw lifted (with the rope already clipped) and clipped into the piece of protection.

19.34 When clipping the rope to the piece of protection it is important to clip the rope correctly (see Figure 19–6). The rope must be clipped so that it runs from the leader’s harness up through the front of the karabiner attached to the quickdraw and down through the back of the karabiner to the belayer. If the rope is clipped the opposite way, the quickdraw will twist when the leader goes past.

19.35 In the event of a fall, the quickdraw will want to twist back to its original position, causing the rope to run on the karabiner gate. The force of the fall may cause the rope to press on the gate of the karabiner and therefore result in the rope unclipping from the karabiner.
SECTION 19-3. LEAD CLIMBING SEQUENCE

Lead Climbing Procedure

19.36 The sequence detailed in Table 19–1 is the suggested procedure for lead climbing.

Figure 19–6: Clipping the Rope
<table>
<thead>
<tr>
<th>The Member</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preliminaries</strong></td>
<td></td>
</tr>
<tr>
<td>Belayer and climber:</td>
<td>Identify the climb (using the guidebook). Things to look for are as follows:</td>
</tr>
<tr>
<td></td>
<td>a. <strong>Length of Climb.</strong> Is the rope going to be long enough? Is the climb more than half the rope-length in height?</td>
</tr>
<tr>
<td></td>
<td>b. <strong>Grade of Climb.</strong> Is it within both climbers’ abilities?</td>
</tr>
<tr>
<td></td>
<td>c. <strong>Equipment.</strong> Does the climb look safe to lead and does the leader have enough and appropriate equipment to sufficiently protect the climb and establish a belay system?</td>
</tr>
<tr>
<td><strong>Base Procedures</strong></td>
<td></td>
</tr>
<tr>
<td>Second:</td>
<td>Tie into one end of the rope. Establish the belay point as for a top rope – bottom belay point (see Chapter 16).</td>
</tr>
<tr>
<td></td>
<td>The second flakes the rope and prepares it for climbing, checking for:</td>
</tr>
<tr>
<td></td>
<td>a. knots</td>
</tr>
<tr>
<td></td>
<td>b. kinks</td>
</tr>
<tr>
<td></td>
<td>c. serviceability</td>
</tr>
<tr>
<td></td>
<td>d. cuts</td>
</tr>
<tr>
<td></td>
<td>e. local abrasions</td>
</tr>
</tbody>
</table>

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### Leader:
Tie into the other end of the climbing rope and establish the rack. The leader considers the type and quantity of protection and organises the rack to suit the climb.

### Leader and second:
Both check the equipment.
Check that:
- a. helmets are worn
- b. rope is tied into the harnesses correctly
- c. all karabiners are locked
- d. all buckles are back-threaded
- e. the leader has established the rack
- f. the belays are connected correctly.

### Leader:
Place the first piece of protection, designed for an upwards and outwards force.

### Climbing Calls

<table>
<thead>
<tr>
<th>Second calls:</th>
<th>‘ON BELAY, CLIMB WHEN READY.’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leader calls:</td>
<td>‘OK.’ Leader checks belay point and second.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second:</th>
<th>Check the leader’s harness.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Check the leader is tied in correctly.</td>
</tr>
<tr>
<td></td>
<td>Check all buckles and helmet.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leader calls:</th>
<th>‘CLIMBING.’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second:</td>
<td>Double-checks the belay.</td>
</tr>
<tr>
<td>The Member</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Second calls</td>
<td>‘OK.’</td>
</tr>
<tr>
<td>Leader</td>
<td>Commences climbing.</td>
</tr>
</tbody>
</table>

**During the Climb**

| Second: | Try to keep visual contact with the leader.                                  |
|         | The second should try to belay from a point where they can see the climb.   |
| Leader: | Place protection as required and clip the rope into protection.             |
| Leader and second: | Hold general conversation.                                                |

**Safety**

| Leader and second: | Always remain alert.                                                       |
| Second:            | The second’s brake hand always remains on the rope.                         |

**Top of the Climb**

| Leader: | Establish the belay system.                                                |
| Leader calls: | ‘SAFE.’                                                                 |
| Second calls: | ‘OFF BELAY.’                                                               |
| Leader calls: | ‘OK.’                                                                      |
| Second: | Dismantle the ground belay point.                                          |
| Leader: | Take up the slack in the rope.                                             |
| Second calls: | ‘THAT’S ME.’ when the rope is taut.                                        |
| Leader: | Clip into the belay point and call: ‘ON BELAY, CLIMB WHEN READY.’          |

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Contents
Construction of a Belay System

19.37 The belay system for lead climbing is similar to that used in the top rope – top belay method (see Chapter 17). The belay system for single-pitch lead climbing is constructed in the following sequence:

a. Once the leader reaches the belay stance, they immediately identify and place a fail-safe piece of protection for a downward force. They then clip a locking karabiner into the protection, pull up a bight of rope (2 to 3 m long) and tie it into the karabiner with a clove hitch.

b. The leader clips a locking karabiner into their harness, through both the waist belt and crutch strap. They then pull a bight of rope through the clove hitch, tie a figure eight on the bight, and clip the figure-eight knot into the karabiner on their harness. At this stage, the rope runs from the figure eight tied into the leader’s harness into an isolation loop of 1 to 2 m in length, and into a figure eight. The figure eight is then clipped into a locking karabiner in the leader’s harness and into the clove hitch tied into a locking karabiner clipped into the first piece of protection that will form a belay point for the belay system.

c. The leader then identifies and places another fail-safe piece of protection for a downward force and clips a locking karabiner into the protection. The leader takes a bight of rope below the clove hitch and, leaving some slack, ties into the karabiner with a clove hitch.

<table>
<thead>
<tr>
<th>The Member</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second calls:</td>
<td>‘CLIMBING.’</td>
</tr>
<tr>
<td>Leader calls:</td>
<td>‘OK.’</td>
</tr>
<tr>
<td>Second:</td>
<td>Take out the pieces of protection while climbing and join the leader at the top of the pitch.</td>
</tr>
</tbody>
</table>
d. The leader takes a bight of rope below the second clove hitch, ties a figure eight on the bight and clips it into the locking karabiner on the leader’s harness.

e. The leader then adjusts the belay system, equalising tension in both the ropes attached to the locking karabiner on the leader’s harness by adjusting the clove hitches tied into each piece of protection. The leader then secures all locking karabiners.

f. The leader checks the system and calls ‘SAFE.’

**WARNING**

The leader is not safe until tied into at least two pieces of protection and the locking karabiners are locked.

g. leader places a locking karabiner, for the belay, into the loops of the two figure-eight knots closest to the harness, feeds and clips the belay device into the belay karabiner, and checks the system one final time. The leader is now ready to belay and gives the call, ‘ON BELAY.’ The complete belay system is shown in Figure 19–7.
Other Belay Systems

19.38 Belay systems for lead climbing may be constructed from equipment other than the climbing rope. They may be constructed from self-equalising slings or a cordelette. Regardless, the belay system must be equalised. The principal reason for equalising the belay system is to spread any potential impact force among the component parts of the belay system.

19.39 Cordelette. The cordelette is a quick and efficient way to equalise two, three or four pieces of protection and create a belay system. A cordelette is usually from 5 to 8 m in length and may be constructed from the following materials:

a. a 6 mm Spectra accessory cord
b. a 7 to 9 mm static accessory cord, or
c. a sewn or knotted 6 m long nylon or Dyneema sling.

Figure 19–7: Lead Climbing Belay System
19.40 Cordelette allows the individual pieces of protection to be equalised and isolated into one culmination point.

19.41 The cordelette is constructed by tying one continuous loop, joined with a triple fisherman’s knot (when using Spectra).

19.42 A cordelette belay is established as follows:

a. Establish suitable anchor points. Place a locking karabiner in each of these points.

b. Loop the cordelette through each of the anchor points (see Figure 19–8).

c. Grasp the cordelette between each anchor point and pull them all together letting the individual loops slide through the fingers and anchors and equalise the cord in length to a central point. Slide these loops to adjust the position of this central point at a position suitable for the belay (see Figure 19–9).

d. Grasping all the loops together tie a figure of eight or overhand knot, creating a culmination point from which to attach to and belay from (see Figure 19–10).
Figure 19–8: Cordelette Belay Set-up – Step 1
Figure 19–9: Cordelette Belay Set-up – Step 2
Figure 19–10: Cordelette Belay Set-up – Step 3
19.43 **Self-equalising Sling.** The belay system constructed with the sling uses an automatic (or self-adjusting) equalisation method which is an easy method to equalise the culminating point. Normally constructed with a sewn or tied sling made from 25 mm tubular nylon tape, the sling may be any length but is usually tied into a loop from a 3 to 4 m length of tubular nylon tape.

19.44 The sling is clipped into two pieces of protection and pulled down and one of the loops is given a twist. A locking karabiner is clipped into the twist, through both loops of the sling, resulting in a sliding and self-adjusting culminating point. The self-equalising sling as a belay system is shown in Figure 19–11.

