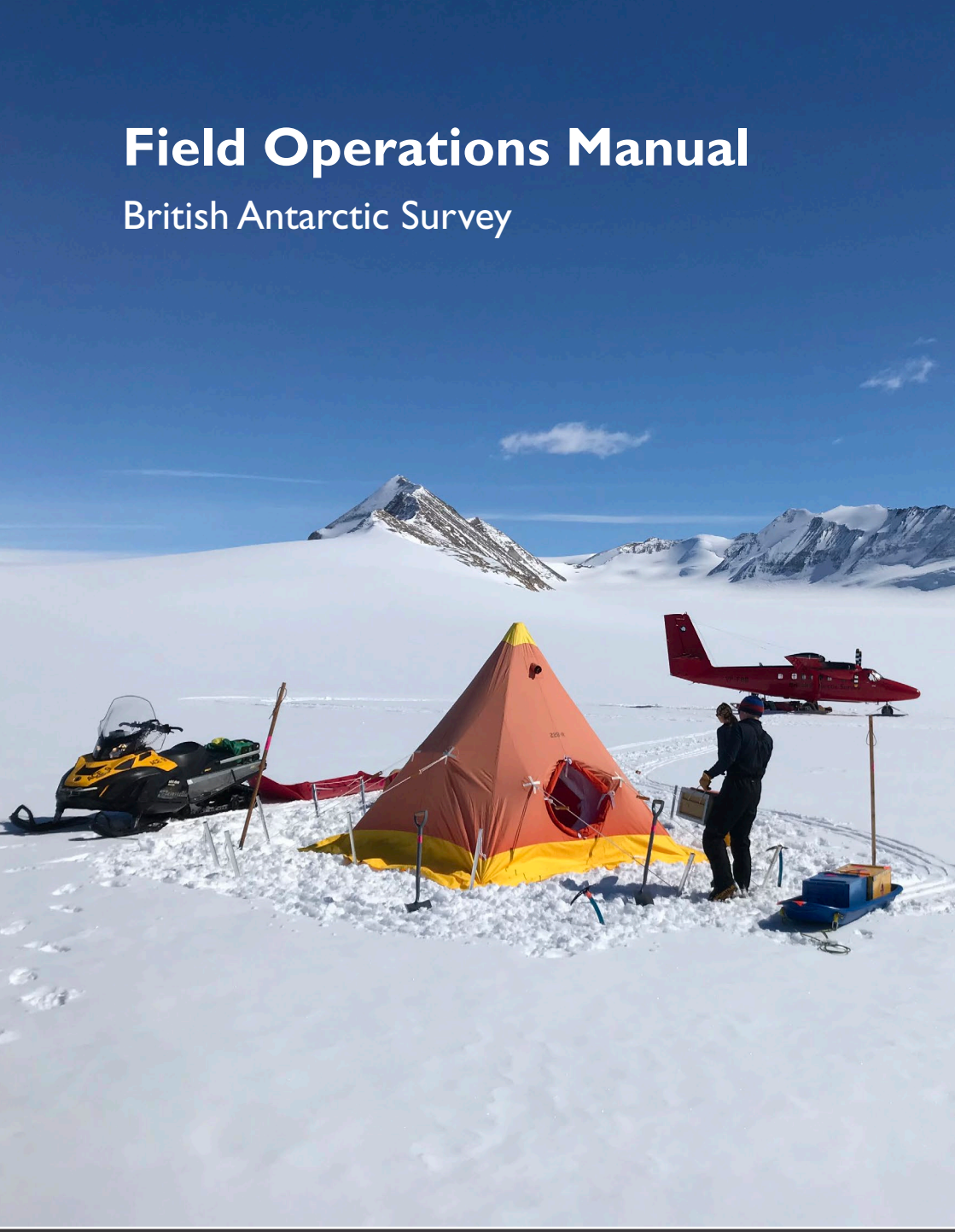
Field Operations Manual

British Antarctic Survey



British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

POLAR SCIENCE
FOR A SUSTAINABLE PLANET

Field Operations Manual

British Antarctic Survey

Loading fuel drums into a Twin Otter aircraft on the Stange Ice Shelf, English Coast, Antarctica (Pete Bucktrout)

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Document control

Users of the Field Operations Manual should ensure that they are operating from the most up-to-date version. Due to the nature of field operations, changes in procedures occur regularly. It is intended that the manual will be reviewed every two years and if significant changes are required then a new version will be produced. Check with the Field Operations Manager to find out which version is the most up-to-date.

This copy of the Field Operations Manual is **version 3.0**

Version 1.0 was published in 2003 and written by Simon Garrod
Version 2.0 was published in 2018 and written by Scott Webster
Version 3.0 was published in 2025 and written by Matt Shepherd

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Cover photo: Input flight to Flask Glacier (Nick Gillett)

Disclaimer

Supporting texts

The following is a list of recommended reading that provides useful background and supporting information to this manual:

- *Field work manual*
- *Field information manual*
- *Traverse operations manual*
- *Winter Skills, essential walking and climbing techniques*, by Andy Cunningham and Allen Fyffe
- *Navigation in the mountains,* by Carlo Forte
- *Rock climbing, essential skills and techniques*, by Libby Peter
- *Mountain Craft and Leadership*, by Eric Langmuir
- *Alpine Mountaineering*, by Bruce Goodlad
- *Staying Alive in Avalanche Terrain*, by Bruce Tremper

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Introduction

Purpose of this manual

The purpose of this manual is to provide a comprehensive reference of field techniques required for operating safely and efficiently in the polar environment.

The Field Operations Manual focuses primarily on techniques specific to BAS. Many of these techniques have been developed over time to suit the unique demands of polar fieldwork. General mountaineering techniques are not covered in this manual. For information on these please see the range of supporting texts provided on all BAS stations, as well as in the Field Training Manual.

It is not intended for staff to simply read this manual and learn how to operate effectively in the field. This manual is a supporting text that goes hand in hand with extensive practical training.

Much of what is written in this manual is directed towards field staff, but this manual is a useful reference for anyone spending time in the field.

As with most areas of mountaineering and field craft there are often multiple ways to safely achieve the same end result. The techniques described in this manual are the standard system used by BAS and should be followed in most cases. There may, however, be some situations where other slightly different approaches are more appropriate. A degree of experience and sound judgment is expected from field staff operating in the polar environment.

Role of the Field Guide

Field Guides – formerly known as General Assistants, Field General Assistants, Field Assistants and most commonly referred to as Field Guides – perform the role of safety and logistics coordinators in the field.

Each scientific project is assigned a Field Guide who is responsible for training personnel in the necessary field skills, assisting with logistical planning, ultimately making decisions based on safety in the field and when appropriate assisting the scientists in their work.

Field Guides all come from a mountaineering background but mountaineering is only a small part of their job with BAS. Prior to a field project departing, Field Guides must prepare all field equipment; this includes tents, stoves, sledges, food, clothing and where necessary technical mountaineering equipment. During the project Field Guides take the lead on all camp management, environmental, safety and travel-related aspects. In addition they have the responsibility to maintain the field kit, making any necessary running repairs, ensuring snowmobiles continue to operate efficiently and maintain communications with base.

Role of the Field Coordinator

Field Coordinators are responsible for running logistic hubs, fuel depots and static field camps and are vital in the support of the BAS field program.

Field Coordinators are responsible for keeping people safe and comfortable in the field while operating and maintaining field logistics hubs such as Sky Blu, Fossil Bluff and deep field fuel depots, along with supporting aircraft operations by providing weather observations, ground support and RFFS.

On stations the Field Coordinators will be responsible for delivering select field training modules to other members of BAS staff, alongside maintaining and repairing field equipment.

Many field scientists have decades of experience and are more than capable of performing all of these duties themselves. The field staff's purpose is to enable the scientific team to focus on their work and maximise their productivity.

Key skills for operating in the field

The following skills and qualities are what make a good Field Guide:

- The ability to make safe and conservative decisions
- Alpine mountaineering experience and ability
- Appropriate training
- Ability to learn new skills and techniques
- A methodical and organised approach
- Knowing your limits and the groups limits
- Effective communication with everyone in the group
- Environmental awareness
- Not putting personal ambitions first
- Common sense
- An aptitude for problem solving

Introduction *continued*

Judgement

The Antarctic is a very large and remote continent where extreme weather and environmental conditions combine to make it a very serious place. There are no quick fixes if problems occur. In winter, there are no aircraft on a continent bigger than Australia.

The underlying principle behind all Antarctic travel is the need to apply conservative and reasoned judgements to all decisions. Accidents often result from a chain of events caused by a number of small errors and bad decisions that eventually snowball into a serious situation.

The more you stack the odds against you, the greater the chance of coming to grief. Take the safe approach every time.

The techniques described within this manual are not exhaustive. There are so many variables present when operating in the extreme conditions found in the Polar Regions that a prescribed set of techniques to cover all situations is simply not practical. Field staff are employed for their ability to problem solve and make dynamic decisions based on the conditions encountered.

The manual has been broken down into sections which are indicated by coloured bars on the edges of the pages for quick identification. These are shown on the right edge of this page.

Chapter 1 – Planning

1.1 Planning fieldwork

The planning phase begins months, if not years before a field project actually takes place. From a Field Guides' point of view allocations to individual projects will normally occur four months before deployment. During this time Field Guides should contact the scientists involved to gain more information on the nature of the project, and the Field Operations Manager for the specific safety and logistics associated with the project.

There are various sources of information that should be consulted before deployment into the field.

These include:

- Maps
- Field reports from previous field parties
- Aerial photographs
- Depot plans
- BAS personnel with specific area knowledge
- Preliminary environmental assessments (PEA)
- Any specialist permits required for the project

Although they are constantly being improved, Antarctic maps are often of very poor resolution and accuracy. Aerial photographs are excellent as navigational aids and also for planning purposes. Reports from previous field parties can provide a wealth of relevant information.

The depot plans should also be consulted. This is stored electronically and gives information on the position of depots, stocks held and the date of the last visit. This information should be built into the project logistics planning. Depot plans are available from the Field Operations Manager (FOM).

Take care when trying to correlate information from maps and GPS fixes. Ground truthing on many Antarctic maps is not good and map errors can be large.

Having a solid plan laid out before deployment is essential and a great starting point, however, do not be afraid to modify the plan based on what you find on the ground. You may be working in frequently-visited areas or indeed areas where we have no knowledge of any previous visits. With satellite imagery we can have a good idea of what to expect but there are still many changeable and unpredictable factors that will affect how we operate once deployed in the field.

1.2 Preparation for field travel

The importance of meticulous preparation for a field project cannot be emphasised enough. Forgetting something important or miscalculating fuel or food quantities can cause significant delay and expense. This sort of error can have consequences for other projects too, not just yours. Don't rely on someone else to make these calculations for you. The FOM will plan this but it is always worth double and then triple checking!

1.2.1 Equipment preparation

The over-wintering field staff will check and service all of the equipment used during the previous field season. It is recommended that before deployment you re-check all of the field equipment allocated to your project. The specific equipment required for a project will vary depending on the nature of the task. All equipment should be checked for damage but also for any traces of soil, seeds or propagules – this is a simple but important biosecurity measure.

Field operations are governed by strict legislation for operating in the Antarctic. Legislation states: "To avoid introduction of alien species, chemical contamination and transfer of materials between sites, (1) Ensure that your equipment and clothing, including footwear, is thoroughly cleaned. (2) Avoid taking unnecessary packaging and materials into the field. Several products used for packaging are prohibited in Antarctica, such as polystyrene beads or chips. (3) Wherever possible, all precautionary measures should be taken to ensure collection and removal of human waste and grey water."

Discuss the specific requirements with the scientists and make any modifications necessary before deployment. It may be that a scientific instrument needs to be mounted to a sledge for example. Create a system and test it before leaving the station.

All items should be clearly labeled with the project Sledge name, year, name of field staff responsible and a weight in pounds. It is unlikely that all of your equipment will go into the field with you so this minimises the risk of something being left behind or sent to the wrong place. Be particularly aware of any items that are classified as dangerous goods and make sure these are clearly identified as such. For further information on this see Chapter 17 – Aircraft operations.

1.2.2 **Preparation for input**

Once all field equipment is checked and labeled it is ready to go into the field. Each station will have slightly different procedures at this point but ask the station management where to depot kit so that it is out of the way.

If deploying by aircraft, load sheets will need to be completed. See Chapter 17 – Aircraft operations for information and advice on filling out load sheets.

Ensure all members of the team have received the necessary and appropriate training, and that the training log has been updated. Check and double check that everyone has the correct equipment and clothing for the field project. Once this is all done inform the FOM or station management that you are ready to go. Many factors can influence field deployment so from the moment you say you are ready you need to be! It is not uncommon for field parties to be on standby for deployment for several weeks.

Chapter 2 – Training

2.1 Introduction

The polar environment can be a harsh and unforgiving place to live and work. This chapter outlines the training and basic knowledge needed before deploying to the Antarctic. The following is specific to BAS operations. Other government and private bodies may have different training requirements for their staff. Further information regarding training content can be found in the relevant chapters in this book. These chapters may also be used as reference material in various module training. References have also been made in the text where appropriate.

2.2 Pre-deployment training

Before heading into the field all staff will undergo formal field training. This training starts before leaving the UK and continues upon arrival in Antarctica. The following is a brief overview of what to expect.

Cambridge Pre-Deployment Training (PDT)

For new employees this will be the first contact with BAS operations and field matters. The pre-deployment training course deals with broad principles and in particular, attitudes towards safety and our environmental responsibilities. It does not cover field travel techniques in any depth. A basic first aid course makes up part of the training.

Wintering team training

This practical three-day training course is for over-wintering personnel only. The topics covered include camp craft, safety in tents, radio operation, mountaineering equipment, crevasse rescue techniques, navigation and continued environmental awareness. The training is modular and is reinforced as one proceeds through the system. There is a strong emphasis on team-building during this session. These courses are station specific and are delivered accordingly.

Field staff training

Field staff will have additional training consisting of a five-day induction week looking into topics such as mindset, BAS-specific field kit and mountaineering skills. This training will then be followed by another five-day training week based in Cambridge looking into skills that Field staff might not already possess, a non-exhaustive list of potential examples being: met training, MAXIMO use, mental health, safeguarding, GIS and GPR Training.

Station induction

Training will continue once staff arrive at the station. Training will differ depending on the location but usually includes a session on general familiarisation of the area, clothing and issued kit, an aircraft safety brief and field medicine. Once these sessions have been completed it is mandatory for most staff to undertake a local travel module. This is the first of the field training modules discussed below.

2.3 Field training modules

Staff will undergo varying levels of field training depending on their role and location. Most staff will undergo training modules covering local travel and co-pilot flights; however, these may vary depending on role.

Local travel

Once completed, this training module allows individuals to have access to the local travel area on station. It discusses topics such as travel regulations and limits, risks and hazards associated with the area, weather, communication, and the correct procedures for access either for work or recreation.

Co-pilot

This module covers what to expect while out on a flight in a BAS Twin Otter, the emergency kit carried and how to use it. This includes practical skills including stoves and their operation, how to erect a mountain tent and communication in the field, along with personal skills including the correct clothing for the deep field, and personal hygiene on short and extended trips.

The following modules are aimed at anyone spending significant time in the field, they start with basic campcraft and get more complex through linked ski-doo travel. These modules allow teams to gain experience in the use of equipment, while also getting used to the environment they will be operating in. These modules could be the first time inexperienced staff have seen these skills. They allow staff to get hands on and comfortable with the kit and the environment before heading on their intended project/trip.