**WARNING**

If one piece of protection fails, it will shock load the other piece of protection and could cause it to fail.
Figure 19–11: Self-equalising Sling
Fixed Belays

19.45 On many lead climbs in sport climbing areas, or in areas which see heavy climbing traffic, the belay system may consist of fixed features such as bolts or chains rather than creating a belay system and bringing the second up to the leader. The usual practice (for single-pitch lead climbing) is for the leader to tie off or clip into the fixed belay system and be lowered off the climb, removing the protection while being lowered. Alternatively, the leader may clip into the belay system, set the rope and abseil the pitch. The procedure for lowering the leader from a fixed belay system is as follows:

a. Step 1. At the top of the climb, the leader clips into the bolts or chains with two quickdraws or slings. If the fixed belay is a chain, the leader clips into the links of the chain, not just around the chain itself. A leader clipped into two chains is shown in Figure 19–12.

b. Step 2. The leader takes a bight of rope, ties a figure eight on the bight, and clips the knot into the harness using a locking karabiner placed on the front of the harness encompassing the waist and crutch straps (see Figure 19–13).

c. Step 3. The leader unties the figure eight attached to the harness and threads it through the bolts or chains (see Figure 19–14). Once this has been done, the leader reties a rethreaded figure-eight knot into the harness encompassing the waist and crutch straps.

d. Step 4. The leader unties the figure-eight knot clipped into the karabiner and removes the knot from the rope, getting the belayer to ‘take in’ the slack. Once this is done, the leader and the belayer check each other, and the leader removes the quickdraws or slings clipped into the fixed belay system. The leader is then lowered to the ground by the belayer, removing the protection placed on the way up.
Figure 19–12: Lowering the Leader from a Fixed Belay – Step 1
Figure 19–13: Lowering the Leader from a Fixed Belay – Step 2
Figure 19–14: Lowering the Leader from a Fixed Belay – Step 3
CHAPTER 20
MULTI-PITCH LEAD CLIMBING

SECTION 20-1. INTRODUCTION

20.1 Multi-pitch lead climbing is carried out on long climbs that are more than one rope-length or pitch in height. The principles of multi-pitch lead climbing are the same as those for single-pitch lead climbing, but a few more procedures must be learned and practised. When attempting multi-pitch lead climbing, pairs need to be able to operate confidently and efficiently in a vertical environment for a long period. Their skills need to be of a high standard, and both climbers must have the knowledge to be able to rescue each other if the situation should arise. A novice lead climber should not attempt a multi-pitch lead climb. Multi-pitch lead climbing, as conducted by a pair, may be carried out in a number of ways:

a. *Swing Leads*. The most common method of climbing a multi-pitch climb is to ‘swing leads’. When both climbers in the pair are competent climbers, one climber will lead the first pitch while the other climber belays and seconds the pitch. At the belay, the climber who cleaned the first pitch will take the rack from the leader of the first pitch and will lead the second pitch, while the first climber belays and then cleans the second pitch. This process continues until the climb is completed.

b. *Block Leads*. The other method is to ‘block leads’. One climber will lead the first pitch while the second climber belays and cleans the pitch. The leader of the first pitch reorganises the rack and then commences to lead the second pitch. The leader may lead all pitches or only selected pitches. The method of blocking leads is suitable when one climber is guiding a multi-pitch climb or when one climber is more skilled and experienced than the other and leads the most difficult or crux pitches. Blocking leads are generally slower than swinging leads.
as more time must be spent reorganising the leader and the rack at the belay.

SECTION 20-2. MULTI-PITCH CLIMBING

Establishing a Multi-pitch Climbing Rack

20.2 The same principles need to be applied when choosing a multi-pitch climbing rack as when choosing a single-pitch climbing rack (see Chapter 19). However, the following should also be considered:

a. When conducting multi-pitch lead climbing, extra protection should be carried.

b. Because the belay may use a piece of protection that is vital to the climb ahead, it may be necessary to carry at least two of the same pieces of protection.

c. The racking of the protection may vary from climb to climb, and the leader may need to rack the protection on a sling in order to aid in a quick changeover and sorting out of gear to enable the next leader to continue on the climb efficiently.

d. Both climbers will need to have a nut tool and belay/descending device on them at all times.

20.3 Leading a multi-pitch lead climb is conducted in the same manner as leading a single-pitch lead climb (see Chapter 19). During each pitch, the first piece of protection must always be a piece that can take an upward and outward force in the event of a lead fall. Protection should be placed at a comfortable distance apart, with the emphasis on protection placed early in each pitch.

Construction of a Multi-pitch Belay System

20.4 The principles of construction of a multi-pitch belay system are similar to those used in the construction of a single-pitch belay system (see Chapter 19). The major difference is that the multi-pitch belay system must contain at least one piece of
protection that will take an upward force. The belay system will also be used as the belay for subsequent pitches, and therefore must also protect the belayer. The multi-pitch belay system is constructed in the following sequence:

a. Once the leader reaches the belay stance, they immediately identify and place a fail-safe piece of protection for a downward force. The leader then clips a locking karabiner into the protection, pulls up a bight of rope (2 to 3 m long) and ties it into the karabiner with a clove hitch.

b. The leader clips a locking karabiner into their harness through the belay loop. The leader then pulls a bight of rope through the clove hitch, ties a figure eight on the bight knot and clips the figure-eight knot into the karabiner on their harness. At this stage, the rope runs from the figure-eight knot tied into the leader’s harness into an isolation loop of 1 to 2 m in length and into a figure-eight knot. The figure-eight knot is then clipped into a locking karabiner in the leader’s harness and into the clove hitch tied into a locking karabiner clipped into the first piece of protection that will form a belay point for the belay system.

c. The leader then identifies and places another fail-safe piece of protection (for a downward force) and clips a locking karabiner into the protection. The leader takes a bight of rope below the clove hitch and, leaving some slack, ties into the karabiner with a clove hitch.

d. The leader takes a bight of rope below the second clove hitch, ties a figure eight on the bight and clips it into the locking karabiner on the leader’s harness.

e. The leader then adjusts the belay system, equalising tension in both ropes attached to the locking karabiner on the leader’s harness by adjusting the clove hitches tied into each piece of protection. The leader then locks all locking karabiners.
f. The leader then places at least one fail-safe piece of protection for an upward force and clips a locking karabiner into the protection. A bight of rope is taken up below the figure-eight knot and clipped into the locking karabiner on the harness, and another figure eight on the bight knot is tied in the rope and clipped into the locking karabiner in the piece of protection for an upward force.

g. The leader checks the system and calls ‘SAFE.’

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**WARNING**

The leader is not safe until tied into at least two pieces of protection and the locking karabiners are locked.

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h. The leader checks the system and adjusts the last figure-eight knot tied so that the entire system is equalised. The leader then locks the last locking karabiner.

i. The leader places a locking karabiner (for the belay) into the loops of the two figure-eight knots closest to the harness, feeds and clips the belay device into the belay karabiner and checks the system one final time. The leader is now ready to belay and gives the call, ‘ON BELAY’. The belay system for a multi-pitch climb is shown in Figure 20–1.

j. As an alternative, the leader may place a fail-safe piece of protection for an upward force and clip a locking karabiner into the protection. A bight of rope is taken up below the figure-eight knot and clipped into the locking karabiner on the harness. A clove hitch is tied in the rope and clipped into the locking karabiner in the piece of protection for an upward force. As this is only a hitch, an isolation loop must be created and the rope finished off and clipped into the karabiner with a final figure eight on the bight knot. While this method has an additional knot, it may be easier to adjust and equalise.
Dismantling a Multi-pitch Belay System

20.5 Once a pitch has been climbed, the leader is safe and has the second on belay, the second can dismantle the belay system. If the system is on the ground it can simply be dismantled in any fashion. If the belay is off the ground or at the top of the first or subsequent pitches, then the belay system should generally be dismantled in the reverse order from which it was constructed. The sequence of dismantling is as follows:

a. The last figure-eight knot that was tied to the piece of protection set for the upward force is untied, and that piece of protection is removed.

b. The figure-eight knot tied into the karabiner attached to the harness is untied, the clove hitch tied to the karabiner attached to the second piece of protection is untied and that piece of protection is removed. If a large amount of
slack is being produced, the second will need to tell the leader to ‘TAKE IN’.

c. The clove hitch tied to the first piece of protection is untied, the figure-eight knot clipped into the karabiner on the harness is untied and the last piece of protection is removed.

d. Once the belay is dismantled, the second is ready to climb the next pitch.

WARNING

The second must not commence dismantling the belay system until they are belayed by the leader. If a large amount of slack is being produced when dismantling the belay system, the second must tell the leader to ‘TAKE IN.’ Dismantling early may result in a serious injury should the second fall before being secure on belay.

Multi-pitch Climbing Procedures

20.6 **Swinging Leads.** If the climbing team is to be effective, the changeover of leaders needs to be organised and efficient. When the second arrives at the belay, the leader must tie off the belay device to make the second safe and prevent a fall. Once the second is safe, the changeover of climbing protection can occur. The climbing pair can sort out equipment and the new leader can organise the protection to be used on the next pitch. When using a sling to rack protection, the changeover is quick and easy, as it can be simply handed over to the new leader. Placing the rack onto the harness can take some time as the pair change and organise the climbing rack. Quickdraws and protection should be exchanged in twos and threes to prevent accidental dropping and loss. If all protection is carried on a single sling, it should be clipped to one climber via a quickdraw or karabiner at all times.

20.7 **Blocking Leads.** The method of blocking leads is less efficient than that of swinging leads at the belay. When the second
arrives at the belay, the leader must tie off the belay device to make the second safe and prevent a fall. Once the second is safe, the leader and second can change over between belayer and climber. The method of changing roles when climbing is as follows:

a. The leader unties a figure-eight knot in the end of the rope tied into their harness, and then ties this end of the rope into the second’s harness (encompassing both the waist belt and crutch strap) with a rethreaded figure-eight knot.

b. The second unties the figure-eight knot in the end of the rope originally tied into their harness and then ties this end of the rope into the leader’s harness (encompassing both the waist belt and crutch strap) with a rethreaded figure-eight knot. Thus the ends of the rope have been switched between the leader and the second.

c. The leader removes the karabiner from their harness, which is tied into the two figure-eight knots from the belay system, clips it into the second’s harness and locks the karabiner.

d. The second releases the belay device and places the leader on belay, and the leader is free to climb again.

**WARNING**

It is essential that the leader removes the rope end from the leaders harness first, or the second will not be tied to any part of the belay system which could result in an unprotected fall.

### 20.8 Traverses

When multi-pitch lead climbing it may be necessary to traverse across the cliff to continue on the climb. When carrying out a traverse, the leader must place the protection closer together to prevent a fall going too far below the traverse line. If the leader falls too far past the traverse line and is unable to climb up to the traverse, then they will need to ascend back up the rope until the traverse can be regained. The second will need to do the same if a fall results in the inability to regain the
traverse. If the leader places protection too far apart, there is a risk of a large pendulum swing in the event of a fall. A pendulum fall could result in a leader or second being turned upside down and increases the risk of injury in a fall.

**Cordelette**

20.9 An alternate to the above multi-pitch belay anchor set-up is to use the cordelette method as described in Chapter 19.
CHAPTER 21

TWIN- AND DOUBLE-ROPE TECHNIQUES

SECTION 21-1. INTRODUCTION

21.1 All the techniques described in Chapter 19 and Chapter 20 refer to using one rope. Both single-pitch and multi-pitch lead climbing can be done using twin-rope and double-rope techniques. The single-rope technique uses a single 8 to 11 mm rope, while the twin-rope technique use ropes between 7 and 8 mm in diameter and the double-rope techniques use half-ropes, between 8 and 9 mm in diameter.

21.2 The twin-rope and double-rope techniques are also different. While the twin-rope technique is rarely used in Australia, double ropes may be of an advantage for many climbs with wandering routes. While twin-rope and double-rope techniques may be conducted with UIAA-accredited single ropes, specialist double and twin ropes are available.

21.3 While double ropes may be used in twin-rope techniques, unless otherwise specified by the manufacturer twin ropes must never be used in double-rope techniques, as they do not have sufficient strength for that purpose. Twin ropes must be marked as twin ropes in their pairs on the rope and rope register book.

21.4 If there is a need to set up a belay stance using these techniques, both ropes need to be used as a single rope, unless otherwise specified by the manufacturer. Twin ropes are only tested together as a single rope and therefore must be used as such, and half-ropes are tested individually with a significantly smaller load.

SECTION 21-2. DOUBLE-ROPE TECHNIQUE

21.5 The double-rope technique (see Figure 21–1) uses two half-ropes that serve as independent protection lines. This
means that each rope is placed into a separate piece of protection when climbing. The second belays with both ropes attached through the belay device. The two ropes that are used should always be of a different colour, preferably a light and a dark colour or two contrasting colours.

21.6 The double-rope technique is employed on a climbing route where protection is not in line and the leader will need to move from side to side to gain protection on the ascent. The double-rope technique prevents rope drag from the zigzag effect of the rope passing through the protection. As the leader climbs the route, each rope is clipped into a separate piece of protection.

21.7 If a blue and red rope were being used, for example, the blue rope would be clipped into the first piece of protection; the red rope would be clipped to the next piece of protection. This alternation is recommended where possible to ensure a higher safety margin and especially in an area where there is a risk of the rope being cut. As the leader climbs they can use the ropes to prevent rope drag on complex terrain, and protect the second on traverse.

21.8 When tying into double rope, it is important to ensure that both the second and the leader have the ropes tied into the harness on the same sides; for example, the blue rope on the left and the red rope on the right.
Figure 21–1: Correct and Incorrect Double Rope Techniques
Double ropes are also very effective on traverses, especially routes that ascend straight up after the traverse. Double ropes ensure that the second does not take a large pendulum swing if a fall occurs. The second is protected by two ropes, one connected through the protection and the other going straight to the belay which prevents a large pendulum fall. The protection for a traverse using double ropes is shown in Figure 21–2.
Figure 21–2: Protecting a Traverse
21.10 The double-rope technique also prevents long falls when clipping into protection. Clipping a single rope poses a greater risk of a longer fall due to the slack being pulled out when clipping the protection. If a fall occurs while clipping, the leader will fall with the slack that has been pulled through, lengthening the fall. When using double ropes, this risk is minimised. This is because the last rope is connected to the last piece of protection independently from the next; therefore, the risk of having a long fall when clipping is small.

21.11 Both ropes can be clipped to the same piece of protection; ideally, each rope should be attached by a separate karabiner.

21.12 Additionally, the double-rope technique provides the advantage of having two ropes. If one rope is cut by a fall or damaged by a rockfall, the second rope will still provide some protection for the leader. Also, two ropes provide more options for descent, as both ropes may be tied together in order to abseil the length of the ropes in a single pitch.

21.13 The belayers job is more complex as they have to handle the movement of two ropes at the same time. For this reason a belay device that takes two ropes in the device must be used. The second needs to manage each rope independently; this means that one rope may need to be taken in while the other may need to be given slack. A figure 8 descender, Münter Hitch, and a Grigri are not suitable for use with double ropes as they do not allow the ropes to be controlled independently. The double-rope technique is a complicated process that needs to be practiced before being used.

21.14 It is possible to belay two seconds up a climb with the double rope technique; however, consideration must be made for protection of both climbers on any traverses that need to be negotiated.

SECTION 21-3. TWIN-ROPE TECHNIQUE

21.15 The twin-rope technique is typically used in mountaineering. This technique uses both ropes in the one piece of protection,
in the same way a leader would use a single rope. Twin ropes absorb more energy than a single rope and therefore can withstand more falls than a single rope. Twin ropes have the added benefit in that, if one rope is cut, another is there to back it up. As per the double-rope technique, this method gives the leader the ability to descend using the two ropes. The twin-rope technique still requires the belayer to manage two ropes but the complexity of this is greatly diminished. The twin-rope technique (see Figure 21–3) should be used in the same manner as the single-rope technique.

**WARNING**

Single ropes may be used for single- or double-rope technique. Unless otherwise specified by the manufacturer, twin ropes must never be used in double-rope techniques as they are tested and rated as a twin rope. Using them in single- or double-rope techniques may result in catastrophic failure. Double ropes can be used in twin techniques.
Figure 21–3: Twin-rove Technique
CHAPTER 22

ARTIFICIAL SURFACES

SECTION 22-1. INTRODUCTION

22.1 Artificial surfaces include artificial climbing walls, high ropes courses (HRCs) and fixed flying foxes (FFs) as well as low ropes courses. They are fixed artificial structures that allow expediency through reduced set-up time.

22.2 They are excellent for novel activities, and can be used in a multitude of ways with very little preparation. UATLs can quickly gain familiarity with the structures. Generally, they are indoors or built sufficiently robust so that they can be used in all weather conditions.

22.3 UATLs with initiative can include safe yet challenging tasks for participants to complete in addition to negotiating the artificial climbing wall, HRC or FF. However, the limitation of the fixed structure means that they can quickly lose their novelty and usefulness for AT when overdone through extended or repetitive activities.

22.4 Artificial surfaces pose similar dangers as roping and climbing in other environments, therefore, there is no difference to safety supervision requirements, procedures or techniques as described elsewhere in this publication.

22.5 All activities involving artificial surfaces in Defence and non-Defence training areas must be supervised by an appropriately qualified and current UATL.

22.6 Artificial facilities may have technical manuals describing the features and engineering specifications of the facility, much like a guidebook does for natural climbing sites. However, all usage and procedures must be in accordance with this publication. While artificial surfaces are set-piece facilities, the OIC remains responsible for issuing orders and for the risk management of each activity every time the facility is used.
22.7 Each facility will possess nuances due to design and typical nature of activities delivered, or may describe procedures that are out-of-date or unsafe. The UATL must avoid these heuristic traps and ensure that the standards and procedures of each activity are in accordance with the minimum safety procedures described within this publication.

Qualifications and Currency of Safety Staff

22.8 In addition to qualified UATLs, personnel who have been specifically trained or have been authorised in writing may conduct and supervise activities on indoor walls.

General Safety Precautions

22.9 Before any artificial surface activity commences, the OIC must ensure that safety orders are understood by all participants and safety supervisors.

22.10 Inspection, testing and storage of equipment. The following precautions are to apply for the inspection, testing and storage of equipment:

a. The OIC of each activity must ensure inspection of all equipment by qualified personnel before, during and after use to ensure serviceability.

b. All safety equipment must be approved by the National Association of Testing Authorities, Australia (commonly known as NATA), UIAA or CE for the purpose to be used.

c. All associated climbing and abseiling stores are to be used for the activity only, and are to be stored separately from general stores in a shaded, well-aired area away from fuel, chemicals or any other substance likely to cause them damage.

d. Equipment is to be red tagged if considered unsafe by qualified personnel. Red tagged equipment is to be returned for disposal action.

22.11 Annex A provides information on the guidelines for the use of indoor and outdoor climbing walls.
22.12 Annex B provides information on the guidelines for the use of HRCs.

22.13 Annex C provides information on the guidelines for the use of fixed FFs.

SECTION 22-2. ARTIFICIAL CLIMBING SURFACES

22.14 Artificial climbing surfaces are indoor or outdoor walls or structures, which are man-made. These climbing structures are located worldwide and have a wide variety of uses including fitness training, school outdoor camps, mobile walls for event use, recreational use and competition all the way up to international World Cup events. Their construction varies from prefabricated sheets or boards, which are bolted to a wall or placed on metal framework to solid steel and concrete spray form over mesh structures. The modular system prefabricated sheets can be plywood or a modular system of fibreglass construction and often have a sandstone like texture for realism. They may come with fixed handholds and footholds or allow the placement of screw-on or bolt-on holds. Similar outdoor bouldering walls or structures are made of concrete with a finish similar to rock. Figure 22–1 shows an example of an artificial climbing surface at an indoor climbing facility.
The handholds and footholds are constructed of a polyester epoxy resin, and come in various colours, sizes and shapes.
(see Figure 22–2). They are interchangeable in placement; however, it is recommended that one colour denotes a specific route.

Figure 22–2: Handholds and Footholds

SECTION 22-3. SAFETY

22.16 During any activity on an artificial climbing wall or bouldering surface, the following precautions must be adhered to:

a. For all climbing activities using ropes for safety, the preferred method to attach the climber to the rope is with a rethreaded figure-eight knot that is tied through both the waist belt and the crutch loop of the harness. The other method is with a figure-eight knot at the end of the rope and an alpine butterfly knot approximately half a metre further up the rope. These knots are then attached by karabiners to the belay loop.
b. Belaying is to be conducted using the four-stage method (see Chapter 16). When belaying, the belayer is to be attached to the ground by an anchor point.

c. Helmets must be worn when climbing, belaying or bouldering.

d. When bouldering, climbers are not to climb more than 2 m above the ground. The height is measured from the ground to a person’s feet. Additionally, when bouldering, the use of a spotter is recommended to steer the climber towards a good landing and may reduce the force of the climber’s fall. Refer to Chapter 15 for further information regarding spotters.

e. Climbers should stick to the established routes, when climbing, to minimise the risk of pendulum swings or flips.

f. Padded mats (crash mats or landing mats) are to be placed at the base of any climbing wall or bouldering structure before use, ensuring that any fall will result in the climber landing on the mat.

CAUTION

Different ADF artificial climbing walls may have local requirements, such as an additional tie-in point for a climber. For tie-in, precautions listed in paragraph 22.16a are the minimum requirements. Local climbing wall requirements must be met, and liaison is required with the relevant personnel who control the wall in each local area.

22.17 Regular inspection and maintenance programs are required for all climbing equipment and fixtures. This must be recorded in a designated facility logbook.
Supervisor Ratio

22.18 When conducting activities on artificial climbing walls and bouldering structures, supervisors may control no more than two ropes for top rope climbing or when lead climbing.