Campcraft

Emphasising and building on the previous modules and trainings, campcraft gives an insight into field living while learning how to stay safe, warm, dry, fed and watered. Participants are taken camping for a night close to the station in a pyramid tent with the BAS system of boxes and P-bag sleeping equipment. This allows time for refreshing and refining personal kit management and hygiene to make life comfortable while in the field. For those new to field living this provides a perfect time to ask questions.

Basic mountaineering

For many this will be an introduction to the use of ice axes and crampons and how to travel safely over snow and ice on foot. It also covers how to put on a harness and how to rope up and travel in glaciated terrain as an alpine pair. This also provides experience to participants before they move on to complete the crevasse rescue module.

Crevasse rescue

BAS uses a 5:1 haul system. Refined over years of use, training is given on this system to ensure participants understand how to perform a crevasse rescue safely and effectively. Taking place over multiple sessions, topics are slowly built upon looking at equipment, anchors and the ropework required.

Linked ski-doo travel

Driving ski-doos safely in crevassed terrain requires specialist techniques covered in this module. Time is spent getting comfortable towing sledges, digging out and manoeuvring sledges, safety considerations and practicing driving safely with units and ski-doos linked together.

The remaining field modules provide training for science projects that require additional skills, specialist winter trips or for recreational purposes.

Sea-ice training

Overwintering staff will be required to do this module to access the sea ice surrounding station. More information and details on sea ice can be found in Chapter 19 – Sea ice.

Skiing

BAS does not teach downhill skiing, and this module is not an introduction or instruction on how to ski. Instead, it explores how to set up boots and bindings to allow competent individuals access to recreational activities available at the stations. There are more in-depth sections to this module that delve into the more complex skills required for backcountry skiing, ski touring and ski mountaineering.

Islands training

This training focuses on the islands surrounding Rothera and focuses on locations and huts, hazards on the islands, ASPAs, communications, emergency procedures and emergency depots amongst other topics. The Islands can be visited for scientific or recreational reasons. All staff visiting the islands must complete this training.

Sledge hauling

This module is one of the most advanced and focuses on the techniques required to travel through glaciated terrain on skis, snowshoes or foot pulling a pulk of equipment. This may be necessary in certain operational situations or more commonly on a winter trip. Despite its appeal recreationally, this type of travel is complex and requires substantial knowledge in a variety of subjects including the equipment used, mountaineering ropework and skills, and competence in specific crevasse rescue scenarios relevant to pulking/skiing.

Additional

Field staff and some over-wintering staff will receive additional on station training in areas such as aircraft safety, operating machinery, weather observations, paramedic training, search and rescue training and snowmobile maintenance. Training varies according to the station and specific job role, but the following topics may also be covered on arrival: waste management, snowmobile operation, fuel spill training, communications, and further field medicine.

2.3.1 **Importance of field training**

BAS has an operational area larger than Europe which means deploying someone into the field is a costly affair. Once a field party is out of station, scheduling an extra flight for unnecessary, non-emergency reasons is to be avoided at all costs. BAS gives extensive training described above, allowing individuals time to develop and understand the environment and gain the skills needed to operate in the Polar Regions.

Chapter 2 – Training *continued*

Participants should enjoy these courses; however, they should also be taken seriously as it is the opportunity to ask questions, make mistakes and learn before a deployment to the deep field or a winter. This training is essential for staff new to the polar environment or returning staff alike. However experienced, it is important to understand the risks involved and not to be complacent, see Chapter 4 – Risk management and hazards and Section 4.2.1 – Heuristics.

2.3.2 **Recreational field travel**

The main purpose of recreational field travel is for staff to have an enjoyable break from station life whilst learning useful Antarctic field skills. They are not intended to be high-risk affairs for the achievement of extreme personal goals.

The Station Leader or Winter Station Leader takes responsibility for recreational trips on behalf of the Director. Trips are scheduled to fit in with the work requirements of the station and other logistical considerations. Recreational travel varies according to station, where the nature of the terrain and the levels of experience vary.

BAS employees are very fortunate in the freedoms they are given for recreational travel. BAS is perhaps the only government body that allows this amount of freedom.

Recreational trips should be thought of as a privilege and not a right.

Short trips

Permission to conduct trips of up to two nights is granted at the FOM/WSL/SL's discretion and only after suitable substitution arrangements have been made for work programmes.

Trips vary according to the station and could be taken by ski-doo, boat or ski/foot using sledge-haul techniques.

2.3.3 **Winter trips**

Each over-wintering member of staff is usually granted two one-week trips during the winter – one before Midwinter and one after. These trips are usually run on a 1:1 ratio. KEP staff have the opportunity to go on three boat-supported trips of five days during the winter. Other stations where there are no over-wintering Field Guides still give staff time off but trips are run differently – see relevant station documentation for specifics.

The purpose of the winter trips is to give staff members the chance to experience field travel and get a break from station life. This is a major 'selling point' of wintering at a BAS station and for many the highlight of their tour.

These trips allow the winter staff to gain personal confidence, learn and develop personal skills in the field, and allow them to be prepared for assisting on fieldwork projects the following summer. In addition, these trips are invaluable for new Field Guides to gain experience in polar travel, enhancing their skills for the coming summer season. It is important to understand that these trips are second to operational requirements and may not go ahead for several reasons depending on the winter season, weather and staff involved.

The trips are not intended to be high risk and Field Guides should not be operating anywhere near their technical limit. It is important to be under no illusions of the seriousness of even a minor accident or injury during the winter in Antarctica. Search and rescue capabilities are minimal and the nature of the weather during winter is such that help may not reach you for days or even weeks.

Every trip requires a proposal form detailing specific intentions of the trip to be submitted to the Winter Station Leader and from there to the Operations Manager and Field Operations Manager. A decision will be taken based on both the Field Guide and the other staff members' experience as to whether specific objectives are appropriate.

The Station Leader's Handbook gives specific instructions on the requirements for winter recreational trips.

Chapter 3 – Personal management

3.1 Introduction

BAS operations involve a variety of activities in a wide range of climates and locations. Having the right clothing for the environment is crucial to comfort and safety.

Failure to wear the correct clothing and use it correctly can lead to several potential problems and risks:

- Hypothermia
- Frostnip and frostbite
- Non-freezing cold injuries
- Skin damage due to UV (sunburn)
- Eye damage due to UV (snow blindness)
- Cuts and abrasion to skin
- Physical eye damage

BAS issue clothing to all staff prior to leaving the UK. Upon notification of going to the Arctic or Antarctic a clothing form should be filled out and submitted to the Stores Manager. It is also recommended that you attend a fitting session in the stores department at BAS Cambridge to ensure sizing is correct. If it is to be your first trip to the Polar Regions it is recommended that your Line Manager attend this fitting with you to offer advice. Clothing issue will depend on your location and the work being undertaken.

Work clothing is provided for jobs that don't require the technical functions of field clothing. Work clothing is often harder wearing but at the expense of weight. Generally work clothing should be used for messy jobs such as refuelling vehicles but in certain situations it may be appropriate to use field clothing for messy jobs. It is accepted that clothing will get damaged through use but using the correct kit where practical will prolong the usable life and ultimately reduce unnecessary costs.

Caution: All personal clothing, footwear and equipment must be washed and inspected prior to leaving the UK for biosecurity reasons. For more information consult the BAS Biosecurity Handbook.

3.2 The layering system

The layering system is a basic principle in the outdoors. As the name suggests it involves wearing a variety of different layers to create warmth rather than one or two really thick warm layers. The advantages of a layering system over one really warm layer are both flexibility to adapt to a multitude of temperatures and also greater overall warmth.

The layering system works by creating air gaps between each layer of clothing; this air warms up with your body heat and is more effective at keeping you warm than one thick layer. In terms of flexibility, using a layering system allows you to remove a mid or top layer in the event of getting too warm due to physical exertion or a temperature change.

If sweat begins to build up this will cause you to chill rapidly as clothes become damp. Therefore, adjusting layers at the right time is crucial. While out working each person has to take a degree of responsibility for his or her own comfort and safety. It is very hard for anyone else to know how warm or cold you are. Extra layers should always be put on when ceasing to move for any length of time and as you begin to heat up take the time to stop and readjust your layers. This ideally needs to be managed so that everyone stops at the same time rather than stopping every few minutes, as someone else needs a layer change.

3.2.1 Base layers

The thin first layer of clothing is designed to wick moisture away from the skin and provides little insulation. A damp layer next to the skin will be uncomfortable and also speed up the process of heat loss. Cotton is a very poor material for transferring moisture away and instead soaks it up leaving the moisture right next to your skin. Cotton t-shirts should never be used as a base layer.

Most base layers are made of a synthetic fiber that is quick to dry. Other base layers are made of wool which provides more warmth while still being very efficient at transferring moisture away from your body.

3.2.2 Mid layers

The next layer in the system is a mid layer. Mid layers are often manufactured from fleece and come in a variety of thicknesses. A thinner micro-fleece works

Chapter 3 – Personal management *continued*

well in most conditions and a thicker fleece can go on top of this in cold conditions or when very little activity is expected. There are lighter alternatives to fleece such as synthetically insulated jackets that are a good substitute for a thick fleece. Fleece trousers are a good mid layer for the bottom half.

3.2.3 **Outer layers**

The main function of the outer layer is to protect against wind and water. The specific choice of outer layer will depend on the environment and the activity being undertaken. The standard outer layer for BAS operations is Paramo jacket and sallopettes. In wetter climates a membrane shell, such as a Gore-tex fabric, can be more appropriate and these are provided if based on the sub-Antarctic islands or working in the northern Peninsula. Paramo however is still available for work in the sub-Antarctic and some people prefer it to Gore-tex.

Outer layers need to be roomy enough to allow several layers of inner clothing to be worn underneath and yet still permit easy movement. If the outer layer is too large and loose it will create a billowing effect and cause heat to be lost from the system.

3.2.4 **Insulated top layers**

In extreme cold conditions an additional outer layer may be necessary. Down jackets and sallopettes are provided on some stations. These items are not very robust and need to be treated with care. Hardwearing one-piece snowmobile suits are also available for situations where extra durability is required and weight is not an issue.

3.3 **Extremities**

Your extremities (head, eyes, hands, and feet) are the most vulnerable parts of your body in the polar environment and typically the first areas of your body that will be affected by exposure. The main risks to your extremities come from cold injury and Ultraviolet (UV) radiation.

Cold injury

The extremities are the first areas of your body that will get cold. Your extremities get cold generally because your core temperature is beginning to drop and your body's automatic response to this is to reduce the energy spent heating the less essential parts of your body and focus on maintaining heat to the vital organs.

Non-Freezing Cold Injury (NFCI)

This is one to be particularly aware of as often appears insignificant at first but can result in life-long problems. NFCI is common in feet when they are exposed to damp conditions just above freezing for a prolonged period of time – also known as 'trench-foot'. Ensure boots appropriate to the temperatures are used and dried out properly each night. Changing socks on a regular basis is also important.

Ultraviolet radiation

UV radiation is far higher in the Antarctic than in northern Europe and consequently the eyes and skin need special protection. Sunscreen should be applied frequently to exposed parts – especially the face, neck and ears. Pay special attention to parts that receive reflected UV from snow, such as the nostrils. Eye protection should be worn virtually all the time, even on cloudy days.

3.3.1 **Eyes**

Your eyes are particularly vulnerable in the polar environment and even more so when in the field.

Snow blindness

The main risk to your eyes is from UV radiation, which can cause snow blindness. Snow blindness is effectively sunburn on your eyeballs – it is incredibly painful and in severe cases can cause long-term damage. Even on a cloudy day the UV radiation can be extremely harmful so get used to wearing eye protection all the time! BAS provides category four sunglasses to all staff going into the Polar Regions.

Weather

Blowing ice crystals or even small stones picked up by strong winds can damage your eyes. When outside in the polar environment you should generally always wear some form of eye protection. Both goggles and sunglasses are provided. Clear lensed goggles are also provided for use in poor weather during the winter but these should not be used in the summer. Always carry goggles and sunglasses when out in the field. This way if the weather changes you are prepared and if

you break your sunglasses you have another form of eye protection. Emergency clothing bags are carried for each person going into the field and these contain an additional set of goggles and sunglasses.

Glasses/contact lenses

The polar environment can make life difficult for those that wear glasses or contact lenses. The air is generally very dry and can cause significant irritation for those who wear contacts. If you wear contact lenses it is recommended that you take daily disposables rather than monthly disposables or hard contact lenses. This is primarily due to the difficulties in keeping reusable lenses clean and issues with them drying out. It is advised that you also bring suitable eye drops to keep eyes and lenses moist. There is of course an issue with contact lenses freezing so make sure you try to keep them warm and store them inside your sleeping bag overnight. Make sure you take a large enough supply in case you end up in the field longer than expected or find you need to replace them more than once a day.

If you wear glasses you must bring two pairs in case you break or lose a pair. BAS can arrange prescription sunglasses for those who need them before departing the UK. Contact your Line Manager for more information. Larger-framed goggles can also be provided to fit over the top of glasses.

3.3.2 **Head**

Headgear is issued to protect against the following:

Cold

Up to 30% of the body's heat can be lost through the head so wearing the correct headgear is important. The main types of headgear issued are peaked windproof hats which cover the ears, fabric tubes (head overs) which can be worn as a neck scarf or as a thermal balaclava, fleece balaclavas and neoprene face masks.

Impact

When travelling on a snowmobile a crash helmet must be worn to provide protection in the event of an accident. A helmet also helps to keep the head warm and protect the face from cold injuries. Additionally it can help to reduce engine noise.

UV radiation

Hats also protect against sunburn. A sun hat is a basic and essential item of polar clothing for warm sunny days.

3.3.3 **Hands**

In the field you will almost certainly experience cold hands on some occasions. This can be exacerbated by handling items that conduct the cold or by working with your hands above the height of your heart. Having your hands up high causes the blood to drain out of your finger tips and because gravity is against you it is hard for your heart to pump a warm blood supply back to the ends of your fingers quickly.

Taking care of your hands is obviously extremely important as you rely on them for virtually everything you do. If you feel your fingers becoming cold, take a minute and warm them up. It is much easier and less uncomfortable to sort your hands out before they become really cold. Even if driving on snowmobiles signal to the lead driver to stop so that you can re-warm your hands if required.

The fit of your gloves is crucial to the warmth they provide. Too small and they may cut off circulation causing cold to set in quickly. Too big and your hands will be unable to warm all the air around them and again they will chill down. In addition to this your gloves must be dry in order for them to work effectively. Any moisture will conduct heat away from your hands very quickly. This can be caused by snow or sweat. If your gloves get damp, change into a fresh pair!

A variety of different types and styles of gloves are available to enable you to find a combination that works well for the work you need to do. Mittens are the warmest style of glove as all your fingers sit together and keep each other warm. The down side to mittens is the loss of dexterity.

Always carry a variety of pairs of gloves with you in the field and take spares! In the evenings make sure you hang gloves up to dry in the tent so that they are ready when you need them next.

Remember that your hands often become cold because your core is beginning to cool. Often sticking an extra jacket on results in your hands warming up.

Chapter 3 – Personal management *continued*

Take particular care when handling fuels as spilt fuel causes rapid cooling of skin. Also be careful handling cold objects (not just metal) as skin can stick to them. If this happens you will want to use a warm liquid to detach yourself from the object – pulling your hand away without doing this will result in a loss of skin and discomfort!

3.3.4 **Feet**

Your choice of footwear depends upon climate, conditions expected and any special applications.

BAS provides footwear for all conditions. The following table suggests the best uses for each item of footwear – note that variations may exist within the system and there may be a small selection of footwear available that is not mentioned here.

Whatever footwear you choose to use make sure the fit is right. Before deploying away from station test your footwear out on and around station to make sure they are comfortable. Fit is extremely important for getting the most out of your footwear. Too tight and you will cut off circulation resulting in cold feet, too loose and you won't be as stable on your feet and risk slipping.

When in the field take special care to dry boots out every night. If boots have removable liners, take them

Footwear	Description	Use
Wellies	Wellington boots with protective toecaps	Wet conditions, sub-Antarctic Islands, South Georgia, islands local to Rothera in summer months. Not recommended for long-distance walking
Mukluks	Super-warm boots with removable liner. Variety of brands but Baffin is most common. Also have protective toecaps	Cold conditions, snowmobiling, deep field when not requiring crampons. Mukluks are good to -30°C, warmer models are available that will be suitable in temperatures as low as -50°C
Walking boots	Normal walking boot with flexible sole	For extensive walking use when not continually on snow or ice – crampons can be used with these boots but not all crampons will be compatible, check before leaving station. Sub-Antarctic islands fieldwork, certain areas on Antarctic Peninsula e.g. Mars Oasis, Fossil Bluff
Work boots	Mostly lace-up boots, some have removable liners, most have protective toecaps, and others don't have laces or removable liners	For use on stations as a work boot. For certain tasks, such as moving fuel drums, protective toecaps will be essential. Ensure you have the correct footwear on for the job you are carrying out
Mountaineering boots	Often synthetic double boots double boots with removable liners. Soles are rigid to accommodate crampons	For use on glaciated and mountainous terrain
High altitude mountain boots	Provide the same features as standard mountaineering boots but with additional warmth, often with integrated gaiters	Winter and deep field use. Not to be used extensively on rock as soles wear away quickly. Some models have foam soles instead of rubber; these soles are only suitable for situations when crampons will be worn at all times, they provide more warmth but less grip and less durability

out and hang them in the apex of the tent to dry, or in station boot rooms if only in the field for a day. Always store footwear inside the tent. Putting on damp or frozen footwear significantly increases your chances of getting a cold injury such as frostbite or a Non-Freezing Cold Injury (NFCI).

3.4 **Work clothing vs. field clothing**

Generally speaking, deep field clothing should be reserved for such use. Items such as Paramo jackets should not be used as an everyday jacket while on stations. Deep field clothing tends to be more expensive and designed with specific needs in mind, often resulting in reduced durability than other items of clothing.

Specific work clothing is issued or made available on station for jobs that do not require the features of field clothing.

As with most things there are grey areas when deep field clothing may be required for a work task on station. For example during the winter it may be necessary to use deep field gloves for some routine tasks such as refuelling. If temperatures are particularly low, the most appropriate gloves may very well be deep field ones. In this situation the priority is your safety and comfort rather than looking after expensive kit, but endeavor to use an older already worn item of field clothing before using brand new items.

The bottom line is... use the most appropriate clothing for the task you are carrying out. Clothing is provided to keep you safe and comfortable. If in any doubt as to the best item of clothing for your needs speak to a Field Guide or a member of station management. If on a station with no Field Guides you can phone the Field Guide office at Rothera for advice.

3.5 **General clothing points**

Sunglasses, goggles, balaclava and mittens should always be carried. Antarctic weather can change rapidly, and clothing is the first defense against it. On all field trips (even a one-day trip) carry some spare clothing, especially gloves, socks, goggles and a balaclava. Emergency clothing bags are part of the standard field kit for field travel but should not be relied upon for spare clothing. It is not uncommon that you will end up in the field for longer than expected. Take enough spares and be prepared for this.

Clothing should be kept clean and in good repair. Clean clothing is thermally more efficient than dirty clothing. It is important to try and avoid contaminating clothes with fuel. Additionally, clothing must be clean and inspected prior to use in the field for biosecurity reasons.

Use the buddy system to ensure your working partners are not suffering from cold injury. Check for frostnip on the face when outside in cold temperatures, especially if there is a breeze or when travelling on snowmobiles.

Some special items of clothing such as down suits and over-boots are not issued as standard. These items are made available through the clothing stores on the stations where necessary. Other items of specialist clothing may be supplied when identified as necessary at the project planning stage.

Personal 'admin' is key in the field – continually monitor how you are feeling and don't be afraid to stop and take a minute to change your clothing layers etc. if you are not comfortable. This will ultimately save a lot of time and hassle compared with ignoring an issue and ending up with a serious injury.

Operating safely and efficiently in the Polar Regions takes time to master. Don't get complacent as even the most experienced people can get caught out. Comfort in extreme environments comes down to a huge number of variables, the foundation of which is ensuring you are well fed, rested and using kit appropriately.

3.6 **Hygiene and health**

Staying clean in the field is very important, it helps prevent infection, food poisoning and improves general wellbeing and happiness.

Hygiene is an often overlooked but important topic. Each situation and amount of time spent in the field is different for everyone, so individual routines will differ. The longer the time spent in the field the more important hygiene will be to manage. Care and consideration should always be given to fellow colleagues, with frank discussions around this topic when needed. This will hopefully make field living a

Chapter 3 – Personal management *continued*

little more comfortable for everyone. Below are some important points and issues to be considered.

3.6.1 **Toileting**

BAS policy is for all solid human waste to be removed from the field and incinerated back on station.

Plastic UN-approved kegs are used for solids. These kegs, more commonly known at BAS as poo bins, should be double lined with a plastic bag so that the waste can be removed at the point of incineration. Care should be taken to avoid urinating in the bins as this takes up space and weight, as well as making them more difficult to incinerate back on station. A certain degree of management is required when using the bins for waste. Buckets should be given a gentle shake after each use to level the waste; failure to do this leads to more bins than necessary being used as the centre fills up. A small amount of baby powder or talc can be applied after each use which helps reduce the smell. Once a bin is full the bag must be tied, and the lid sealed. Disposable gloves are available for this task. It is a good idea to have a plentiful supply of hand gel inside the toilet tent.

It is acceptable to urinate in the snow but be mindful of areas that are visited frequently. Use a flag to mark a 'pee spot' and leave it in place when you depart if others will be there in the near future.

Toilet tents make the whole process a lot more civilised! Modified pup tents make a perfect toilet shelter for travelling projects while an old pyramid works well for larger static camps. Consider the needs of those in the field party and if required a pee trench can be dug inside larger toilet tents if needed. A pee bottle can be used inside the toilet tent for increased privacy then disposed of at the pee flag. They can also be used inside a pyramid tent at night or during a storm. For women, a pee funnel will make this a much easier task. Be mindful to keep the bottle warm when full as it will freeze if left out in the cold.

It is vital that you wash your hands properly after going to the toilet. Alcohol gel is useful, as are wet wipes.

When working in the coastal areas, particularly in the sub-Antarctic, go to the toilet below the tide line – bins are not always necessary for removing waste in this context. Refer to the project Environmental Impact Assessment for specific guidance.

3.6.2 **Washing in the field**

There is usually no shortage of water in the Polar Regions; you may just have to melt it first! A good wash once a week does wonders for morale as well as being hygienic. Privacy can be difficult to find around camp, it is best discussed within the team to find a space for this, some examples could be tents used at dedicated times or snow walls built on day trips. Water washing is ideal, using a bowl of warm water with soap and flannel, however wet wipes can be a good alternative. Take the time to wash regularly while on a long field season.

The largest types of field camps that BAS operates, such as Sky Blu, Fossil Bluff, the tractor traverse etc., often have enough space for privacy and the ability to create warm water easily. This means washing and keeping clean is reasonably straightforward. Hand pump showers and washing bowls are also available for these places. Staff that are stationed at these camps will give further information of the exact facilities available.

Medium-sized static field camps will have a minimum of one toilet tent and potentially an array of work tents in varying sizes. These can potentially be used for privacy; however, they are not heated and could have equipment inside. Communication between team members is key before using these areas. Washing outside on a calm sunny day is manageable but be mindful of others around camp.

Small field camps and travelling camps will usually have a designated toilet tent which allows a small private space. In these scenarios a modified Pup tent is used, and a pit is dug inside to allow for stooped standing space. Alternatively, the living pyramid can be used. Wet wipes are invaluable in these situations, but it is possible for a small pan of hot water to be made for a flannel Nalgene wash.

3.6.3 **Women's health in the field**

Many challenges exist for women living and working in the field. It is important that all colleagues, male and female, are aware of these challenges to work together well and be mindful of others. It is important to discuss this topic openly and honestly to help avoid embarrassment or anxiety on either side. There are usually simple solutions to addressing some of the challenges, for example at the beginning of the day

or upon arrival at a camp pointing out opportunities and places where some privacy might be sought. This can help reduce anxiety and potential embarrassment.

All women are provided with a pee funnel in their BAS kit bag, which makes peeing in the field a much easier task. They can be used at pee flags, in the toilet tent or in a pyramid tent during the night or in a storm. Although easy to use, practicing first is essential, especially with field clothing and layering. A top tip is to kneel when using in a tent.

Having a period in the field can be very challenging, PMS and cramps can sometimes be debilitating, finding private changing spaces can be difficult as well as keeping clean. PMS symptoms can include severe cramps, fatigue, insomnia, depression, and mood swings. Symptoms can be pre and during a menstrual cycle and can last for several days.

A period waste kit is available from BAS clothing, which is a small outer dry bag with some sealable plastic bags inside, allowing waste to be stored easily and discreetly. At least two types of period products such as sanitary towels and tampons should be carried, this allows for backup in case of infection. Enough supplies should be carried for the full time expected to be spent in the field plus plenty extra to cover for any extra time or delays returning to base. On shorter trips from a day to a week, period products should be carried even if one is not expected, the Antarctic environment can sometimes play havoc with a menstrual cycle. It's also a good idea that other team members carry a small emergency period kit with them too, as a day trip from station can last up to a week or more in the field.

Caution: TSS (Toxic Shock Syndrome) is a rare condition that can be life-threatening, caused by toxins produced by bacteria. Symptoms can include; high temperature, flu-like symptoms, vomiting, diarrhea, rash and muscle pain. If you suspect it – seek medical help immediately.

Menstrual cups are becoming more popular; however, they usually require running water to clean after each use and sterilising in between periods. Sterilisation pots can be purchased easily, but thought should be given on how to clean between uses with no running water. Period pants are another popular period product, however these can be difficult to change on day trips with no facilities or changing space and washing facilities can also be limited.

All menstrual waste should be emptied into the camps poo bin, this includes menstrual cup waste which can also be disposed of at pee flags.

Menopause is something that all women go through and usually occurs anytime between the ages of 40 to 60 years old. Symptoms can be very challenging, sometimes debilitating, last for years and change or evolve over time. These can include irregular periods, sleep disturbance, mood changes, brain fog, memory loss, hot flushes, aches/pains, anxiety, depression, migraines, sleep disturbance, loss of bone density and frequent UTIs.

3.6.4 **Physical health issues**

A minor ailment in the field can quickly develop into something more serious. If you have hurt yourself or start to feel unwell it is important that you communicate this to the rest of your team. It may be that a few days of light duties are enough for you to recover and prevent an illness or injury from developing any further.

All Field staff are trained in first aid and a comprehensive medical kit is carried by field parties. A doctor can be contacted via satellite phone or by request over HF radio. If in doubt about a medical related problem, consult the doctor.

Bear in mind that help can sometimes be days or even weeks away if bad weather prevents an aircraft or boat from getting to your location.

For further information on health in the field see the station doctor.

3.6.5 **Mental health**

Staying physically well in the field is essential, and your mental wellbeing is just as important for maintaining overall health and positive wellbeing. Preparing for good mental wellbeing in the field can start before you leave. You could begin by thinking about the conditions you might face and the possible challenges of those conditions; you can start the process of developing a personal tool kit of strategies to help look after your mental health and practice these before you leave (you can also do this once you're

Chapter 3 – Personal management *continued*

in the field and may need to adapt them when in the field). When deployed, it can be helpful to develop a daily routine, as this can help keep you grounded and provide a sense of normality in your day-to-day. Mindset is also important; remember to celebrate the small wins and the big ones, whether individual or team achievements.

Periods of rest and recovery are essential for maintaining mental resilience and wellbeing. Think about your sleep habits and lie up needs. Pack some earplugs, headphones and books to allow yourself to get a good rest. When sharing sleeping spaces, be considerate of others, it can also be helpful to discuss and set any ground rules for the shared space. Where possible, build a reasonable schedule that includes rest periods or days. Learn to notice when you are starting to feel tired and communicate with others when you need to rest to avoid fatigue. Rest is essential for maintaining physical and mental resilience and minimising accidents.

If it is your first time in the field or you are going to a new location, speak to your colleagues who have been before and ask them any questions or for any tips they have. This can help you mentally prepare for what to expect but also can help alleviate any nervousness you might be feeling about the trip. Your teammates can also be a good source of support; having someone to talk to about challenges can relieve stress and loneliness. There is a range of wellbeing support available to staff. With improved access to the internet at certain field sites, staff can now stay in contact more easily with family and friends and access support services such as the BAS Mental Health First Aiders for in-the-moment resources and support. Contact information is available on the Safety Together Card shared in your PDT pack or on the Ice Flow health and wellbeing pages.

3.7 **Communal living and team dynamics**

Living in the field is hard work mentally, physically and emotionally, being away from loved ones, potentially over the festive period or other significant events happening in individuals' lives, mixed with physical effort required for the environment. Many scientific personnel are personally invested, having potentially prepared for years leading up to the field season. These stresses can put strain on individuals in different ways, it is important to remember that everyone copes with this differently.

Working in a close-knit team, for many weeks at a time can be very isolating. Creating a platform for communication across the team can allow for frustrations and concerns to be raised in a productive way. Whatever the size of the team, creating time for meetings about goals, procedures and problems can be useful, allowing for all involved to be on the same page and feel confident in the tasks. These can either be run by the Scientists or the Field guide on the project depending on the topics at hand. Whoever leads these meetings should remember the BAS culture of respect and allow for multiple ways to communicate within a group.

Creating this discussion can be important in small teams and in some cases makes the difference between a successful season and not.

If individuals need to communicate while out in the field, Iridium phones are available for operational use but can also be used for modest personal use (see Chapter 11 – Communications). If outside help is required Line Managers can be contacted privately via this, along with the doctor for other issues.

Be mindful of others that require private space.

Chapter 4 – Risk management and hazards

4.1 **Introduction**

Risk management is hugely important when operating in the Polar Regions. Besides the obvious environmental hazards there are many other dangers that are hard to predict or control. This Chapter briefly outlines the hazards that exist in the BAS operational area.

Comprehensive training and clear briefings of the relevant risks, along with common sense, knowledge and experience dramatically reduce the threat from such hazards.

For further information on any medical-related injuries discussed in this consult the doctor on station.

4.2 **Heuristic traps**

Heuristics are the shortcuts humans use to make decisions quickly in certain situations. They are used in day-to-day life to streamline mundane tasks that would otherwise use vast amounts of mental bandwidth. However, they have an ability to become a 'trap' when we try to use them to take mental shortcuts in the polar environment. These shortcuts which allow the brain to 'snap' to a decision or conclusion can create hazards otherwise known as heuristic traps.

This chapter will break down the common heuristic traps, give explanations and give examples in context for BAS operations and fieldwork.