Procedures

22.19 The same procedures for top rope climbing (see Chapter 17) and lead climbing (see Chapter 19) apply to artificial climbing surfaces.

SECTION 22-4. BELAYING

22.20 When conducting climbing on artificial surfaces, the belay method is the same as in Chapter 16. Although the method of setting the anchor point may differ from the outdoor environment, the principles for using a bottom belay and anchor point remain the same. An example of a fixed anchor point for an artificial climbing wall is shown in Figure 22–3.
22.21 Figure 22–4 demonstrates an anchor point constructed from the climbing rope, and Figure 22–5 demonstrates an anchor point constructed with a sling girth-hitched to the anchor point.
Figure 22–4: Anchor Point with Climbing Rope
Figure 22–5: Anchor Point with Girth Hitch Sling
Retractable Auto Belay Systems

22.22 Many modern climbing facilities now have retractable auto belay systems where the climber is belayed by an auto retractable device located at the top of the wall rather than by another person. Also known as auto belay these devices are a self-regulating magnetic braking system designed to cope with a large variety of climber weights.

22.23 The climber begins by clipping into a tape on the auto belay with two locking karabiners. The climber then attaches the two locking karabiners to the belay loop on their harness, conducts a safety check, and begins climbing. As the climber ascends the wall the tape retracts into the auto belay device which is anchored securely at the top of the wall. When the climber reaches the top or a high point they weight the tape and are lowered to the bottom.

22.24 The auto belay regulates the speed according to the weight of the climber through the use of internal magnets. The climber is entirely reliant on the auto belay so it is important that these devices are regularly checked and serviced by the wall owners.

22.25 Not needing a belayer makes these set-ups extremely handy for group use, adult training, people with no climbing partner or new climber familiarisation, reducing the need for supervision of the belayers.

SECTION 22-5. HIGH ROPES COURSES

Introduction to High Ropes Courses

22.26 HRCs offer an effective facility to produce stress, fear and uncertainty during an unfamiliar activity in an equally unfamiliar environment. If conducted properly the level of perceived risk should produce uncertainty in the participant’s mind, while requiring them to conduct complex and challenging tasks, thus developing resilience and self-reliance.

22.27 This combination of perceived risk and uncertainty, followed by well-conducted facilitation allows participants to develop and
practice coping mechanisms and experience stress and fear, prior to being placed in life-threatening situations on the battlefield.

Purpose

22.28 HRCs can be used as a single-day introduction-level activity in isolation or as part of an AT activity involving multiple disciplines over an extended period of time. HRC activities are generally easy to conduct as they have a set sequence of events, allocation of equipment, and safety staff familiar in their use.

General Planning and Considerations

22.29 All roping, top rope climbing and abseiling planning considerations, fundamentals, safety considerations, supervision ratios, and rope-craft are to be applied to the conduct of any HRC, including rigging the activity, rescue techniques and the conduct of the activity; however, each facility will require unique methods to ensure that a safe and rewarding activity is experienced by users.

22.30 These nuances, abilities, limitations and technical engineering specifications will be identified when the activity is built and initial training is delivered by the company contracted to build and deliver the facility. It is imperative that this information is documented in an appropriate Technical Facility Manual that includes the engineering specifications, load ratings and safe working load limits for the structure.

22.31 The OIC must ensure that a safety brief is delivered to all personnel prior to commencing the activity, an example is contained in Annex B.

Fundamentals of a High Ropes Activity

22.32 HRCs are generally an introduction- or familiarisation-level AT activity, which involves ascending onto the course and then negotiating various obstacles at height, including changing ropes from one activity to the next. At the completion of a wing, participants must descend off the course by climbing down or being lowered off by a belayer.
22.33 Due to their construct, it is possible to conduct an activity with a large number of participants actively engaged in the activity at any given moment.

22.34 All ascending and descending is to be done in accordance with the relevant roping or climbing chapter of this publication.

22.35 Rope change overs between obstacles on each wing is normally done on platforms at the end of each section, using a safety line. The rule of ‘make safe, before you break safe’ must be applied.

22.36 Participants climbing onto and off the activity using ladders over 2 m high are to be on a belay system at all times. Ladders are to be fixed or secured with a lanyard to the pole or platform upon which they are being used.

General description High Ropes Course

22.37 HRCs are generally designed with a tower as the centrepiece and one or more wings leading off that centrepiece, with a variety of activities along those wings.

22.38 Figure 22–6 shows an example of a typical HRC and the likely positions of safety supervisors, denoted by numbers 1 through 8. Table 22–1 identifies the locations and roles of those safety staff.
Figure 22–6: Typical High Ropes Course Layout

Table 22–1: Locations and Roles of Safety Staff

<table>
<thead>
<tr>
<th>Position</th>
<th>Location and Description of Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground Level. Supervise brake person for two abseil lines.</td>
</tr>
<tr>
<td>2</td>
<td>Upper Platform. Dispatch on one abseil line off the tower and supervise ascending climber once at the upper platform.</td>
</tr>
<tr>
<td>Position</td>
<td>Location and Description of Responsibilities</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>3</td>
<td><strong>Upper Platform.</strong> Dispatch on one abseil line off the tower and supervise ascending climber once at the upper platform.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Lower Platform.</strong> Attachment of climber and supervise belayer on postman’s walk rope. Backup check for climber on ascending ladder (as required by Position 8).</td>
</tr>
<tr>
<td>5</td>
<td><strong>Lower Platform.</strong> Attachment of climber and supervise belayer on high beam. Backup check for climber on ascending staples (as required by Position 8).</td>
</tr>
<tr>
<td>6</td>
<td><strong>Left Ground Level.</strong> Supervise belayers and climbers on playpen and Jacob’s ladder, including rope changeovers at platforms.</td>
</tr>
<tr>
<td>7</td>
<td><strong>Right Ground Level.</strong> Supervise belayers and climbers on playpen and multi-vine, including rope changeovers at platforms.</td>
</tr>
<tr>
<td>8</td>
<td><strong>Ground Level.</strong> Supervise hook up and belaying of climbers and belayers on ascending staples and ascending ladder up to the abseil tower.</td>
</tr>
<tr>
<td>9</td>
<td><strong>Officer-in-Charge (Not Shown).</strong> Supervise the safety supervisors, ensuring that they are diligent in the application of their role. Perform or supervise any lower off or rescue.</td>
</tr>
</tbody>
</table>

**Safety Supervisors/Participant Ratio**

22.39 As outlined in Annex A to Chapter 1, UATLs can only supervise two ropes for novice participants.

22.40 Due to their unique layout, this is sometimes not achievable on an HRC given that the ropes, and/or connection and disconnection positions may not all be observable from the one position. For example in Figure 22–6, the safety officer responsible for hooking up the two participants and their
22.41 As responsibilities may be shared between safety supervisors on the same rope, we apply a similar principle to the two rope policy. That is, a safety supervisor should have no more than two responsibilities to monitor, such as:

a. two belay ropes (on wings)
b. one belay rope and one ascent rope (lower platform)
c. two abseil line brake persons, or
d. any combination that allows constant supervision of up to two responsibilities, given the course layout and activity format.

22.42 It is not unusual for one safety supervisor to hand off responsibility of a participant to another, however; the OIC must ensure that this process is understood by all participants and included in the safety brief.

22.43 In some cases, a safety supervisor may only have one rope to supervise, but they may act as checkers for other participants hook ups or belay techniques and so on.

Hazards

22.44 During all HRC activities there are a number of hazards and medical considerations that need to be addressed. The following is a list of common issues:

a. All hazards and medical considerations associated with roping and climbing are to be addressed during pre-activity planning.

b. Equipment must be serviceable and fit for task. All safety equipment must be inspected by the OIC before, during and after each activity. Safety supervisors are to assist with this task during the activity.

c. HRCs must be derigged on a regular basis when not in use, with all knots removed from ropes and all ropes
should be rotated through various activities, to prevent rope fatigue.

d. Ropes must be inspected before and after each use to ensure that dynamic ropes are replaced after the appropriate level of use or wear (these ropes will typically absorb many more falls than during natural climbing activities).

e. If being used as an introduction to AT, the supervision of belayers and backup belayers must be consistent, constant and close.

SECTION 22-6. FIXED FLYING FOX ACTIVITIES

Introduction to Fixed Flying Fox Activities

22.45 An FF activity places participants in a position requiring them to display physical courage and self-reliance through physical capability. The activity involves a high perceived risk with low real risk making it an excellent medium to develop resilience through experience.

Purpose

22.46 Fixed FF activities can be used as part of a single day activity in isolation or as part of an AT activity involving multiple disciplines over an extended period of time. Fixed FF activities are often used to enhance a military activity involving many skill sets.

22.47 FF activities are generally easy to conduct as they have a set sequence of events and allocation of equipment, safety staff and simple procedures.

General Planning and Considerations

22.48 All roping planning considerations, fundamentals, safety considerations, supervision ratios, and some rope-craft are to be applied to the conduct of any fixed FF.
Due to the course being fixed and inspected regularly for
serviceability, the main points of emphasis for the OIC and the
safety supervisors are:

a. briefing and dressing the participants (including safety
   staff) in the appropriate harness and equipment, prior to
   leaving the ground
b. a safe ascent up the facility via the fixed ladders and
   platforms to the dispatch platform
c. secondary check and hook up to a safety line, prior to
   stepping onto the dispatch platform
d. the safe attachment of participants to the runway lines
   (typically steel wire rope), via a trolley system whereby
   the main lanyard and hand loop attaches to the centre
   point of the trolley with the main karabiner (first point of
   contact) and a second longer safety lanyard is then
   attached to the backup cable with a second karabiner on
   the side of the trolley (second point of contact)
e. final dispatch check procedure (the six-point safety
   check, which can be remembered by using the following
   mnemonic prior to traversing down the line (see
   Table 7–1):
   (1)   A = Anchor
   (2)   B = Buckles
   (3)   C = Karabiner
   (4)   D = Device
   (5)   E = Everything else
   (6)   F = Friend.

f. the safe conduct of the traverse down the line
g. a safe de-rigging from the activity, once safely on the
ground.

In order to keep the participant engaged in the activity and also
prevent unnecessary shock loading of the system, it is advised
that handles be provided (made from 25 mm tube tape or similar), attached to the trolley system. This will:

a. ensure that the participant remains engaged with the activity by having an element of control
b. allow the participant to cushion the landing by lifting themselves to the appropriate height
c. prevent the participant from having their hands entangled elsewhere in the system
d. prevent the unnecessary shock loading of the fall arrest harness and safety lanyards used to secure the participant, thus prolonging their use.