4.2.1 **Heuristics**

Each of the following is an individual issue common with poor decision making. If not thought through, the following issues can lead to major problems.

Familiarity

Engaging in an activity believing it is correct due to it being known to us (familiar), having already undertaken it previously. It creates an illusion of security and safety using the knowledge 'it was ok last time'.

Conformity

This can be thought of as herd mentality; following is easier than leading. Following others into a situation without speaking up can subsequently lead to situations that are uncomfortable and unsafe.

Commitment

Once an initial decision is made to start, it is hard to alter the original decision based on external factors. This need to remain consistent with the original decision can potentially lead to disaster. Just because one decision was correct does not mean the following ones are.

Expert halo

Believing one person is in control of all the decisions, making the whole team look to them for answers. As the 'expert' they then feel pressured into making these decisions, despite potentially not having the knowledge, equipment, or skills to deal with them.

Social proof

Starting an activity because there is evidence it has been done before, without fully understanding the details and risks at play. Just because there is evidence of people doing an activity before you does not immediately make it safe.

Scarcity

Valuing recourses or opportunities more highly as they are rare and hard to achieve. This subsequently leads to pushing decisions through where they would not usually occur due to the nature of the rare situation.

4.2.2 **Heuristic examples**

Below are some examples of the above and how they fit with field operations. Procedures are in place to try and prevent these situations from happening, but individuals are responsible for their actions. Procedure is there to keep employees safe, but an understanding of the human factors in the polar environment is important.

Familiarity

Being familiar with the environment from previous/ continued exposure creating a level of comfort.

Example – Known routes or areas are flagged and therefore making decisions to travel along these routes despite conditions.

Example – Not taking a second pair of gloves as 'you've never needed them before'.

Chapter 4 – Risk management and hazards *continued*

Conformity

Agreeing to undertake a task due to wanting to be socially accepted, despite thinking it is too dangerous. Subsequently being involved in a major incident.

Example – Recreational skiing off station but nobody mentioned the weather and you know it is set to get worse; you don't feel comfortable speaking up, but you don't want to miss out. Two people then go missing in the poor weather and are reported missing. Rescue efforts are needed to retrieve them.

Commitment

Decisions to push on are often discussed about and agreed as a team. After this it is hard to alter that decision without conscious effort.

Example – 'We said we would limp the broken ski-doo back. So, we should push on even though it's broken down again. It'll be fine we can manage it, even if we get home way later than planned'.

Expert halo

Often working in small teams you are the only specialist in the group. This creates an expert halo unless we are open to the group about our failings.

Example – A co-pilot arrives at Fossil Bluff for the night having never been there before. The staff based there are looked at for the travel limit but provide inaccurate information. This leads to the co-pilot being in an area that is unsafe as they expected the advice given to be correct.

Social proof

Seeing tracks leading outside the flag line and deeming it safe to follow as people have been there already.

Example – A team of two Field Guides roped together leave the flag line walking over a crevasse, leaving behind nothing but footprints. A third person comes along, sees the footprints, and decides to follow. They then subsequently fall into the crevasse.

Scarcity

Science objectives are often years in the planning, this can lead to decisions being pushed through to benefit the project that would not otherwise be made.

Example – 'We only have one day left, we MUST get X, Y & Z done today'. Despite only completing two tasks on all the previous days out, the team stretches thin to achieve an unrealistic goal which leads to fatigue and cold injury.

4.3 **Human error**

Mistakes caused by a lack of concentration or communication, rushing, fatigue and stress are all factors on staff than can cause human error. In the polar environment, a small mistake could have a significant consequence. Ensuring all staff in the field are well informed, rested and fuelled has a significant impact on reducing the risk of these issues creeping into a field season.

4.4 **Risk of minor injury**

A minor injury in the field such as a cut, sprain or broken bone, or any other injury caused by any one of the hazards discussed in this chapter, would be considered a serious incident. Minor injuries in the polar environment can quickly escalate to major problems. Conducting operations in a conservative manor means the risk of these minor injuries are reduced, further reducing the need for a major response. The cold is a major hazard and compounds injuries into life-threatening scenarios.

BAS field operations run on an 80:20 model. Only operating on 20% and saving 80% in reserve for unplanned situations. This allows room for problems to be dealt with in an effective and safe way without overstretching or allowing cold injuries or other issues to creep in.

Should an evacuation be needed, this could take from hours to days to weeks depending on how far from station the incident occurs. These timescales all require long-term care of a casualty meaning a small injury can quickly become life threatening in the polar environment.

4.5 **Cold injuries**

Cold temperatures are common in the Polar Regions and pose a serious risk to people. It is however an easy hazard to manage providing the right equipment is available and used properly.

4.5.1 **Frostnip**

Frostnip is the first stage of frostbite and can occur very quickly when skin is exposed to severe cold. A light wind is enough to speed up the development of frostnip and should be guarded against. Any exposed skin is at a much higher risk of becoming frostnipped but covered areas can also be affected.

The first signs of frostnip are pins-and-needles, throbbing and aching of the affected area. Frostnipped skin will go white with a waxy appearance.

Keep an eye out for these signs on others while operating in cold conditions in the field. If you notice that you or someone else in the group has signs of frostnip it is important to cover up the affected area. It can sometimes be enough to put on a balaclava or facemask.

To prevent against frostnip make sure you have no skin exposed to the wind. Wear facemasks, neck gaiters and goggles when required. If you or someone else gets frostnip don't panic, if dealt with properly it should clear up in a very short space of time and leave no long-term damage. Be aware of a cold sensation in any of your extremities and do something about it! Cold or damp footwear/gloves speeds up the development of a cold injury like frostnip so always dry your clothing and change items if they become damp.

4.5.2 **Frostbite**

If left alone frostnip will develop into frostbite. This is far more serious and can cause lasting damage. The initial stage of frostbite after frostnip causes proper tissue damage. The affected area will feel hard and frozen. Skin may blister and swell and may become itchy. This stage is known as superficial frostbite and only affects the top layers of skin. Effective treatment is required to prevent lasting damage and this treatment begins with getting into some shelter immediately!

If left untreated the frostbite will advance into a more severe form. Skin will become white, blue and black in appearance and will feel cold to the touch. This is very serious and damage will extend deeper into the tissue, affecting muscles, tendons, nerves and even the bones. At this stage the tissue is beginning to die and immediate medical attention is required. In extreme cases this tissue may need removing or amputation.

4.5.3 **Non-Freezing Cold Injury (NFCI)**

This is one to be particularly aware of as it often appears insignificant at first but can result in life-long problems. NFCI is common in feet when they are exposed to damp conditions just above freezing for a prolonged period of time – also known as 'trench-foot'. Ensure boots appropriate to the temperatures are used and dried out properly each night. Changing socks on a regular basis is also important. If you think you have an issue with your feet then make the rest of the team aware – do not ignore it! If identified and sorted quickly this issue will completely resolve, if not it can lead to long-term nerve damage and constant pain/discomfort.

4.5.4 **Hypothermia**

Normal body temperature is around 37°C, when this drops below 35°C you become hypothermic. This condition can quickly become life threatening and needs to be treated immediately.

Main causes of heat loss that can lead to hypothermia:

- *Convection* – chiefly through wind chill
- *Conduction* – direct contact with cold from wet clothing or snow
- *Radiation* – losing heat through moisture evaporation from skin and breathing
- *Exhaustion* – body becomes unable to produce energy to maintain warmth
- *Injury* – an additional complication as a result of an incapacitating injury

To prevent hypothermia it is important that you keep yourself warm! Keep moving when possible (on a long ski-doo journey make regular stops at agreed intervals and get off the ski-doo to get your muscles moving. If you are getting cold don't wait until an agreed stop – signal to the lead driver and stop as soon as it's safe to do so). Keeping yourself well fed and hydrated is also important to maintaining warmth, as is going to the toilet regularly!

Signs of hypothermia:

- Shivering
- Sensation of cold and tiredness
- Clumsiness
- Disorientation
- Slurred speech

When managing a group in a cold environment you must all work as a team. If you notice anyone displaying any signs of hypothermia do something about it and do it quickly! If you yourself start to feel cold do something about it before it gets as far as hypothermia. Hypothermia affects the brain so once

Chapter 4 – Risk management and hazards *continued*

it sets in, it is hard for an individual to recognise it in themselves.

If someone in the group shows signs of hypothermia the basic actions are to prevent further heat loss. Get the casualty into some form of shelter as quickly as possible and remove any damp or wet clothing.

For more details on how to treat someone with suspected hypothermia contact the station doctor.

4.6 **UV-related injuries**

Although operating in a cold environment, heat and UV radiation from the Sun also poses a great risk. The ozone layer in our atmosphere is particularly weak at the poles so UV radiation is even stronger. In addition to this a snow-covered surface will reflect UV radiation, increasing its affects.

4.6.1 **Sunburn**

Sunburn can be incredibly painful and will occur when working in the field if you are not careful. Each person should carry a bottle of sunscreen on their person and apply it regularly (sunscreen will freeze so keep it in a pocket close to your body). A minimum of factor 30 should be used but factor 50 is strongly advised. In the cold your face and neck are often the only areas of exposed skin but do not neglect hands and arms if clothing is removed. Lips can be badly damaged in cold, dry and sunny conditions so remember to use lip screen with UV protection. Primary healthcare modules all contain additional supplies of sunscreen. Make sure you apply sunscreen regularly even on cloudy days as UV radiation will still penetrate.

> Caution: Sunscreen goes out of date; ensure the bottle you are using is still in date!
>
> Factor 50 is strongly advised for field use in the Polar Regions.

4.6.2 **Snow blindness**

In simple terms snow blindness is sunburn to your eyeball! It is extremely uncomfortable and best avoided at all costs. Category three or four sunglasses that fit snuggly around your eyes with no gaps are essential for fieldwork and should be worn virtually all of the time. Get used to your sunglasses being one of the first things you put on in the morning. Snow goggles with UV protective lenses are also suitable and should be carried as a back-up/for use in poor weather. Don't be fooled into thinking that you won't get snow blindness on a cloudy day; almost 80% UV can pass through cloud.

4.7 **Fatigue**

Exhaustion is a serious issue in the field and needs to be guarded against. Particular attention should be paid to all members of a group with regards to energy levels. A day in the field should be structured to allow plenty of time for food and drink breaks. Encouraging everyone to keep some snacks accessible in a jacket pocket helps. Everyone needs to take some responsibility for this themselves and ensure you get the necessary calories to fuel your body. If you feel tired and a bit weaker than normal then make the time to stop and take on some fuel!

4.8 **Exposure**

Being out in the elements is a risk which is amplified if immobile or injured. Having no protection to the harsh elements puts individuals at risk of exhaustion, hypothermia, and other cold injuries. This is usually managed by using the correct clothing and equipment, continued movement, eating and drinking, and taking appropriate shelter.

However, if an individual is unable to do the above to keep themselves warm this will lead to problems. Having the correct equipment on hand will greatly reduce the risk posed due to exposure (See Section 3.2 – The layering system and Section 5.2 – Rucksack contents).

4.9 **Snow conditions**

In the Polar Regions snow can take a variety of forms that each present different challenges and risks. Being aware of the different snow conditions you are likely to encounter and accepting that a different approach to travel may be necessary depending on conditions is half the battle. Plan ahead and think about the effect that poor surfaces will have on your operations. Don't be afraid to alter your plans if conditions dictate.

4.9.1 **Sastrugi**

Sastrugi are parallel ridges of hard snow caused by the wind. Sastrugi can vary from a few centimetres in height to serious obstacles as large as two metres from trough to crest! Sastrugi can often be as hard as concrete and can easily tip a sledge and/or snowmobile. Where possible it is easier to travel with the lines of sastrugi but often this is not practical. If you have to cross sastrugi perpendicularly then adjust your speed according to its size.

4.9.2 **Soft snow**

Soft, deep snow is a huge challenge when it comes to moving around in the Polar Regions. The presence of a large fall of fresh snow presents risks as it can cover up hazards such as crevasses, enough so that you cannot see them but not enough that they are always safe to cross! In addition to this, soft snow is slow to travel in by any means of overland transport. Snowmobiles often struggle with deep snow and can overheat easily if the volume of snow covers the exhaust. Expect any journey to take a lot longer in soft snow and make regular stops to allow vehicles a chance to cool down.

Soft snow creates additional hazards for aircraft as they can struggle to pick up enough speed to take off. If expecting an aircraft at your location after a heavy fall of snow try to compact the surface by driving up and down on a snowmobile (towing a fully loaded siglin sledge can help too).

Camping in soft snow is another challenge that you will experience. Tents are not as secure when pitched on top of a large quantity of powder snow. Do your best to dig down to a hard layer before pitching. If this is not possible then monitor the tent closely. When winds pick up soft snow is easily scoured and could potentially leave your tent exposed on a pedestal (see Chapter 6 – Camp management for more info).

4.9.3 **Surface ice**

Blue ice areas are challenging as vehicles and people get very little traction when moving around. Some snowmobiles are fitted with metal studs on the track (ice cleats) to help with this problem. Be aware that even with ice cleats a snowmobile will not be able to tow a heavy sledge across blue ice, especially if there is any incline. If a snowmobile loses traction part way up a slope it can slide back down and get out of control very quickly with potentially very serious consequences. Blue ice is generally caused by strong winds scouring away snow on a glacier to leave a hard polished surface. The presence of blue ice suggests that you are in an area that regularly experiences strong winds!

4.9.4 **Wet conditions**

In areas closer to the coast, wet conditions can be common during the summer months. Wet snow can be hazardous for travel and also uncomfortable for living in. Clothing and equipment often gets wet in such conditions and can be hard to dry. Vehicles can struggle to get traction on wet, slushy snow and the going can be slow. In some cases melt pools form on the surface of the snow and need to be avoided.

4.10 **Crevasses**

4.10.1 **Travelling on glaciers**

Crevasses are a constant threat on glaciers and present a serious danger when operating in the field. The skills necessary to travel safely on glaciers can only be learnt through time and experience.

Where the risk of crevassing exists it is essential that all party members are roped together, have the correct equipment and are fully versed in rescue techniques. This applies whether travelling on foot or snowmobile – unroped travel on glaciers requires the specific approval of the FOM – for more information on glacier travel see Chapters 13 and 14.

Glaciers move – just because someone has reported safe passage with no sign of crevasses do not get complacent. Always keep a look out for crevassing and travel in good contrast and good visibility.

Crevasse bridges can be appreciably weaker in the late afternoon after the sun has warmed the snow. Travelling at night may be preferable in some locations. They are usually at their strongest at the end of winter due to maximum snow cover and cold temperatures.

The threat from crevasses is not exclusive to travel and is present whenever in glaciated terrain. For example, arriving at a field site by aircraft can be particularly hazardous, as often people will step out

Chapter 4 – Risk management and hazards *continued*

unroped. Before a field landing ask the pilot to circle the site and look out for any evidence of crevassing – if in doubt one person should attach themselves to the aircraft via a climbing rope and investigate the area around the plane using an avalanche probe. It is possible that a plane could land and not expose a crevasse but the concentrated pressure from a person's foot could open something up – never become complacent!

4.10.2 **Crevasse exploration**

It is common to explore crevasses from a recreational point of view and occasionally for scientific purposes. This practice has many associated risks and needs to be managed accordingly.

Not all crevasses are suitable for exploration. Crevasses also shift under the weight of the glacier with gravity so although at one point a crevasse may have been explored safely it needs to be re-assessed each time a visit is made.

The greatest danger in entering a crevasse comes in the form of falling lumps of snow and ice. This can be from bridge collapse, icicles attached to the underside of the bridge, or from cornice collapse. Exploring crevasses on particularly warm days is not advised. Avoid entering a crevasse with a bridge as it is often difficult to assess its stability.

Risk assessing a crevasse can be a complicated process and often there will be risks that cannot be fully tested. Always err on the side of caution and if in any doubt as to the safety and suitability of the crevasse do not continue!

Steps to assessing a crevasse:

- Before entering a crevasse, you should first inspect the edge by setting up a solid anchor a good distance back from the crevasse you intend to enter – be aware that there may be other hidden crevasses in the area!
- Attach yourself securely to the rope (make sure there are knots in the end of the rope) with abseil device and back-up and move towards the edge. Always keep the minimum possible amount of slack in the system in case you misjudge where the edge is
- As you near the edge expect there to be a cornice if the crevasse is open. Get yourself low to the ground and use a probe to find the edge of the solid ground
- Once the edge has been located use an ice axe or a shovel to dig away the cornice
- Protect the edge with a spare axe or rucksack and then descend over the lip
- Do not descend all the way at first. Now that you are inside the crevasse and have a better view stop and take the opportunity to assess the other risks: is it a free hanging abseil? Will the group all be able to ascend back out? How wide is the crevasse? Are there more areas of cornice that could collapse? Is there a floor to the crevasse? Is that floor a false floor?
- Once you have assessed the above, continue down to the floor of the crevasse to finish your risk assessment. You can now ascend back to the surface with the knowledge of whether exploration of this particular crevasse is safe

4.11 **Steep ground**

Steep ground is inherently risky due to the potential for a slip or a fall. Manage the risk appropriately taking into account conditions and the ability of the group. Do not be afraid to use a rope to keep the group safe on steep ground where the consequence of a fall could be serious. Be aware of the risk from both below (a fall) and from above (rock, snow fall).

Other factors will influence the safety of steep ground, for example is it windy? Is the scientist trying to carry out some work? Are you carrying heavy rucksacks? Consider each situation individually and make safety the priority.

4.12 **Avalanches**

When operating on, above, below or near a snow slope, avalanches are always hazards that need to be considered and managed. Any slope with snow on it is at risk of avalanching. Having a detailed knowledge of past and present weather influences along with the ability to assess the terrain being crossed is the foundation of managing avalanche risk.

It is beyond the scope of this manual to delve into the topic of understanding avalanches and assessing terrain and snow, but there are some great resources

available – for example 'Staying alive in Avalanche Terrain' by Bruce Tremper. This book is considered the best text for the topic of avalanches and, although written from a North American perspective, the principles within are easily transferred to the polar environment. A certain level of avalanche knowledge and expertise is expected of BAS Field guides.

4.12.1 **Avalanche risk assessment**

To assess the avalanche risk there are three core elements we need to consider: terrain, weather and snowpack. In addition to these three factors there is also the human influence – that is the people in the group. These four factors make up the foundation of avalanche risk assessment. **I**

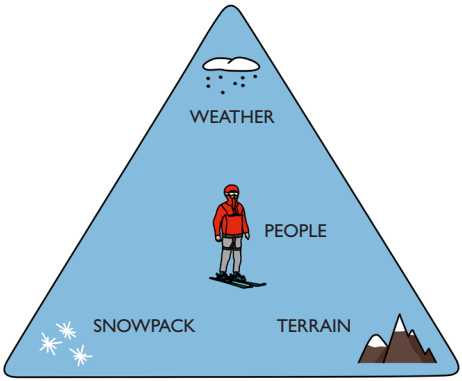


Figure 1 – Avalanche triangle

Note: Make sure the people in your party are aware of the risks and included in the decision-making process throughout the day.

4.12.2 **Planning and avoidance**

The best way to avoid an avalanche is to turn around if there is any doubt. Avalanche rescue equipment should be carried at all times along with the knowledge of how to use it. However, this should be a last resort and hopefully not needed. Avoidance and good decision making are the main defences against being caught out by an avalanche while operating in the field. When planning access to sites or days out, try to use appropriate safer options such as ridges or wind scoured slopes, and avoid open slopes and terrain traps where possible.

Be flexible with plans while out during the day and be aware of the weather and underfoot snow changes. Using these observations, combined with looking out for the red flags listed below during the day, are good starting points to avoid being in an avalanche. Further training will be given to staff on station – See Chapter 2 – Training.

Red flags: Recent avalanche activity in the area, snow cracking or collapsing underfoot (whoomphing), winds moving snow, heavy snowfall, rapidly rising temperatures, cornices.

4.12.3 **Avalanche terrain**

Most avalanches occur on slopes between 30° and 45° This is because less steep slopes don't produce a big enough gravitational pull for an avalanche to occur, and steeper slopes tend to have frequent small sluffs of snow which prevent large quantities of unstable snow from building up – this is a generalisation however, and sizable avalanches can, and often do, occur on slopes below 30° and above 45°!

Other areas that increase avalanche risk include convex slopes, leeward slopes, areas under steep slopes, run out zones, terrain traps and areas of snow on top of slick surfaces (Large grass slopes, slabs of rock, ice etc.).

4.12.4 **Precautions for potential avalanche terrain**

Warning: All party members should wear avalanche transceivers and know how to use them. Each party member should also carry a shovel and a probe.

- If you suspect there is a risk, find an alternative route

Chapter 4 – Risk management and hazards *continued*

- Study the terrain and consider the weather history
- Be wary after new falls of snow, wind deposited snow, thaw, rain etc.
- Keep clear of lee slopes and corniced slopes
- Keep high on the slope or on the ridges to avoid being the trigger
- Ascend or descend a doubtful slope directly as traverse lines can trigger avalanches
- Stick to buttresses and ridges and avoid gullys and bowls
- Consider belaying your partner if a suspect slope has to be crossed
- Be on the lookout for warning signs such as cracking of snow, snowballing either by the action of sun or wind, a hollow sound or feeling to the snow and the collapse of the crust under your weight. The most reliable clue will be evidence of previous avalanches. However, yours may be the first
- Avoid dubious slopes above hollows and depressions (terrain traps). The snow from an avalanche would accumulate to a much greater depth than if it was strewn across an open slope

4.12.5 **Avalanche searches**

In the event of someone being caught and buried in an avalanche, a fast response search is vital to maximise the chances of the victim surviving. The chances of survival for a buried avalanche victim drastically decrease beyond 15 minutes. **2**

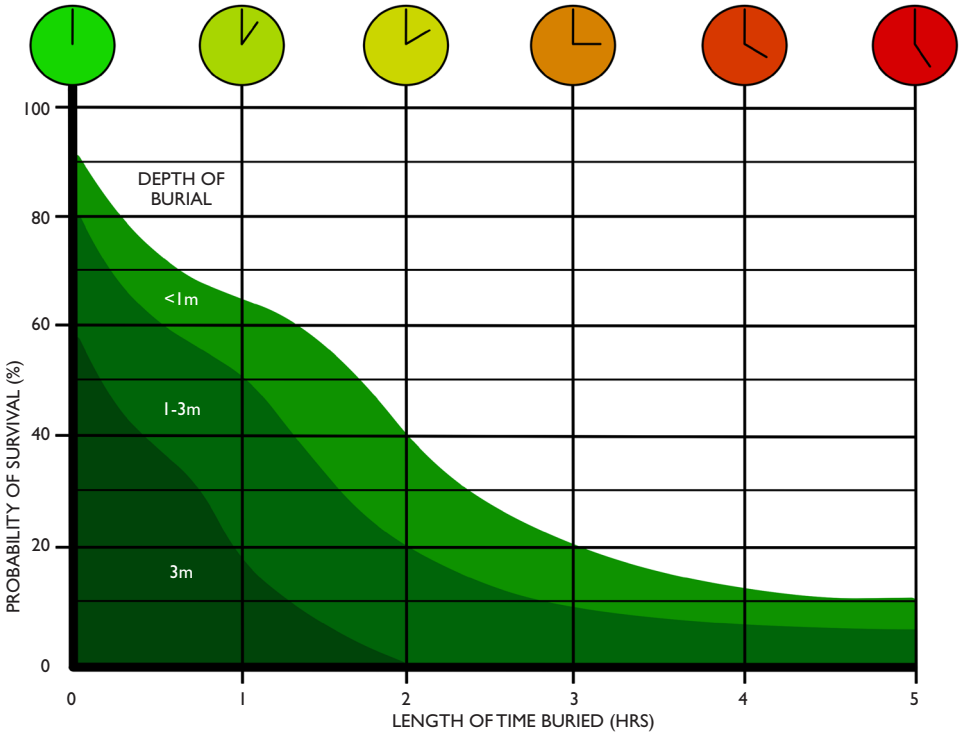


Figure 2 – Avalanche survival graph

To locate and dig out a buried avalanche victim in less than 15 minutes, a structured system for searching is required. An avalanche transceiver, lightweight shovel and probe should be carried by everyone to enable this swift rescue. Knowledge of how to use these items is essential and further training will be given on station on the use of avalanche equipment for staff that are required to use such items. See Chapter 2 – Training for further information.

> Caution: If in any doubt over the stability of a slope, avoid it!

4.13 **Cornices**

Cornices are overhanging lips of snow that build up on the leeward edge of ridges, summits and plateaus. They are often present at the lip of wind scoops. Cornice collapse can be unpredictable and they must always be treated with caution.

Cornices present two main dangers:

- Falling through them
- Being hit by a collapse when underneath. A collapsing cornice can also trigger avalanches in certain conditions

From above cornices can be difficult to see, especially in flat light with poor contrast. On reaching a summit or travelling close to the edge of a ridge or plateau be wary of their presence. The fracture line can be metres back from the edge.

Only one person at a time should approach an edge. In many circumstances the risk of approaching a badly corniced edge is unacceptable. If you need to check the edge for a descent route for example use a rope to safeguard your inspection.

From beneath, the danger exists that a breaking cornice could trigger an avalanche or the cornice itself could be large enough to injure anyone in its path. Cornices can also hold large icicles, which can become lethal projectiles.

Avoid working underneath cornices, especially in terrain traps such as gullies that can channel falling debris. **3**

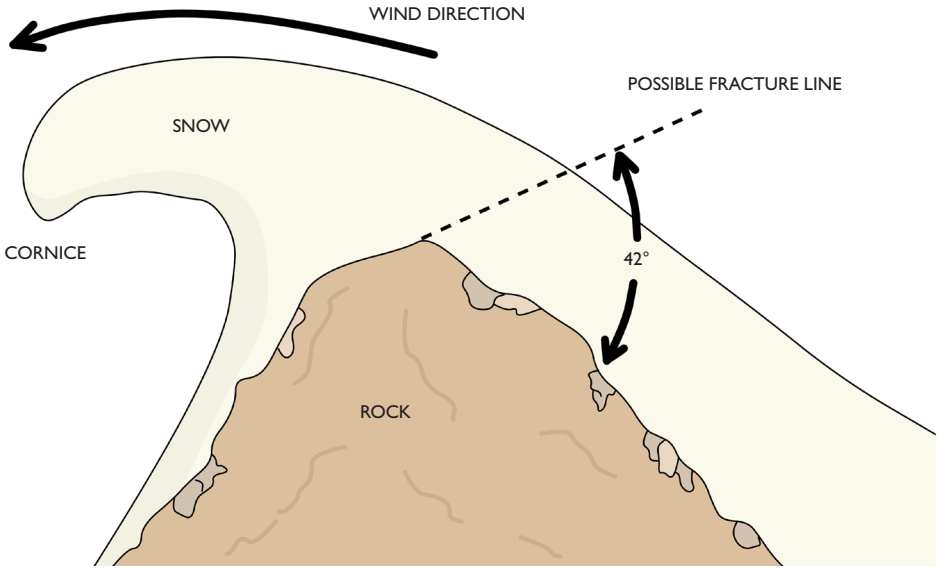


Figure 3 – Cornice

Chapter 4 – Risk management and hazards *continued*

4.14 **Rock fall**

Prevention is by far the best option when it comes to the risk of rock fall – if you can choose an alternative work site or travel route that is not exposed to rock fall then do it!

If you have to work somewhere that rock fall is an unavoidable risk then observe the following precautions:

- Always wear an approved safety helmet
- Avoid terrain traps such as gullies where rock fall will be channeled into a narrow area
- Keep to high ground where possible, ridges and buttresses
- Consider the time of day that you are in these risky areas. If the slope has the sun on it then ice that bonds the rocks to the slope will thaw causing them to fall
- If travelling in a group move close together so that any rocks disturbed by one person don't get a chance to build up momentum by the time they reach the next person
- Look out for signs of recent rock fall – rocks on the snow surface

4.15 **Ice cliffs and seracs**

Ice cliffs can be found at the termination and edges of glaciers and ice shelves, often by the coast but not always. Seracs are freestanding columns of glacial ice that form when a glacier is broken up by intersecting crevasses. Both ice cliffs and seracs are extremely unstable and can collapse without warning.

Avoid routes that traverse underneath either ice cliffs or seracs. Also be aware of the dangers of travelling above ice cliffs or seracs as these areas are often heavily crevassed.

If there is a need to be near either ice cliffs or seracs limit your time here and think about stopping in areas where some shelter is provided, i.e. behind rock outcrops or spurs. Consider the aspect of these features in relation to the sun, as they will be unstable when the sun is shining directly onto them.

4.16 **Water hazards**

Polar fieldwork can involve contact with a number of water hazards. This section will not discuss sea-ice travel as detailed information on this subject is contained within a dedicated chapter (Chapter 19 – Sea ice.

4.16.1 **Melt pools**

Melt pools can form in wind scoops at the base of nunataks/mountain faces or in depressions on glaciers and ice shelves. They can vary enormously in depth and may be open water or ice covered.

Great care should be taken when walking over ice-covered melt pools.

> Caution: The load bearing capacity of freshwater ice is only half that of sea ice.

Move very carefully on slopes above bodies of open water. Take a belay if it is necessary to negotiate steep terrain above melt pools.

Working with ski-doos on shelf ice may involve travelling through shallow melt pools and deep slushy snow. To reduce the risks, scout ahead on foot or travel at night when surface conditions are firmer.

4.16.2 **Melt streams**

Streams and fast-moving water can be found in the Antarctic Peninsula area.

If streams are a problem you may need to:

- Re-route to avoid the obstacles
- Bridge the obstacle using equipment carried
- Move by aircraft
- Work at night if there is a diurnal variation. Lower temperatures may make crossings easier and safer
- Streams feeding into lakes and the sea can cause areas of thinner ice. Be particularly careful in these areas

4.16.3 **River crossings**

In sub-Antarctic and Arctic locations rivers are common and may at times need to be crossed. Even a

small river can generate a surprising amount of power – be careful not to underestimate a river.

> Caution: If the point in the river you are at looks hazardous then try to find an alternative section to cross where the water is slower moving or don't cross at all!

Before crossing, assess the flow of the river and any down-stream hazards that could cause an issue if you were to be swept off your feet. Undo any rucksack straps so that a bag can be jettisoned in the event of being swept off. The following diagrams show two methods of safely crossing a small river. **4/5**

4.16.4 **Tides**

Tidal range can affect coastal travel. A rising tide can result in a party being unable to retreat. Crevassing is often at its most chaotic around the coast and retreat inland may not always be possible.