Fundamentals of the Fixed Flying Fox

22.51 Due to their fixed nature, and construction, it is possible to conduct an activity involving a large amount of participants.

22.52 All ascending on the facility should be via fixed ladders and platforms, where the climbers are protected by the facility’s built-in safety elements. If these are not sufficient, then the relevant roping chapter of this publication should be referenced and those measures adopted for ascending the facility.

General Description of the Fixed Flying Fox

22.53 Fixed FF facilities are normally anchored at one end by a tower, which facilitates the height required to ensure that participants make it safely across the activity. The facility is normally multi-level, connected with ladders and gates.

22.54 A dispatch platform is normally located on an upper level. This level also incorporates the anchor system for the runway lines and provides a location to connect participants.

22.55 There are often other activities conducted on this facility, such as an outdoor climbing wall activity, military rope climbing or cargo net climbing. These activities can be incorporated into the FF activity or done in a stand-alone format but must be supervised appropriately.
22.56 At the other end of the runway lines is a landing area, terminating anchors for the runway lines, a soft fall area, and ladders or platforms to assist in de-rigging participants.

22.57 Figure 22–7 shows an example of a fixed FF activity and the likely positions of the safety supervisors, denoted by the numbers 1 through 6. Table 22–2 identifies the locations and roles of those safety supervisors.

![Figure 22–7: Example of a Fixed Flying Fox](image)

Table 22–2: Locations and Roles of Safety Supervisors

<table>
<thead>
<tr>
<th>Position</th>
<th>Location and Description of Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Tower Safety Supervisor Line 1.</strong> Attach participants, perform safety checks and dispatch participants.</td>
</tr>
<tr>
<td>2</td>
<td><strong>Tower Safety Supervisor Line 2.</strong> Attach participants, perform safety checks and dispatch participants.</td>
</tr>
<tr>
<td>3</td>
<td><strong>Tower Safety Supervisor Line 3.</strong> Attach participants, safety checks and dispatch participants.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Ground Supervisor – Tower Area.</strong> Brief, dress and check participants prior to ascending the tower. Administration control.</td>
</tr>
</tbody>
</table>
Safety Supervisors/Participant Ratio

22.58 As outlined in Annex A to Chapter 1, UATLs can only supervise dispatching of two ropes at any one time for novice participants. However, one per line is preferred for FF.

Hazards

22.59 During all FF activities there are a number of hazards and medical considerations that need to be addressed. The following is a list of common issues:

a. All hazards and medical considerations associated with roping and climbing are to be addressed during pre-activity planning.

b. Equipment must be serviceable and fit for task. All safety equipment must be inspected by the OIC before, during and after each activity. Safety supervisors are to assist with this task during the activity.

c. Harnesses and tethers must be inspected before and after use to ensure that equipment is replaced after the appropriate level of use.

Annexes:

A. Artificial Climbing Wall – Safety Brief Card

B. High Ropes Course – Safety Brief Card

C. Fixed Flying Fox – Safety Brief Card
ANNEX A TO CHAPTER 22

ARTIFICIAL CLIMBING WALL – SAFETY BRIEF CARD

OICs must ensure that they give orders appropriate for their activity that are relevant to the technical specifications of the facility, and specific to their exercise, which are understood by all participants. In addition the following specific safety information must be delivered before commencement of the activity, as part of, after or separately to the exercise orders.

Pre-activity Check
1. Stability of wall
2. Height of wall
3. Anchor points – what is required
4. Routes up/down
5. Location of safety vehicle if required
6. Evacuation plan
7. Location of nearest medical facility
8. Serviceability of equipment

Equipment for Activity
1. Harness
2. Karabiners (different types)
3. Belay devices
4. Rope
5. Belay point
6. Medical equipment
7. Mats
Contents

8. Climbing boots
9. Helmets

Check during Activity
1. Rope wear
2. Belay point
3. Personal equipment
4. Participants
5. Mats are positioned under climb

Safety Brief Appointments
1. OIC is …
2. Safety officer is …
3. Medic is … (if present)
4. UATLs are …
5. Driver for safety vehicle (if used) is …

Location
1. Current location …
2. Layout of facilities (toilets)

Communications
1. Nearest phone is …
2. Emergency phone numbers are …

Medical Information (as Applicable)
1. Safety vehicle …
2. Keys are located …
3. Med kit is …
4. Med kit contains …
5. Stretcher is …
6. Nearest hospital is …
7. Route to hospital …
8. The medic is located …
9. Actions-on accident:
   a. apply immediate first aid
   b. send for professional medical aid/evacuation coordinated by OIC.
10. Evacuation plan

Equipment
1. Description/fitting/check of equipment
2. If equipment is removed, get checked by the wall leader
3. Rethread harness straps
4. No smoking with equipment on
5. Do not drop equipment
6. Tuck away loose clothing, etc.

Bouldering Procedure
1. No bouldering above 2 m where the height is measured from the ground to the climber’s feet
2. If attempting a difficult move, request a spotter
3. Demonstrate bouldering and spotting

Climbing Procedure
1. Climbing calls …
2. Belay point and top rope system only dismantled by order from OIC
3. Do not run or throw anything
4. Pay attention to leaders and report any injuries
5. Demonstrate both belaying and climbing technique
Contents

22A-4

6. Rehearse belay technique on ground
7. Test participants ability to hold a fall
8. Lowering technique
OICs must ensure that they give orders appropriate for their activity that are relevant to the technical specifications of the facility, and specific to their exercise, which are understood by all participants. In addition the following specific safety information must be delivered before commencement of the activity, as part of, after or separately to the exercise orders.

Safety Brief

1. Layout of HRC and safety critical areas
2. Heights of platforms
3. Anchor and belay points
4. Climbing routes up and down on wing(s) and abseil tower (if applicable)
5. Actions on:
   a. Minor injury
   b. Serious injury
   c. Witnessing an unsafe practice
   d. Hearing ‘STOP STOP STOP!’
6. Evacuation plan
7. Location of nearest medical facility
8. Appointments for the activity:
   a. OIC/OCA
   b. Safety supervisors
   c. Medic(s)
d. Other UATLs (outside of OIC/OCA)
e. Driver of safety vehicle

9. Locations:
   a. Toilets
   b. Admin area
   c. Safety/Emergency phone
   d. Medical equipment
   e. Safety vehicle
   f. OIC/OCA

Participants' Equipment for Activity

10. Helmet
11. Harness
12. Karabiners (types and uses)
13. Belay devices
14. Descent devices
15. Abseiling gloves

Sequence of Events

16. Detail the sequence for the day's events
17. Dress participants in equipment required and allocated groups
18. Demonstrate all processes to be conducted during the activity, including climbing and abseiling calls and replies, for the following:
   a. Hooking up of a participant to a belay rope
   b. Climbing and belay technique
   c. Backup belayer technique
   d. Climbing technique for cave ladders, staples on poles or ladders as applicable
e. Abseil calls, technique and brake duties
f. Technique and calls for lowering a climber
g. Final safety check before climbing (ABCDEF check)
ANNEX C TO CHAPTER 22

FIXED FLYING FOX – SAFETY BRIEF CARD

OICs must ensure that they give orders appropriate for their activity that are relevant to the technical specifications of the facility, and specific to their exercise, which are understood by all participants. In addition the following specific safety information must be delivered before commencement of the activity, as part of, after or separately to the exercise orders.

Safety Brief
1. Layout of FF and safety critical areas
2. Heights of platforms
3. Anchor and belay points
4. Climbing routes up and down
5. Actions on:
   a. Minor injury
   b. Serious injury
   c. Witnessing an unsafe practice
   d. Hearing ‘STOP STOP STOP!’
6. Evacuation plan
7. Location of nearest medical facility
8. Appointments for the activity:
   a. OIC/OCA
   b. Safety supervisors
   c. Medic(s)
   d. Other UATLs (outside of OIC)
Contents

22C-2

e. Driver of safety vehicle

9. Locations:
a. Toilets
b. Admin area
c. Safety/Emergency phone
d. Medical equipment
e. Safety vehicle
f. OIC/OCA

Participants Equipment for Activity
10. Helmet
11. Harness
12. Karabiners (types and uses)
13. Trolleys and pulleys
14. Tethers/safety lines
15. Hand loops/line

Sequence of Events
16. Detail the sequence for the day’s events
17. Dress participants in equipment required and allocated groups
18. Demonstrate all processes to be conducted during the activity, including:
a. climbing the tower
b. dispatching or stepping off the tower
c. Final safety check before traverse (ABCDEF check)
d. actions on not crossing the whole traverse
e. de-rigging from the runway lines
CHAPTER 23
AID CLIMBING

SECTION 23-1. INTRODUCTION

23.1 Aid climbing is a style of climbing where the climber stands on or pulls up via devices attached to fixed or placed protection to enable upwards progress.

Grades

23.2 Aid climbing does not use the Ewbank grading system. The following grade ratings describe how difficult an aid climb is. **Table 23–1** is an example with both American and the Australian gradings.

**Table 23–1: Grading Systems**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A1) (M1)</td>
<td><em>Easy Aid.</em> Placements straightforward and solid.</td>
</tr>
<tr>
<td></td>
<td>No risk of any piece pulling out.</td>
</tr>
<tr>
<td></td>
<td>Etriers generally required.</td>
</tr>
<tr>
<td></td>
<td>Fast and simple for clean aid, although clean placements usually take more time and experience.</td>
</tr>
<tr>
<td>(A2) (M2)</td>
<td><em>Moderate Aid.</em> Placements generally solid but possibly awkward and strenuous to place.</td>
</tr>
<tr>
<td></td>
<td>May be a tenuous placement or two above good protection with no fall danger.</td>
</tr>
<tr>
<td>Grade</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>(A3) (M3)</td>
<td><strong>Hard Aid.</strong> Testing methods required.</td>
</tr>
<tr>
<td></td>
<td>Involves many tenuous placements in a row.</td>
</tr>
<tr>
<td></td>
<td>Generally solid placements (which could hold a fall) found within a pitch.</td>
</tr>
<tr>
<td></td>
<td>Long fall potential, up to 50 ft (six to eight placements ripping), but generally safe from serious peril.</td>
</tr>
<tr>
<td></td>
<td>Several hours required to complete a pitch, due to the complexity of placements. (This is where the going gets real.)</td>
</tr>
<tr>
<td>(A4) (M4)</td>
<td><strong>Serious Aid.</strong> Lots of jeopardy.</td>
</tr>
<tr>
<td></td>
<td>Big fall potential is common, with uncertain landings far below.</td>
</tr>
<tr>
<td>(A5) (M5)</td>
<td><strong>Extreme Aid.</strong> Nothing really trustworthy of catching a fall for the entire pitch.</td>
</tr>
<tr>
<td></td>
<td>These climbs are generally reserved for pitches with no bolts or bolt holes (This means danger. A5/M5 and above always refers to a string of placements that are marginal.).</td>
</tr>
<tr>
<td>(A6) (M6)</td>
<td><strong>Theoretical Grade.</strong> A5, M5 climbing with marginal belays which will not hold a fall.</td>
</tr>
<tr>
<td></td>
<td>The leader falls, and it is into the abyss for the whole team.</td>
</tr>
</tbody>
</table>

**Note:**
The American gradings are preceded by the letter A. The Australian gradings are preceded by the letter M.
23.3 Tools, such as camming units, tapers and natural anchors, offer the mainstay placements for the majority of standard aid routes. Placing a nut is easier and faster than placing a piton.

23.4 Aid placements can be, and often are, more marginal than those required for free climbing. Examples include the placement of an SLCD where only two cams are in contact with the rock or micro-taper in a shallow seam. So long as the piece can hold body weight in the direction of pull, it is a viable aid placement. Solid placements are preferred, but due to terrain, time considerations, and so on, a marginal piece may have to do.

Equipment

23.5 Aid climbing is very equipment intensive, most of the equipment has been covered in previous chapters. A list of additional equipment that may be required is as follows:

a. pitons  
b. copperheads  
c. hooks  
d. aid slings  
e. fifi hooks  
f. daisy chains  
g. haul bag  
h. portaledges.

23.6 Pitons are suitable when clean protection cannot be found. Placing a piton involves picking the right size, placing it in a crack, and hammering it in. Pitons scar the rock, and are time-consuming to place and remove. There are a number of pitons on the market that range in size. A couple that are handy to have are Realized Ultimate Reality pitons and Bird beaks (see Figure 23–1).
23.7 Copperheads (or mash heads) are cylinders of copper or aluminium swaged onto a cable; they are mashed into shallow groves or pockets as aid placements (see Figure 23–2).
There are three basic types of hooks: the Chouinard hook, the Leeper Logan and the ring-angle claw. The Chouinard hook is the classic, most commonly used hook. The hooks are used for advanced aid techniques and only used after a lot of practice (see Figure 23–3).

Figure 23–2: Copperhead

**23.8**

There are three basic types of hooks: the Chouinard hook, the Leeper Logan and the ring-angle claw. The Chouinard hook is the classic, most commonly used hook. The hooks are used for advanced aid techniques and only used after a lot of practice (see Figure 23–3).
Etrier

23.9 Etriers, also known as aid slings, or aiders, are fashioned from sewn webbing, featuring four, to six steps. Knotted etriers can be crafted from a long piece of 25 mm tubular webbing, but are inferior to sewn etriers. Sewn steps are far easier to place a foot into. When it is windy, the sewn etriers are best. For long and difficult routes you will need to rig your etriers with ‘grab loops’, consisting of short loops of webbing on the top of each etrier. This saves your hands, as you are continually pulling yourself up by the grab loop, an alternative is to grab the karabiner (see Figure 23–4).

23.10 When purchasing sewn etriers, buy them from the same manufacturer. Hold them up against one another and compare.
The dimensions of the steps (step length) should be precisely the same for both etriers, because you will want to have both feet at the same level while standing in them. Also try to have your etriers in different colours, it will help with the management when climbing.

![Figure 23-4: Etriers](image)

**Fifi Hooks**

23.11 Fifi Hooks are used in lieu of a karabiner to connect the climber to the piece or a daisy chain. They can be tied into a short sling tied directly from the harness. An optimal length sling will allow you to hang comfortably while the feet are in the third step. Fifi hooks make it easier to hook into the piece for a rest. The
23-8

downside is that the fifi hook, dangling from the harness, tends to catch on everything (see Figure 23–5).

Figure 23–5: Fifi Hook

Daisy Chain

23.12 A daisy chain acts as a secure connection of the climber to a placement. The overall length extends from your harness to the tip of your reach. Girth hitch the daisy chain directly into the harness, instead of clipping it in. The girth hitch will never come undone, eliminates the clutter of an extra karabiner on your harness, and does not need to be checked like a karabiner clip in. A daisy chain is shown in Figure 23–6.
Haul-bag

23.13 A good quality durable haul-bag is essential; padded carrying straps are required for long approaches. Stout wide haul-bags are far easier to get equipment into and out of than narrow bags. Offset haul straps allow one set of straps to be detached from the haul point for easier access inside (see Figure 23–7).
Portaledges

23.14 Portaledges (see Figure 23–8) are specially constructed hanging tents which are suspended from a single point. They are available in both single and double models. Single portaledges come in two basic styles of suspension: four point and six point. Four-point suspensions are lighter and less prone to tangles. For structural reasons, double portaledges require six-point suspension.
Harnesses

23.15 Aid climbing harnesses generally have thicker waist and leg loop padding to provide better support and comfort for the climber. Some offer supplementary attachment points to adjust position. Additionally, they will often have additional gear loops.

Shoes

23.16 Any medium weight hiking boots will do for aid climbing. A reasonably stiff sole is desired, since you will be standing in etriers for hours at a time. A durable rand around the toe is preferred as the toe of the boot is subject to wear from the rockface. Optimum wall boots are comfortable for both hiking and standing in etriers, yet allow for a reasonably high standard of free climbing.

Gloves

23.17 Cleaning and hauling is harsh on the climber’s hands, so a pair of fingerless, thin but durable, tight fitting goatskin leather gloves are best.
Leading

23.18 Practicing aid climbing on free-climbing cracks with SLCDs, nuts, and clean gear is a good way to perfect the basics (as well as following such pitches with ascenders). Do not practice piton placement techniques at a free climbing area. The main objective for your first few aid leads is to get familiar with the motion and sequence of efficient ascent, and working out the system so the basics become second nature: placing, testing and hanging on gear. For someone used to free climbing, the slowness of aid may be unnerving.

23.19 Cleverness is an asset on aid pitches. Good judgement and innovative thinking are qualities of a good aid climber, besides the main challenge of climbing efficiently, an aid pitch offers a continual set of minor challenges, each one unique, and each one requiring a slightly different solution. Virtually all aid climbing, even for the expert, is a constant struggle with organisation, requiring vigilance to keep track of all the gear. If you stay organised, half the battle is won.

23.20 Table 23–2 contains the suggested sequence for base procedures. Table 23–3 contains the suggested sequence for climbing procedures

<table>
<thead>
<tr>
<th>Climber</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climber No. 2</td>
<td>Establish belay point.</td>
</tr>
<tr>
<td>Climber No. 1</td>
<td>Rack selection (choice of type and quantity of protection, racks protection to suit): both tie in as per normal lead climbing.</td>
</tr>
<tr>
<td>Climber No. 1</td>
<td>Should have the daisy chains girth hitched to their harness and then clipped into the etriers by a clip gate karabiner.</td>
</tr>
<tr>
<td>Climber No. 2</td>
<td>Should have the daisy chains/ascenders/etriers girth hitched to their harness</td>
</tr>
</tbody>
</table>
Climber No. 1 Checks the belay point.

Both Check equipment (helmet, harness tied on correctly, daisy chains are girthed hitched on correctly and connected to the etrier in the correct fashion).

Climber No. 1 Places their first piece of protection for an upward and outward pull and clips the rope into the piece.

<table>
<thead>
<tr>
<th>Serial</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Places their next placement.</td>
</tr>
<tr>
<td>2.</td>
<td>Clips a clip gate karabiner in the placement (may need to extended with slings or quickdraws.</td>
</tr>
<tr>
<td>3.</td>
<td>Then clips one etrier into the clip gate and tests the place.</td>
</tr>
<tr>
<td>4.</td>
<td>Using the grab loops on the etrier for balance, climb up until able to place the next piece in.</td>
</tr>
<tr>
<td>5.</td>
<td>Repeat Serial 2 and Serial 3.</td>
</tr>
<tr>
<td>6.</td>
<td>Once satisfied with the placement, move onto the top piece using the grab loops on the next etrier for balance.</td>
</tr>
<tr>
<td>7.</td>
<td>Retrieve the etrier from the bottom piece.</td>
</tr>
<tr>
<td>8.</td>
<td>Clip the rope into the bottom piece.</td>
</tr>
<tr>
<td>9.</td>
<td>Climb up to the second step, or sub-second step, and prepare to place the next piece.</td>
</tr>
</tbody>
</table>

*Table 23–3: Climbing Procedure*
23.21 The No. 2 follows the lead climber by ascending the fixed rope placed at the belay by the leader. The ascent rig is set up as follows:

<table>
<thead>
<tr>
<th>Serial</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>(b)</td>
</tr>
<tr>
<td>10.</td>
<td>Repeat all the way to the belay point (You may wish to use both etriers in the one piece for the ease of climbing.).</td>
</tr>
</tbody>
</table>

Following Pitches

- **Girth hitch the daisy chains to your harness.**
- **Connect an ascender to the daisy chain by a locking karabiner as per the following:**
  1. The top ascender is slightly below full arm extension (you do not want to be stretching to reach it), the daisy to the ascender must be tight. That is at a comfortable arm’s reach of the upper ascender, the climber can rest on their harness via the daisy. If it is too short you cannot get a full arms extension, and are left to 'jug' with quick little strokes. If the daisy is too long, you cannot lean back on the ascender, and are left to hang off your top hand, which will flame out quickly. To shorten the daisy chains use the small eyes on the chain.
  2. The length of the bottom daisy to the lower ascender is not so crucial, but it should not be too long. This daisy will catch you if you fall out of your etriers while your top ascender is being moved past a point.
  3. Now connect your etriers to the same locking karabiners on the daisy chains. The feet positions for the etriers should be:
    - **the top ascender is the third step**
(b) the lower ascender should be the second step.