4.16.5 **Freshwater lakes**

Beware of freshwater lakes around Signy, Bird Island and KEP stations. These lakes freeze at times but can be very weak. Frozen freshwater is not as flexible as sea ice and can break under far less weight. These lakes should be avoided in most cases but if a particular need arises to be operating on or around them then the Station Leader should be consulted.

4.17 **Other hazards**

There are a number of other unique hazards specific to particular areas. For example in the sub-Antarctic areas, deep bogs can be a real risk. Local knowledge is essential and training on awareness of such hazards must be carried out on station.

4.18 **Altitude sickness**

The reduction of oxygen with height can lead to altitude sickness. Field parties in the Antarctic occasionally operate at altitudes of over 3,000m. Although problems at this height are generally rare it is worth bearing in mind that pressure is lower in the Polar Regions and as a result altitude sickness can be experienced at lower altitudes than in other locations.

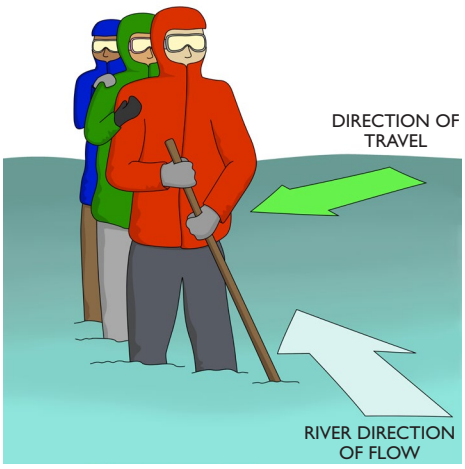


Figure 4 – Line astern river crossing

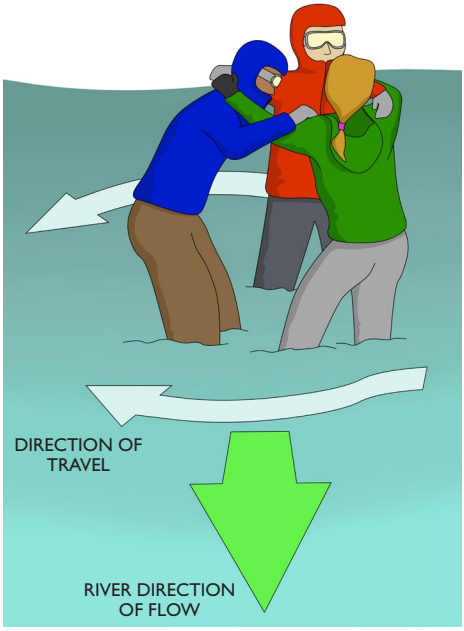


Figure 5 – Huddle river crossing

Chapter 4 – Risk management and hazards *continued*

Gradual acclimatisation to increased altitudes is the most effective method for avoiding altitude illness. Due to the nature of field deployment by aircraft this is not always possible. It is therefore recommended that for the first day or two after arriving at significant altitude all members of the party should take things slowly and make a conscious effort not to over-exert themselves. Often just walking in deep snow at altitude is enough for some people to feel the effects of a reduction in oxygen. Be aware that everyone will acclimatise at different rates and just because you feel fine doesn't mean everyone will.

All members of a field party working at altitude should be aware of the symptoms of altitude sickness and are encouraged to make even the most minor symptoms known to the Field Guide. Illness at altitude should always be considered to be altitude sickness until proven otherwise.

Symptoms of altitude sickness:

- Headache
- Nausea
- Vomiting
- Fatigue
- Poor appetite
- Dizziness
- Sleep disturbance

As said before it is unlikely that altitude sickness will be experienced at the altitudes in question but if in doubt seek medical advice from a station Doctor via satellite phone.

4.19 **Wildlife considerations**

It is possible that you will encounter wildlife while working in the Polar Regions. In Antarctica you are only likely to come across wildlife while working by the coast, whereas in the Arctic you may come across wildlife at any point. There are certain hazards associated with the following wildlife.

When operating nearby any wildlife, always move slowly and avoid unnecessary loud noises. Keep your distance where possible, try to avoid getting within five metres of any wildlife and if your presence is distressing an animal move away further. Where possible consult with the relevant scientific personnel regarding the best routes past known areas of wildlife or consult the BAS Wildlife Interaction Manual for further information on operating around wildlife.

Some field projects require interactions with wildlife. In such cases direct contact is governed by Environmental Impact Assessments and specific permits covering handling wildlife. Unless the necessary permits are in place you should not be within five metres of any wildlife.

> Caution: It is important that you are cautious around wildlife for both your safety and the well-being of the wildlife.

4.19.1 **Seals**

A number of species of seals can be found in both the Arctic and Antarctic. Some species display more aggressive behaviours than others (particularly when stressed), but all seals should be treated with caution. Beaches with breeding seals are particularly hazardous for those with limited experience of dealing with marine mammals.

Although some species of seal may appear sluggish on land they can all turn and move surprisingly quickly over short distances. Treat them with respect and do not approach too closely. In addition to the physical risks from seals there is a risk of contaminated snow/water from excrement. Choose camping spots in coastal areas carefully and ideally away from groups of seals.

Seal bites can be extremely nasty and often become infected. Any seal bite, no matter how minor, must be reported.

Fur seals

Fur seals are highly aggressive during their breeding season and will chase people. The following precautions should be followed when passing near fur seals:

- Choose a route that minimises contact with the seals
- Carry a stick, pair of ski poles or bog chisel for protection. If a seal approaches making a loud noise by banging the stick or touching of the whiskers with a stick or the handle end of a ski

pole (to prevent injury to seal) is often enough to deter them. Avoid overzealous use of the stick as this can agitate the seal and provoke more aggression

- In areas of high seal density work in pairs, this way one person can be a lookout while the other carries out the task
- Take extra care when wearing hoods or sunglasses with side protectors that may limit peripheral vision
- Particular care needs to be taken if operating near fur seals during breeding season: September-November. During this time male (bull) seals will defend their territories and any humans entering them will be aggressively attacked. Speak to the station leader and appropriate science personnel to check which areas are safe to move through
- Look out for animals hidden behind rocks or in tussock grass

Leopard seals

Leopard seals are extremely powerful and at times aggressive animals that may present a hazard on shore or while on sea ice. Treat leopard seals with extreme caution and be on the look out for them near to ice edges or tide cracks while operating on sea ice (more on this in Chapter 19 – Sea ice).

Elephant seals

Elephant seals are usually very docile creatures. They often fight with each other but tend not to be bothered by the presence of humans. This said you should be cautious around them due to their size. If an elephant seal rolled onto a person they could easily crush them. Take particular care if camping near a group of elephant seals as again they will do serious damage to a tent and anyone inside if they decide to roll onto it.

During breeding season (September-November) male elephant seals become very aggressive and can move at a surprising speed. Be very cautious on breeding beaches and avoid getting anywhere near two bulls fighting.

Mothers with young pups can be very defensive, take care not to get between a female elephant seal and her young. Do not approach elephant seal pups.

4.19.2 **Penguins**

Movement around penguin colonies can be hazardous as heavy guano contamination makes conditions underfoot slippery. This is a particular hazard in areas where there is potential to fall in the sea.

Large groups of penguins also create a health hazard in relation to finding clean snow to melt or fresh water supplies. Always take an adequate supply of fresh water from station when planning a multi-day trip near a penguin colony.

Penguins do not pose any significant threat to humans. Penguins are, however, vulnerable to disturbance from humans and every care should be taken to avoid causing them distress. Unless you are assisting in scientific work relating to penguins you should remain at least five metres away from them and always outside the margins of a colony.

4.19.3 **Nesting birds**

Some bird species will attack people when they have eggs or young chicks. Skuas and Antarctic terns in particular will dive bomb any passers-by at these times. Do your best to avoid alarming nesting birds, and if you have to travel past them consider wearing a helmet. It can also be useful to attach a flag to your rucksack as the birds will often attack the highest point and therefore miss your head.

If you do have to travel close to nesting birds take care not to step on eggs or small chicks, which can be extremely well camouflaged. Most nesting birds will flee human approach, leaving their eggs and chicks vulnerable to predators and the cold. Move quickly, but do not run – however tempting when being dive-bombed! If travelling as a group stay close together. Consult with the appropriate scientific personnel before travelling through such areas for advice on the best routes.

4.19.4 **Polar bears**

Polar bears are only present in the Arctic but pose a serious risk to all who come into contact with them. These beautiful creatures are incredibly powerful and if startled or starved have been known to injure and in some cases kill humans. Polar bears are generally very curious and if they spot a camp will possibly come to investigate further. They are known to scavenge for food and have an acute sense of smell.

Chapter 4 – Risk management and hazards *continued*

When travelling and working in the Arctic, all field parties must carry a rifle/shotgun and flares. Each member of the group should be trained in what to do in the event of a bear encounter. If a bear is spotted flares should be used in the first instance to try and scare the bear away. If this does not work then firing a few warning shots with the rifle is the next option.

If a bear is undeterred and charges at a group then shooting it is the only option. This will take an incredibly cool head and experience of firing a rifle. Each situation will be slightly different and giving hard rules on when to fire is unwise. You must aim for the chest and not the head as polar bears have very thick skulls. Even if you hit the bear with the first shot you must quickly re-load and fire again, and again. Shooting a bear would obviously be a traumatic experience for all involved and should be seen as a last resort. All that said, bear encounters in the Arctic are relatively rare and bears charging at people are even rarer. Be particularly cautious when mothers are with young or if you come into contact with an old or injured bear.

When operating in an area with polar bears BAS policy is for huts to be used rather than tents. If camping has been given the go-ahead by BAS operations management then an alarm system must be set up around the camp. The alarm should consist of a trip wire that activates a shotgun blank or a loud alarm that will hopefully frighten off any curious bears. It will also alert the group as to activity outside. Everyone in the group must be well versed in what to do in the event of the alarm going off in the middle of the night. A response should include grabbing all available flares and the rifle. In the first instance poke your head out of the tent very slowly and cautiously so as to not startle a bear.

Food should be stored carefully in sealed bags and food waste disposed of away from camp. Toilets should also be sited out of the alarmed perimeter of camp, as this is often the first area a curious bear will visit.

Keep a look out for fresh bear tracks in the snow and if some are spotted close to camp consider having a 24-hour watch with someone on lookout with flares and the rifle.

The subject of operating in polar bear areas is extremely complex and cannot be fully understood from a book alone. See specific guidelines on Arctic stations for more information on dealing with polar bears in the field.

4.19.5 **Musk ox**

Musk ox are large and powerful animals. Generally they will not be aggressive towards people unless they feel threatened. Pay close attention to their body language – if they continue grazing then you probably have nothing to worry about, but if they start to sway their heads or form a defensive line then they see you as a threat. In this instance retreat from the area slowly. During breeding season the males rut and are more aggressive than normal. Keep clear of rutting males and mothers with calves.

4.19.6 **Arctic fox**

Arctic fox are often shy creatures but they will scavenge around camps for food. Foxes pose very little danger although if you get too close they may bite. Some Arctic fox are known to carry rabies and any bite has the potential to become infected. Arctic foxes will avoid you but if you find one in camp make sure you don't corner it. Avoid any dead foxes as disease can still be transferred.

4.20 **Sub-Antarctic islands risks**

BAS's operational area also includes numerous sub-Antarctic islands. These pose their own risks along with crossover with the risks discussed in this chapter. Hazards on the islands include underfoot hazards that are not present in other areas. Snow-covered grass, uneven ground, hazardous historic sites, smaller staff teams to deal with incidents are just a few issues posed in these areas. More information and the associated hazards can be found on station documentation or by asking the station leader on site.

Chapter 5 – Personal survival

5.1 **Introduction**

All BAS personnel should have a basic knowledge of survival and relocation techniques. The information contained within this chapter is not complicated but could save your life if you become lost or disorientated while out in the polar environment.

Never underestimate the seriousness of the polar environment. The weather can change dramatically in an instant. It is important not to become complacent with your surroundings and always venture out prepared for the worst. Plan ahead and be prepared.

For detailed and specific search and rescue techniques of a missing person or people see Chapter 22 – Search and rescue.

5.2 **Rucksack contents**

When heading anywhere in the Polar Regions, it is important to take a rucksack, the contents of which could provide critical immobilisation away from help. The following is a list of basic items that should be included in a personal daypack. This list is not exhaustive as it is designed to cover a wide variety of environments. It can be used as a starting place for additional items to be added, such as; crevasse rescue gear, avalanche specific kit, overnight extras, specialist equipment etc.

This equipment is designed to be carried by each individual and should be considered additional to that being worn at the time. For further information, Field Guides on station are a good recourse. If none are present, an email can be sent to the Rothera Field Department.

Suggested Items include: Personal First Aid Kit (PFAK, IAP), group shelter, big gloves (mitts), spare work gloves, spare hat and buff, down/ synthetic jacket (can vary in size depending on location but should be big enough to go over all other layers), goggles (glacier goggles if required), water bottle, flask, radio or other relevant form of communication (make sure this is charged), sunblock, lip balm, sufficient high calorie food and water. **6**

5.3 **Actions if lost or weather deteriorates**

In unfamiliar or obscured terrain it is very easy to become disorientated, particularly in strong winds. This can happen when moving between tents or huts in the field and even station buildings. In really bad conditions visibility can be less than a couple of metres.

Even if you are poorly equipped you will survive if you:

- Don't panic
- Plan your actions
- Remain positive and alert

5.3.1 **Initial actions**

- STOP – take a moment to assess the situation and formulate a plan
- Don't do anything that will lessen the chance of searchers finding you
- Establish comms if you have a radio – broadcast blind if necessary. Use a whistle and blow six short blasts every minute. Keep doing this
- If a search is imminent, stay where you are and protect yourself from the weather
- If you do move, try and leave an indication of your intentions

If a search is not imminent:

- Do not wander aimlessly about hoping to find a landmark. By doing this you might move far from the location of a search area
- Minimise your heat loss. Fasten clothing and stay dry
- Stop and think. Use available shelter or sit with your back to the wind. Try to remember your movements and work out how to find your way back
- Take a note of the wind direction. It is your reference point for subsequent movement. Use any other navigation aids you possess
- Signal with whatever means you have available. This could be a radio, whistle, flares or a torch. Listen for the sounds of searchers
- Try a search pattern. This could be a square search or a spiral search (see Figures 7 and 8)

If searching doesn't work then:

- Go to ground before you become exhausted
- Bivi or lie down in the lee of a rock, snowdrift or sastrugi. It is essential to shelter from the wind as much as possible

Chapter 5 – Personal survival *continued*

Figure 6 – Rucksack contents

#	Item of gear
1	Personal First Aid Kit (PFAK, IAP)
2	Group shelter
3	Big gloves (mitts)
4	Work gloves

#	Item of gear
5	Hat
6	Down/synthetic jacket
7	Goggles (glacier goggles if required)
8	Radio and/or satellite phone

#	Item of gear
9	Buff
10	Flask
11	Water bottle
12	Sunblock & lip balm
13	High calorie food

- Bury your body as much as possible or allow yourself to become covered by drifting snow
- Curl up and keep your back to the wind
- Cover your face with gloves or balaclava and wait calmly for an improvement in the conditions
- Keep listening for the calls of a search party
- Place an obvious marker so a search party can find you if buried
- Don't fall asleep – the weather will get better eventually

5.4 **Comms**

If venturing out away from camp or station it is wise to always take some form of communication. This is particularly important if the weather is less than perfect or you are working alone.