(4) Your first few efforts ascending a rope in this method are invariably strange and frustrating escapades requiring more energy to move up than to actually climb the same section of rock. But once you get the daisy lengths dialled in, become familiar with placing the feet in various steps of the etrier and the required weight shifts and motions, you will find your rhythm and will be jogging up the rope in no time.

23.22 As the rope is ascended, the gear that the leader placed must be removed, or cleaned. This requires moving the top ascender past the karabiner connecting the placement to the rope. On perfectly vertical pitches, you simply unclip the rope from the karabiner. Other times, and owing to tension on the rope, the top ascender must be unclipped from the rope and reclip above the piece. To accomplish this, your weight must be entirely on the lower foot, in the lower etrier.

The Climb Sequence

23.23 The sequence detailed in Table 23–4 is the suggested procedure for aid climbing.

<table>
<thead>
<tr>
<th>Climber</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminaries</td>
<td></td>
</tr>
<tr>
<td>Both</td>
<td>Identify the climb (use guidebook) suitability determined by climber’s ability, equipment and weather conditions time limitations. How long is it going to take you to complete the climb?</td>
</tr>
</tbody>
</table>
Cleaning Roofs, Traverses and Pendulums

23.24 One of the trickiest aspects of cleaning is following the rope over roofs and across traverses (the techniques are the same). When the next piece is way off to the side, for instance, it is impossible to fully weight the top ascender (clipped above a piece to be cleaned) because the bottom ascender will, be sucked up into the bottom piece before the top piece is fully weighted. This happens when the leader has either tension-traversed or pendulum from a piece, or when a long sideways reach was made.

23.25 One technique is for the cleaner to reclimb the placement with a set of etriers (pushing the ascenders along as you go). You may clip an extra etrier into the next piece, stand in it and clean the previous piece. This gets dicey if the placements are slim, but when they are solid, this is a suitable method. Generally, however, all of the climber’s weight is suspended continually.

<table>
<thead>
<tr>
<th>Climber</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>At the top of the pitch establish a belay point. Once the belay point is set up the No. 1 calls ‘SAFE’ to the No. 2. Identify and start to build the haul line anchor point to one side if possible. Starts to haul the bag up to the belay point.</td>
</tr>
<tr>
<td>No. 2</td>
<td>Upon hearing ‘SAFE’ No. 2 removes the rope from the belay device provided they are on the ground and safe. Prepares themself for the climb (releases the haul bag). Starts to ascend the rope and cleans the route.</td>
</tr>
</tbody>
</table>
from the ascender/etrier/daisy system with the techniques that have just been covered.

23.26 The most frequently used method is to clip the top ascender as high as possible on the rope – above the piece – then use both hands to manipulate the rope through the bottom ascender, the other to manually open the cam on the bottom ascender. It is necessary to equalise the weight by pulling the rope below the ascender with sufficient force to enable the cam to be opened manually. Then, with the cam open, slowly lower yourself out by feeding the rope through.

SECTION 23-3. MULTI-PITCH ROUTES

Carrying and Hauling the Pack

23.27 Most multi-pitch aid routes require a pack. If the pack is light enough, or if the terrain is low-angle and un-haulable, the second can carry it as they follow. For most steep routes, however, it is preferred that the leader hauls the pack after they lead the pitch. Many multi-pitch routes require a full day’s worth of provisions (6 kg or more of food and water), emergency rain gear, headlamps, plus a spare rope.

Basic Systems

23.28 The most strenuous job on the wall is hauling the bags. Especially early on, when the water bottles are topped up and the food sacks are full. The basic haul system takes a few minutes to set up properly and requires a pulley and two ascenders. A sturdy, smooth-running pulley is essential (always bring spares).

23.29 From your belay anchor, pick a suitable placement to haul from. Hauling puts substantial stress on the anchor, so make sure it is one of the more substantial anchor points in the belay system. Equalise two anchor points if possible. Instead of connecting the pulley directly to a piece, use a sling to allow the pulley to rotate, thus reducing torque on the bearing of the pulley. Also be aware that once you have hauled them up, you will need to clip the bags off somewhere, so the haul point
should be close to where you will anchor the bags. It is best to anchor the bags off to the side from where the team will hang, usually shoulder to shoulder, to reorganise for the next lead. The following is a suggested way to construct a haul point:

a. First, run the haul line through the pulley and clip the pulley into the haul point.

b. Establish a progress capture pulley.

c. Then clip the other ascender, right side up, onto the rope just below the pulley on the opposite side of the progress capture pulley, this is then connected to your harness by a sling or daisy chain to assist with the haul up (see Figure 23–9).
Figure 23–9: Example of a System for Hauling the Bag
23.30 There are many self-camming hauling pulleys available. These are incredibly convenient devices, avoiding the need to rig an ascender into each haul system (see Figure 23–10).

Figure 23–10: Self-camming Hauling Pulley

Packing the Haul-bag

23.31 Just as with packing for any trip, the haul-bag always seems too small at first. The trick is to lay out the items deemed essential for the trip (discarding a few in the process), then coming up with a general packing plan. It pays to have the bag properly organised. Certain things (like storm gear) need to be more accessible than other items. Any bulge (beware of cans) will quickly turn into a hole no matter the fabric of the bag. Minimise the damage by creating a smooth cylinder. A foam sleeping mat is the first item to go into a haul-bag. Next, pile in those items you will not need for the initial few days (see Figure 23–11).
Connecting Haul-bags to the Haul Line

23.32 The haul line must be detachable from the haul-bag (clip the haul line into the haul-bags with either two opposing clip gates or a jumbo locking karabiner). Protect the knot in the haul line with a few wraps of tape, or better still cover the knot with the cut off top of a drink bottle. If you do not, the constant abrasion of the knot against the rock will grind the sheath right off, (thus the reason why static line rope is used as your haul line) (see Figure 23–12).
Retreating

23.33 Retreating off big walls is often serious business, especially when you add 150 kg of haul-bag and free-hanging abseils into the equation. Once you have reached the halfway point on a wall, most climbers feel that ‘the only way off is up’. There is a shade of macho posturing in this credo, but with so much steep rock already below you, abseiling, bag lowering, and lost gear...
involved in reversing directions, it is almost always an easier affair to carry on.

23.34 To safeguard against retreat, pick a good time to start the route, watching for danger signs like cirrus clouds. Predict and prepare for all eventualities. Consider emergency strategies at every stage of the route; for example, what will you do if a partner gets injured. Proper wet weather gear will often prevent an emergency retreat, self-rescue is the preferred escape. Calling for a rescue should be avoided unless absolutely necessary. Understand that a rescue is always an involved business, with serious dangers for your rescuers.

Descent

23.35 Some walls have walk offs; others, abseils off the flanks of the formations or you abseil to the start of the climb and then walk out. Descending with gear is best facilitated by hanging the haul-bag from the harness, though massive bags must be lowered independently. On circuitous routes, the bags must be tethered and reeled into the lower anchor/belay.

Waste and Garbage

23.36 All waste and garbage must carried out with the climbing party.
CHAPTER 24

TYROLEAN TRAVERSE

24.1 A tyrolean traverse or highline traverse is a method of crossing a gap using a horizontal rope stretched between two anchors. It can be used within a range of activities or as an activity within its own right. A zip-line, or FF is in essence a type of tyrolean traverse where height is lost over the distance of the span.

24.2 **General Considerations.** When selecting a site for a tyrolean traverse, the following should be considered:

a. **Anchors.** A variety of suitable anchor points are needed at both ends of the traverse. Anchor points for a tyrolean traverse must meet the same requirements as outlined in Chapter 6.

b. **Span.** The straight-line distance between the anchors is only limited by the availability of ropes, and the ability to tension the ropes. In general, a span of up to 300 m should be considered as the maximum. Spans greater than 50 m will require additional effort in construction and will typically be very difficult to tension correctly.

c. **Launch and Landing.** Launching and landing areas need to be carefully considered when selecting a site. It is important to ensure that participants can connect and disconnect from the tyrolean traverse safely.

d. **Rescue.** The height of the traverse, environmental factors, and how a rescue may be conducted need to be considered. The height of the span may change the type and approach to a rescue.

Components of a Tyrolean Traverse

24.3 The following components are required for the construction of a tyrolean traverse:

a. **Runway Lines.** The runway lines are the main load-bearing ropes, they are to be a minimum of 11 mm
diameter static rope. A minimum of two lines are required, but more can be used if required. The length of the runway lines needs to be longer than the span, to allow for rigging and spare slack. If shuttle lines are not being used, the runway lines must be long enough to reach the base of the drop being spanned from both anchors.

b. *Trolley.* The trolley consists of pulleys and karabiners that traverse the runway lines. The trolley is constructed to ensure that connection to each runway line is independent. A trolley may be reused or reconstructed for each participant.

c. *Shuttle Lines.* Shuttle lines are not mandatory, but are useful for controlling the passage of the trolley. Additionally, shuttle lines provide a backup to the runway lines and can be used in the conduct of a rescue.

24.4 Figure 24–1 shows a simple tyrolean traverse.

![Figure 24–1: A Simple Tyrolean Traverse](image)

24.5 There are two ways of determining length of runway lines. When the intended method of rescue is to lower the participant to the ground, the following formula will allow the calculation of the required length of the runway lines.
24.6 The length of rope required for the runway lines can be calculated using Pythagoras’ theorem where the span and the drop are known. See Figure 24–2 for the formula depiction. The formula is:

\[ a^2 + b^2 = c^2 \]

Where: ‘a’ is equal to half the span, ‘b’ is equal to the depth to the ground under the span, and ‘c’ is equal to half the length of rope required minus the extra for rigging and slack.

Where: the span is 30 m and the drop is 50 m, the formula only calculates half the span, so the span distance is halved:

\[ 15^2 + 50^2 = c^2 \]
\[ 225 + 2500 = c^2 \]
\[ c^2 = 2725 \]
\[ \sqrt{2725} = 52.2 \text{ m} \]
\[ 52.2 \text{ m} \times 2 = 104.4 \text{ m} \]

Add 10% for rigging and the required rope length is 115 m.
24.7 The second way of determining runway length is to measure the distance between two points. This can be done using maps, guidebooks, or measuring with rope. This style of tyrolean is a simple traverse where the ropes will not reach the base of the span and therefore will need to have shuttle lines attached to the trolley to allow for rescue.

24.8 In a perfect world, both ends of the traverse are at equal height. In the real world the traverse is often on a slope. This change in height can produce a scenario where the effort needed to work the shuttle lines can easily create the same forces as required for a vertical haul.