> Note: Lone working in the field is generally not best practice however there may be some instances when this is appropriate, e.g. within a flagged boundary or near a station. Bird Island and Signy have designated single working travel boundaries – see station documentation for more information.

VHF radios are the most appropriate forms of communication over short distances and it is recommended that these are turned on and carried on your person (see Chapter 11 – Communications for more information).

Carrying a whistle is another useful form of communication and if close to camp can be an effective mode of communicating. Be aware though in bad weather and with strong winds it may be hard for someone to hear, especially if they are inside a tent with the fabric flapping.

Think about carrying a handheld GPS or InReach device if it is completely necessary to be out in really bad weather. If nothing else this will allow you to pass your position to a search party.

5.5 **Search patterns**

If you find yourself lost or disorientated, the following search patterns are effective ways of methodically searching an area in order to relocate yourself. The idea is that you search in such a manner that you always return to the point at which you first accepted you were lost, thus not getting any more lost!

5.5.1 **Square box search**

The square box search is a useful technique if you become disorientated whilst moving around camp. Do not move too far in the initial box pattern.

- Move upwind for ten or twenty steps – it may be necessary to crawl
- Move across the wind (left or right) the same distance, then downwind and back to your starting point having completed a square. You may not be at exactly the same spot but you should be close to it
- If nothing is found and you have not regained your bearings, then go upwind the same distance again and complete a square in the other direction. This process can be repeated upwind and downwind of the starting point. The distance covered in each box will depend on the visibility
- When you are sure you have covered the four squares, repeat the process with larger squares **7**

5.5.2 **Spiral box search**

This is a very useful search technique as it can be used to search both large and small areas. The time taken to search an area is dependent on the visibility.

The principle behind this technique is that you travel on an ever-increasing spiral with the area covered always being within your range of visibility. To conduct this search pattern on foot you will need a compass. If no compass is available you can use the wind direction to determine your heading. The length of the legs travelled will depend on the visibility.

- From the start point walk towards magnetic north. Count your paces and stop when you can no longer see the start point
- Turn 90° to your right and travel on a bearing of 090° (M) for twice the distance you could see. If you had no compass walk towards the wind and then turn right and go through the same steps
- Turn 90° again and travel three times the original distance on a bearing of 180° (M)
- Keep turning through 90° and increase the length of each leg as per the illustration **8**

Chapter 5 – Personal survival *continued*

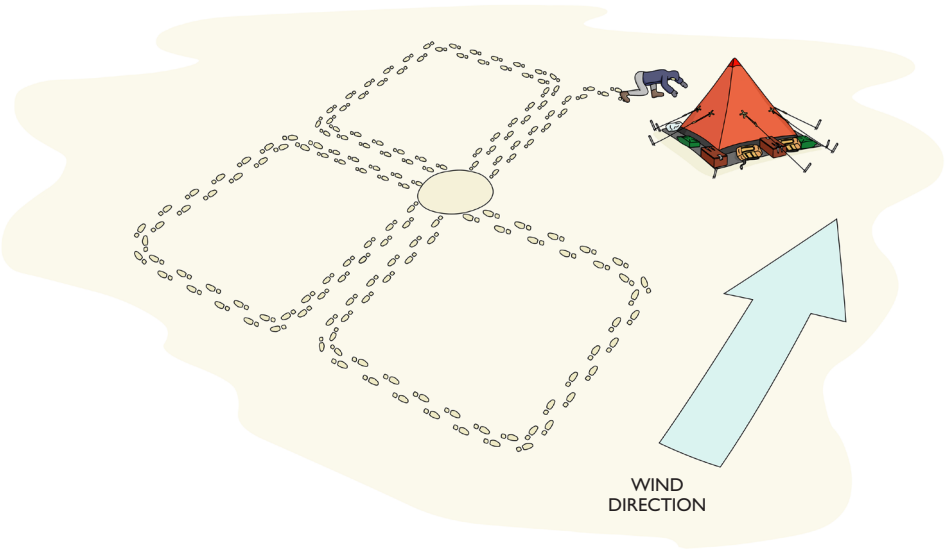


Figure 7 – Square box search

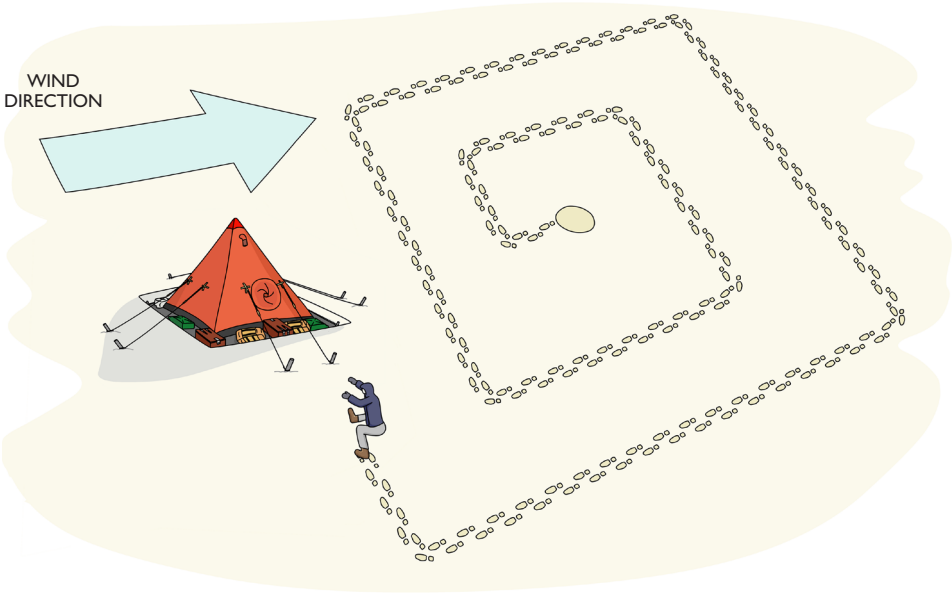


Figure 8 – Spiral box search

5.6 Emergency shelters

If you are caught out in a polar storm without any shelter you will be lucky to survive for more than a few hours. There are, however, a few techniques for creating an emergency shelter that will buy you valuable time and significantly boost your chances of survival. Don't wait until you are caught out to learn these techniques – practice them as part of your field skills development.

The type of shelter constructed will depend on the following:

- The terrain
- Type of snow
- Tools carried
- Size and condition of the party
- Time available/Risk to exposure
- Duration shelter is needed

A shovel, snow saw and ice axe are all useful tools for constructing a snow shelter. Without these tools you can still make an adequate shelter but it will take longer and use more energy.

Adequate ventilation is crucial in all emergency shelters. Ensure you have a system for ventilation and maintain it by regularly clearing snow.

Always mark a shelter from the outside with whatever you have to indicate your position should someone be looking for you.

5.6.1 Group shelter

A bothy bag, or group shelter, is a lightweight emergency shelter that comes in a variety of sizes. Smaller shelters can be used for casualty packing in emergency or personal survival situations. Larger shelters can accommodate a group ranging from 2-12 people. They are useful to carry if conducting work as a group away from other forms of shelter e.g. tents. All forms of group shelter work in areas with or without snow and are fast to deploy, providing useful protection for a range of situations. These lightweight bits of kit could prove useful as a quick pop-up shelter for travelling science and are especially useful on sub-Antarctic islands when working away from huts and where emergency snow shelters are not an option.

5.6.2 Huts

There are numerous field huts in the BAS operational area. These structures can offer shelter in an emergency. It is worth knowing what is available in the areas you will be operating in. More information can be found in the station documentation and Chapter 8 – Field huts.

5.6.3 Snow grave/trench

Snow graves are very simple emergency snow shelters that can be constructed on flat, snow-covered ground. As the name implies this type of shelter is essentially a grave. If caught out on a plateau or ice-shelf this may be the most appropriate shelter to construct.

The hole is constructed by digging a trench long enough for a person to stretch out and deep enough to give head room when sitting or crawling in and out. A hole cannot be more than two people wide, so a third person will require an extension and perhaps a separate entrance.

Snow blocks cut from the trench are leaned against each other over the hole to form a roof. If the snow is wet, roll it into a ball and then cut the blocks to shape.

If the snow is too wet or unconsolidated to form a roof it will have to be constructed from whatever you have available such as jerry racks, tarpaulins or ski poles. Snow should be packed into any gaps that appear in the roof and a gutter should border the walls.

A ventilation hole must be made and put a flag in to mark your position. **9/10**

5.6.4 Shovel up

Appropriate when:

- On featureless snow surfaces
- Several people need shelter

The snow mound can be built in a variety of snow conditions. A pile of rucksacks and other equipment is used to reduce the amount of snow that needs to be shoveled.

To build a snow mound:

1. Pile equipment in the deepest patch of snow available. Avoid unnecessarily flattening the site.

Chapter 5 – Personal survival *continued*

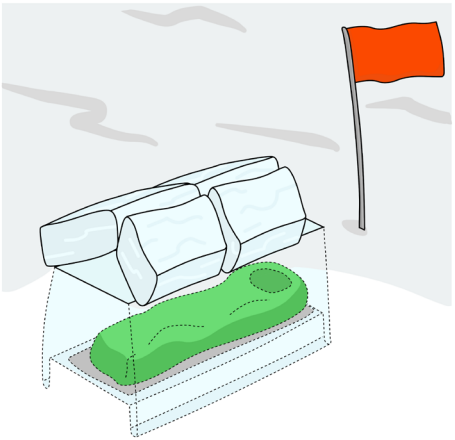


Figure 9 – Snow grave single

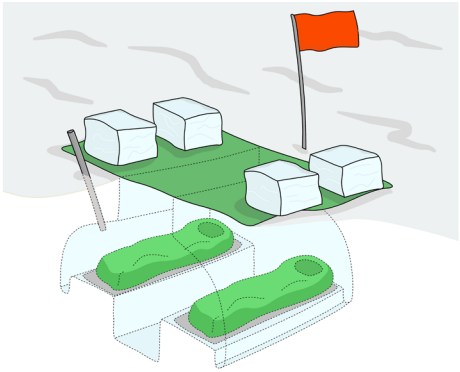


Figure 10 – Snow grave double

Figure 11 – Shovel up

2. Starting well away from the equipment, shovel snow into the centre of the site burying the pile of equipment. To increase the strength of the mound, pat the snow down as you proceed.
3. Dig into the mound on the downhill side or away from the wind to form an entrance.
4. Dig out the interior and equipment leaving a high sleeping platform. Add the snow removed to the outside, particularly upwind. A blue light will filter through the walls when they are about 300mm thick. Alternatively bamboo canes can be snapped/cut into 300mm lengths. These are pushed through the walls of the mound so they are flush with the outside. When you hit them from the inside, the walls are then 300mm thick.
5. Form a vent by poking a ski pole through the roof, leave in place so that vent can be maintained by wiggling the pole when snow fills in.
6. Smooth the inside to avoid drips. Dig a gutter close to the walls if the snow is wet. **11**

5.6.5 **Bivi shelter**

The easiest type of emergency shelter to construct in snow is a bivi shelter. Bivi shelters need to be dug into the side of a steep bank of snow so are not always an option in the Polar Regions. If a good site is available then a bivi shelter can be constructed in approximately 20 minutes – this obviously depends on the density of snow, with harder snow taking longer to excavate.

To construct a bivi shelter:

1. Find a bank of snow at least two metres deep.
2. Dig straight into the bank to make an entrance tunnel. This should be approximately shoulder width and go back about one metre.
3. Next start to dig upwards and carve out a chamber large enough to sit comfortably. Cut a seat that slopes backwards so that you don't melt off it.
4. It is important to dig the chamber large enough so that you can also sit on something (rucksack or similar) to insulate yourself from the snow. See other considerations in this chapter.
5. Partially close up entrance hole to prevent blowing snow from entering the shelter.
6. As with all shelters ensure there is adequate ventilation – an ice axe or ski pole can be pushed through the front of the shelter to provide a vent.
7. Smooth off the inside walls and roof to prevent any drips from forming and landing on you. **12**

5.6.6 **Snow holes**

A snow hole is just that – a hole dug into the snowpack for shelter! A number of variations exist depending on the particular situation in relation to group size, depth of snow, snow consistency and tools for digging.

The snow hole proper takes a significant amount of time to construct but can provide very comfortable shelter from the elements for a large number of people. It is unlikely that you will be able to build this type of shelter in less than a few hours so it is not that practical for emergency situations when protection is needed quickly.

Figure 12 – Bivi shelter

5.6.7 **Blocked hole shelter**

This type of shelter is really a variation of the bivi shelter above. It works well on less steep banks of snow or where the snow is firm enough to create good building blocks.

To build a block hole shelter:

1. Cut a slot into the slope to create a chamber with roof, large enough to sit upright and on top of something for insulation purposes.
2. As with the bivi shelter the ground should be sloping, this helps with the digging process by using gravity to excavate the snow and also creates a sink from which cold air can escape.
3. If possible dig the snow out in blocks rather than hacking the snow into loose shovelfuls – these blocks will be used later.
4. Once the digging has been completed the front of the shelter must be blocked up. To do this cut a level platform on both sides of the hole and high enough up that you leave a small entrance to crawl through.
5. Cut a block of snow large enough to cover the width of the shelter (this is known as a lintel). Ski poles or similar can be used to help support the blocks if necessary.

Chapter 5 – Personal survival *continued*

6. Place more blocks on top of the lintel until the hole is covered. Use loose snow to fill in the gaps.
7. Crawl inside and create a ventilation hole with a pole or axe (if using one of these items to support the blocks carry out this step first!) **13**

Figure 13 – Blocked hole shelter

Other Considerations

In all the above scenarios, heat loss through the ground is a major issue when trying to stay warm. Sitting directly on the snow will cause heat to be lost through conduction. Try to sit on something insulating such as a foam pad. Other items could include rucksacks, ropes, spare layers or folded up bothy bags. Anything can be used providing it insulates your body from the ground.

Extra down/synthetic clothing should be put on once inside, capturing body heat.

3.6.8 **Alternative shelters**

If you cannot build any other form of snow shelter, a good-sized crevasse may provide the essential protection from the elements that you need. This is a last resort and the other shelters discussed previously are far better and come with less risks attached.

Before entering a crevasse for shelter you should consider the following:

- Ensure anchors for getting into the crevasse are solid
- Consider any snow bridges that will be overhead – you will need a snow bridge overhead to prevent constant spindrift falling onto you but the bridge needs to be sufficiently stable so as to not collapse on top of you!
- Be aware of secondary snow bridges and if possible anchor yourself to the crevasse wall, leaving the surface rope in place as a back up
- Leave a marker on the surface at the point you entered the crevasse to help rescuers to locate you

Other means of shelter may be close by, a vehicle cab for example or in certain locations an old hut.

Chapter 6 – Camp management

6.1 Introduction

Polar fieldwork involves prolonged time spent camping in remote locations. A typical field season can be anything from a couple of weeks to three-and-a-half months, with the flying season extending as long as five or six months in some years. Effective camp management is essential to staying healthy and being comfortable while camping for long periods. It is the Field Guide's responsibility to take the lead on camp management and train the rest of the team in the techniques and practices that will help with this, but everyone must work as a team and do their share of camp tasks.

This chapter aims to give a brief overview of the types of field camps that might be experienced in the BAS operational area, and covers the necessary skills for setting up, maintaining and packing up a travelling field camp. The various tents in the system and their best uses are discussed along with practical advice on how to pitch the tents.

Note: BAS policy on camping states: single occupancy is acceptable, however no combustible equipment may be used in this instance.