24.9 Safety Considerations. The following safety precautions are to be observed when constructing and operating a tyrolean traverse:

   a. The runway lines must be a minimum diameter of 11 mm. These lines should also be in good condition.

   b. A minimum of two runway lines are required for a tyrolean traverse supporting human life.
c. Tensioning of the main lines can only be done with a 3:1 mechanical advantage system, operated by up to three average-sized personnel.

d. A minimum of three independent anchor points must be used at each end of the traverse.

e. The minimum amount of sag (measured with a 200 kg load) must be equal to or greater than 10 per cent of the span.

f. The tension on each unloaded runway line should never exceed 2.5 kN (250 kg), this can be achieved using 7 mm accessory cord and a four wrap Bachmann’s knot, as the Bachmann’s knot will slip if greater than 2.5 kN of force is placed on it.

g. The Bachmann’s knot must be constructed with only four wraps when used on 11 mm rope when using 7 mm accessory cord.

h. The total trolley weight must not exceed 200 kg. The trolley weight is calculated by adding the weight of all the ropes, karabiners, pulleys and any personnel, and their equipment suspended between the two anchor culmination points.

i. The collection of runway lines must have a combined breaking strain of 30 kN, including all terminations and anchors.

j. Shuttle lines must be used if the runway lines are not long enough to be lowered so that a person suspended by the runway lines can reach the ground.

Tensioning the Runway Lines

24.10 A horizontal rope fixed between two anchors produces a catenary curve. It is the shape made by any flexible but inelastic rope or chain when there is equal weight acting on each unit length. The catenary equation is easily solved on a computer, but it has one fundamental mistake, it does not account for any stretch. Rope stretch affects the equation in
two ways: as the tension increases, the rope stretches, lowering the sag and decreasing the tension again, this repeats until the system settles into equilibrium. Additionally, a stretched rope is slightly thinner, so therefore a metre of stretched rope is slightly lighter.

24.11 A rope suspended between two points will always have sag, and tension will create a force at each anchor culmination point even when no vertical load is applied to the rope.

24.12 Differing anchor heights at each end of the highline, will apply additional forces to the higher anchor. Figure 24–3 shows the force angles.

![Figure 24–3: Force Angles](image)

24.13 To calculate the forces on the anchors, assuming the anchors are at the same level, the following simple mathematical equation can be used:

a. Load (L) x span (S) divided by 2 x sag (D); or
b. \( \frac{LS}{2D} = \text{force (F)} \)
c. For example:

\[
80 \text{ kg} \times \frac{50 \text{ m}}{2} \times 5 \text{ m} = 4000/10 = 400 \text{ kg or 4 kN}
\]

24.14 As the angle of sag gets closer to zero, the tension increases at an increasing rate, until the rope snaps.
24.15 Using low-stretch 11 mm rope manufactured to EN1891 standards, if the maximum carriage weight is set at 2 kN (200 kg), then the minimum safe sag when in use (anchor force below 6 kN) is roughly 10 per cent of the span. To keep the anchor force below 3 kN, use 20 per cent sag. See Table 24–1 for anchor force calculations.
### Table 24–1: Anchor Force Calculation Table

<table>
<thead>
<tr>
<th>Angle A (°)</th>
<th>Sag/Span (%)</th>
<th>Rope Tension (kN)</th>
<th>Tension (with 200 kg load) (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>25</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>17</td>
<td>1.46</td>
<td>3</td>
</tr>
<tr>
<td>15</td>
<td>13</td>
<td>2.17</td>
<td>4.4</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>8.6</td>
<td>2.88</td>
<td>5.8</td>
</tr>
<tr>
<td>5</td>
<td>4.4</td>
<td>5.74</td>
<td>11.5</td>
</tr>
<tr>
<td>4</td>
<td>3.5</td>
<td>7.17</td>
<td>14.3</td>
</tr>
<tr>
<td>3</td>
<td>2.6</td>
<td>9.55</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>1.7</td>
<td>14.3</td>
<td>29</td>
</tr>
<tr>
<td>1</td>
<td>0.9</td>
<td>28.6</td>
<td>57</td>
</tr>
</tbody>
</table>
24.16 If the runway line slopes, there is more tension on the top anchors than the bottom anchors. The vertical load or total load on an end anchor increases when the trolley approaches it.

24.17 If the shuttle line is being used to control the speed of the trolley, then some forces are being applied to the shuttle line. If the load is in the natural centre position (equilibrium between the two anchors) then all the forces are applied to the runway lines.

24.18 The 2.5 kN tension limit will restrict a rope-based tyrolean traverse to about 300 m span; above this the sag with a trolley added is so large it will be unmanageable.

24.19 Tensioning a tyrolean traverse is not an easy task, over-tensioning is seriously dangerous. Short spans are easier to over-tension, due to the smaller amount of rope elongation across the span.

24.20 It is important to learn the ability to feel the tension in a rope. This is done by gripping the rope and pressing sideways with your thumb. It is surprisingly accurate once you know what a 10 kN or 20 kN rope ‘feels like’. Figure 24–4 gives you an example of feeling for the tension in the rope.

![Figure 24–4: Feeling for the Tension in the Rope](image)

24.21 When a tyrolean traverse is used for the first time, the rope will stretch and retain some of that extra length, at least until it is rested or washed. It can be tempting to keep increasing the tension to allow for this stretch. Care needs to be taken; the
more stretch is taken out, the more it will stretch the next time. The rope’s elasticity curve is not a straight line. This means that a rope with all the stretch ‘taken out’ is less bouncy than a rope used once, and this can have a bearing on how it behaves in a shock load event.

24.22 In order to ensure that excessive tension is not applied to the runway lines, a ‘fuse’ is constructed. The ‘fuse’ is designed to slip, paying excess slack rope into the system, increasing the sag therefore reducing the overall tension. A four wrap Bachmann’s knot, which is known to slip at 2.5 kN, when used as the fuse, will self-manage by paying excess rope into the system whenever the runway lines are overloaded.

Tyrolean Traverse Build Process

24.23 The following steps can be used to build a tyrolean traverse:

a. Identify from which side of the gap it will be easiest to control the fuses and rigging. This end will be referred to as the Near End.

b. Construct three independent anchor points culminating together at a rigging plate. Repeat this for the other side which will be referred to as the Far End.

c. Using a rope or cord which is longer than the span, carefully either walk the rope around, walk across the bottom or throw the rope across the gap. Use this rope to progressively transfer the runway lines and shuttle lines across the gap.

d. At the Far End, secure the end of the runway lines and the shuttle line into the rigging plate using a figure-nine knot. Ensure that all karabiners are secure and that appropriate rope protection is in place. Additionally, ensure that safety lines and etriers (if necessary) are in place to keep participants safe and assist with the dismount of the traverse.

e. At the Near End, attach two five-bar rack descenders to the rigging plate. Attach each runway line through these
descenders. Tie off and secure the end of the rope into the rigging plate using separate karabiners.

f. Using two 5 m long, 7 mm accessory cords, tie a four wrap Bachmann’s knot to each runway line. Secure the end of each cord into the rigging plate using a Münter mariner knot on separate karabiners. Move the Bachmann’s down the runway lines by hand adding tension to the runway lines.

g. Ensure that all karabiners are secure and that appropriate rope protection is in place. Additionally, ensure that safety lines are in place to keep participants and dispatchers safe.

h. Attach a bolt-on 3:1 mechanical advantage system to one runway line. Using no more than three average-sized personnel, haul the slack out of the runway line; ensure that the Bachmann’s is moved down the rope. Repeat for each runway line until the tension is even across both runway lines.

i. Construct a trolley that provides an independent connection to each runway line. A suggested method for a reusable trolley is by using two pulleys and two figure 8 descenders as shown in Figure 24–5.

j. If using shuttle lines, connect the shuttle line to the trolley and the rigging plate from each side of the span. The shuttle line may be ‘pinned’ to one of the runway lines, using alpine butterflies with clip gate karabiners every 3 to 5 m. An alternative method of trolley construction is to connect the participant directly to a pulley, with a safety line connected to the other runway line. This method creates more friction and is more suitable for sloped traverses. This method is shown in Figure 24–6.
Figure 24–5: Reusable Trolley

Figure 24–6: Single-use Trolley
Raising and Lowering from a Traverse

24.24 Under some circumstances, it may be required to raise or lower a person from mid-span on a traverse. This can be used in an activity to raise perceived fear as the participant is not able to be in control. Achieving this requires preparation prior to dispatching onto the traverse. The following, in addition to the traverse set-up, is required:

a. Shuttle lines from the trolley to each side of the traverse.

b. An 11 mm static rope, that is as long as the drop to be lowered down or raised up plus the span distance, is to be established at the dispatch end as a lowerable rope, through a belay plate or equivalent. The running end of this rope is fed through an additional pulley affixed to the trolley.

c. If lowering, the running end of the rope is attached to the person to be lowered, who is also connected to the trolley using a separate safety line.

24.25 To operate the raising or lowering:

a. Once the person or trolley is at the point of the span where the raise or lower is to be conducted, the shuttle line at the opposite end of the traverse (where the person was not dispatched from) is to be securely tied off.

b. When lowering, all possible slack is to be taken in on the lowering rope. The person being lowered may need to assist by pulling up on the runway lines. Once tensioned, the lowering line is to be held in the brake position, while the person being lowered disconnects their separate safety line. Once disconnected, they are lowered to the ground in a controlled manner.

c. When raising, a mechanical advantage system is to be applied to the raising line. This line is raised until the person reaches the pulley, where they will connect a separate safety line to the trolley. Once safe, the raising line is lowered until the person’s weight is on their safety
The shuttle line tie-offs are released and the person completes the traverse.

**24.26** If raising or lowering two people at the same time, the second person is attached in the same manner as either the assisted abseil or pluck-off. *Figure 24–7* shows the raise or lower set-up.

*Figure 24–7*: Tyrolean Raise or Lower Set-up
Rescue

24.27 The approach to a rescue on a Tyrolean traverse will vary depending upon the style of traverse constructed. If a person on a traverse requires rescue the following should be considered:

a. If the runway lines are long enough to reach the base of the drop being crossed, then lowering them is the simplest and easiest rescue.

b. If the runway lines are too short, then the shuttle lines are essential to conduct the rescue, typically by mechanical advantage to haul the person to the side.
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