6.2 Camping in Antarctica

Traditionally the BAS camping system in Antarctica has been based around a two-person set-up using a pyramid tent for living. Although still the most suitable tent for small teams, other systems are now becoming more practical in certain situations.

When deciding on the most appropriate set-up for camping consider the following:

- Planned duration in the field
- Number of camp moves or is it a static camp?
- Number of people in the group
- Expected weather conditions, is it a known area or likely to experience strong winds?

Camping in Antarctica is almost always going to be on snow. Camping in snow-free areas is discouraged due to the environmental impact this can have. See Section 6.5.1 Campsites – things to consider.

6.2.1 Climate

Due to Antarctica's vast geographical coverage the climate can differ greatly from one area to another. The table below indicates the three main climate areas and associated weather.

Area	Temp. range	Precipitation	Wind
Interior	-20°C to -60°C	Very little – less than 50mm water equivalent per year	<20 knots
Coastal	0°C to -30°C	400mm water equivalent	0 to 80 knots
Peninsula	+5°C to -20°C	250mm – 5,000mm water equivalent depending on specific area	0 to 100 knots

Specific weather for each area can vary considerably, the table above gives guidance on what to expect only. Read past travel reports to get a more accurate idea of what conditions to expect.

6.3 Camping in the sub-Antarctic

For the purposes of this section the 'sub-Antarctic' includes all fieldwork conducted north of the Antarctic Circle (46°-60° South). Most of Antarctica lies within the Antarctic Circle, however the northern end of the Peninsula falls into the sub-Antarctic region along with the South Orkney Islands (Signy) and South Georgia (KEP) and Bird Island. The climate found in these areas is very different to that further south and as such the techniques for camping differ slightly.

6.3.1 Climate

The average annual temperature in the sub-Antarctic is above freezing with temperatures fluctuating between approximately -4°C and +5°C. However, the wind chill factor means that much colder temperatures are encountered on most days, particularly when crossing glaciers and exposed high ground. Precipitation is common and during the summer months this can often fall as rain, sleet or snow.

6.3.2 **Considerations**

The milder temperatures and increased precipitation require you to think carefully about where you locate your camp in the sub-Antarctic. Think carefully about how a downpour of rain will affect your chosen site and avoid camping too close to areas that could flood. Tents will need to be waterproof, so a standard ventile pyramid is unlikely to be the most appropriate tent for camping in this region.

There is a good chance that when camping in the sub-Antarctic you will be close to wildlife. Ensure that your camp is situated away from any colonies of animals, particularly during breeding seasons. See Chapter 4 – Risk management and hazards for information on wildlife hazards.

6.4 **Camping in the Arctic**

BAS occasionally operates field projects in the Arctic as well as the Antarctic. The environment is similar but with some key differences that require a slightly different approach to camping. The obvious difference with camping in the Arctic is the presence of polar bears. This adds a significant element of objective danger that needs to be considered and managed while camping. For this reason huts are more commonly utilised rather than tents. If working in the Arctic consult the Head of Field Operations for further advice. Also see Chapter 4, Section 4.19.4 for an overview of operating in regions with polar bears.

6.5 **Camp location**

Before setting up a camp, be it permanent or temporary, careful thought should be given to the location. It is beyond the scope of this manual to go into great depth on this subject. As with many field decisions the question should be asked, what if?

6.5.1 **Campsites – things to consider**

- The relationship of the site to the hills, cols etc. Could you relocate to a less exposed/less turbulent area?
- Is the site likely to suffer from high accumulation (lee of the hills)?
- Avalanche, serac fall, rock fall, crevasse risk?
- Tides and wave action on beach sites (northern peninsula and sub-Antarctic Islands)
- Wildlife hazard and impact
- What does the sastrugi tell you about the predominant wind direction? Where will drifts form?
- Environmental impact:
  - Is it possible to re-use a previous campsite rather than disturbing a new area?
  - Has your camping and scientific equipment, including clothing and footwear, been cleaned before being transferred between sites to avoid transfer of non-native organisms?
  - Ensure the camp is located as far as feasible from areas with sensitive biological or geological features such as: bird and seal colonies, lake margins, stream beds and associated fans, and vegetated areas, to avoid damage or contamination
  - Where possible, camps should be established on areas of permanent snow and ice, and not on ice-free ground.
  - Take special care to ensure that no food or wastes are accessible to animals
  - You should map and record (preferably using GPS coordinates), and report the location of your camp site and any sites of disturbance for future reference
  - Are you in a protected area such as an ASPA or ASMA (see Section 5.21.1 – Protected areas)? If so, you must have an Environmental Impact Assessment and permit with agreed mitigations and you must refer to the Management Plan as it may have additional requirements for field camps
  - Refer to the 'field camp' guidance in the SCAR Environmental Code of Conduct for Terrestrial Scientific Field Research for further information

6.5.2 **Basic actions when setting up camp**

- Plan ahead if possible to select a safe site
- Think about where the strongest wind will come from
- On arrival decide on a clean area (upwind) for snow blocks and a dirty area (downwind) for the toilet. Put in a pee flag at this stage

- Try to minimise the amount of carrying you will have to do by setting up the tent close to the sledge
- Depot surplus equipment and sledges in a line perpendicular to the wind to reduce drifting

6.6 **Small camps**

BAS has a strong history of operating small teams' deep field in the Antarctic. Often this comprises a two-person team of Field Guide and scientist, though it can now easily be scaled up for an additional person to make a three or be doubled to form a team of four. Small teams have the advantage of being easy and cost effective to deploy while allowing the party to be mobile and thus cover a large amount of ground. This system is still very much in use and, while working as a small team, effective camp management and teamwork are key to efficiency. **14**

6.7 **Medium camps**

This style of camp is usually semi static meaning it is quick to set up but still can still be moved easily if necessary. The management of this type of camp is dependent on the objectives and type of work carried out. A range of tents can be used including standard Pyramid tents, mountain tents, Clam tents or Arctic Oven tents. All these are used for various applications in different situations, meaning this can be a very flexible setup used for many taskings. Unlike the smaller camp, the BAS Box system is used differently, meaning only the boxes and equipment required are flown into the project. There may also be boxes specifically designed to facilitate more staff used in this scenario.

These camps often rely heavily on aircraft support, as this enables more working and living space but still allows for an easy and fast deployment. This type of camp can accommodate from four to ten staff but there is also potential to expand and facilitate more staff depending on project type and aims. Aero surveys, instrument servicing and some scientific project work are conducted in this style.

6.8 **Large camps**

The management of a large camp is generally the same as that of small and medium camps – just obviously on a bigger scale! With more people in a team come more tents for sleeping and the extra consideration of a living space large enough to accommodate the whole group. Due to the nature of large camps, they are often (but not always!) static, and the work carried out invariably involves a number of work tents with wider infrastructure not found at smaller sites. Camps of this style can range from large scientific setups through to logistical camps set up routinely by BAS (e.g., Sky Blu). **15**

6.9 **Other camp types**

Occasionally BAS operates camp setups that do not fit into the previous three categories.

These could be undertaken for many reasons but will likely use a hybrid of the camps previously described. A Tractor Traverse is another example but is extremely different than those described above. See Chapter 16 – Tractor traverse for more information.

If camping out of an aircraft, See Chapter 17 – Aircraft operations for more information on kit permanently carried.

6.10 **Logistical sites**

BAS operates two summer only logistic sites; Fossil Bluff and Sky Blu, with the purpose being to easily facilitate aircraft movements and refueling in the initial stages of field flying from Rothera. These sites are permanently staffed by field coordinators throughout summer and fit into the category of large/ other style of camp. Both can facilitate multiple transiting aircraft and support large groups of people for days at a time. Despite being staffed, these sites will still require visiting staff to help with tasks if time allows. This need will vary depending on location and time of year, but the individuals stationed there will be able to advise. This could include but is not limited to cooking, cleaning, water collection, digging out depots, or larger tasks that are easier with lots of helping hands.

For more information on the following see the Specific SOP or speak to a field coordinator, a member of field staff or the FOM.

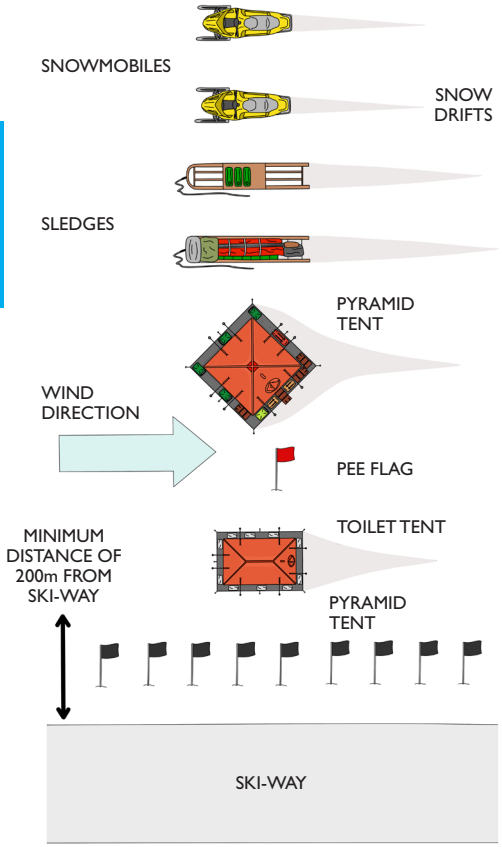


Figure 14 – Aerial view of small camp

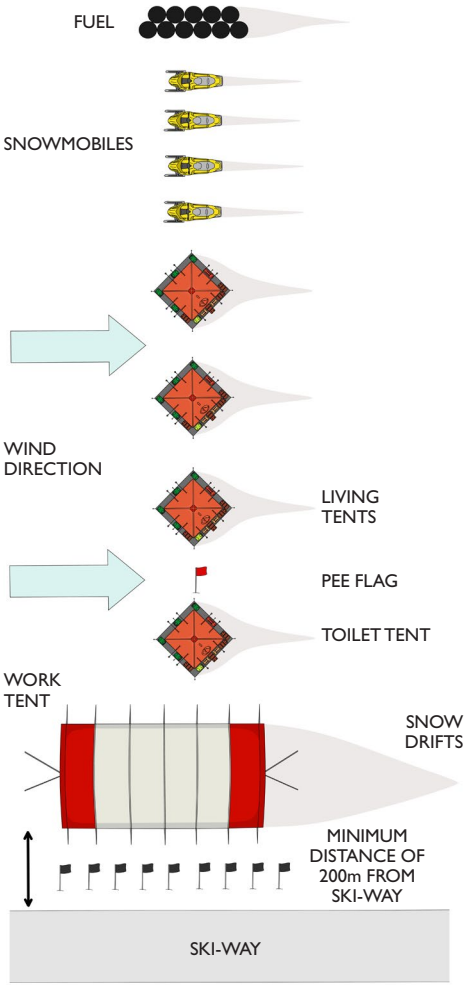


Figure 15 – Aerial view of large camp

6.11 **Fossil Bluff – (KG)**

Managed as a summer only forward operating hub for BAS field flying operations, Fossil Bluff will usually be the first stop on a trip into the field. Bluebell Cottage is the main accommodation located 1km from the skiway. At the skiway there are basic amenities in the form of an apple hut for shelter and basic toileting facilities. For extended stays, washing and toilet facilities are available at the Cottage, along with reflex stoves for warmth. Fossil Bluff is permanently staffed during the summer by a Field Coordinator who will oversee the smooth operation of the site through its operational months.

6.12 **Sky Blu – (SBR)**

The last fully staffed stop for a Twin Otter on a trip into the deep field and staffed throughout the summer months by a Field Coordinator, Sky Blu is a challenging place to live and work but can also be hugely rewarding. It sees regular flights each summer from the BAS Twin Otters which help move science projects and personnel into the deep field. Large quantities of fuel are often dropped here through airdrops in collaboration with the RAF. The camp is comprised of two Weather Haven tents, one being the main living tent with reflex heating, the second being a garage tent to allow the machinery based here to be maintained. The sleeping accommodation consists of fiberglass melon huts and various tents depending on the number of occupants. There is also a designated toilet space with room for washing and peeing on extended stays and pee flags at both the apron and the living Weather Haven for ease of access.

6.13 **Etiquette in the field**

The deep field or any logistics camp in Antarctica are harsh places to live and work. These are not hotels, and all staff are expected to help with tasks.

The more hands-on staff are the more efficient things become, thus making everything safer and more successful.

Everyone is at work and visiting staff are expected to assist with tasks as required. Speak to those on site for more clarity.

Managing water in the polar regions is a task that requires constant attention. This can vary from melting snow blocks in a pot through to large melt tanks with designated shovels and machinery. It is always worth checking with field coordinators or station leaders at bigger camps/ stations, as it can be quite labor intensive and those responsible will be grateful for the additional help.

6.14 **Pyramid tents**

The most commonly used tent for Antarctic camping within BAS is the pyramid tent (also know as the Scott tent). Although heavy and very traditional in design and construction, the pyramid has proved itself to be the best tent for the Antarctic. A properly pitched and anchored tent can withstand winds in excess of 80 knots. The penalty of the pyramid is its weight – approximately 47kg.

Although modern geodesic mountain tents are very strong, none are capable of withstanding the high winds and pressure of snow accumulation as successfully as the pyramid. The pyramid also has to undergo the rigors of life in the field, which can be very hard on equipment.

Pyramid tents are traditionally made from ventile; a tightly woven cotton that is inherently flame retardant, durable and windproof. Ventile is snow proof but not waterproof! Some pyramid tents are made with a nylon outer.

It is almost impossible for a correctly pitched pyramid to blow away, but a poorly-pitched, or poorly-sited pyramid will greatly reduce your chances of survival. **16**

6.14.1 **Pitching a pyramid tent**

It is important that this sequence of events has been practiced before you go into the field. Good communication and teamwork will make this job much easier.

- Assess where the strongest wind will come from (sastrugi) and work out the correct orientation for the tent
- Dig out a level platform for the tent to sit in. If the surfaces are soft, dig in well
- If surfaces are hard then the poles will need to

be dug in. In the platform, measure out the width between poles and dig diamond shaped holes to take each of the four pole ends. Have these measurements already in your head or carry a length of string showing the exact distance – tents vary a little. Use whatever method you find most suitable. The holes should be deep enough for the poles to 'hang'

- Lift the tent into position
- Extend the guys. It is important to extend the guys to the maximum extent whilst still leaving room for tightening. This gives the best angle of pull on the tent fabric
- Place the pegs so that the guys are at 90° to the tent
- Go to opposite sides of the tent and tension the guys simultaneously
- Back fill the pole holes
- Peg out the valance. The tent fabric should be taught and smooth. The valance seams should touch the ground
- Place boxes, jerries, snow blocks etc. on the valance. If using snow blocks put the crust side to the wind
- Fine tune the tent tension if necessary

Every time you pitch the tent, regardless of the weather and forecast, it is worth pitching as if a 100-knot blow was expected. Plan for the worst. **17**

6.14.2 **Storm pitching a pyramid tent**

Storm pitching should be viewed as a last resort and is to be avoided if at all possible. If the weather is worsening, the decision to set up camp should be made earlier rather than later.

If two parties are travelling together, pool resources to get the tents up. If the wind is too strong then use the pup tent.

Basic actions when storm pitching:

- Dig out a platform and the pole holes
- Have some heavy boxes and full jerries ready to weigh the valance down
- Put the tent on the ground with the apex into the wind

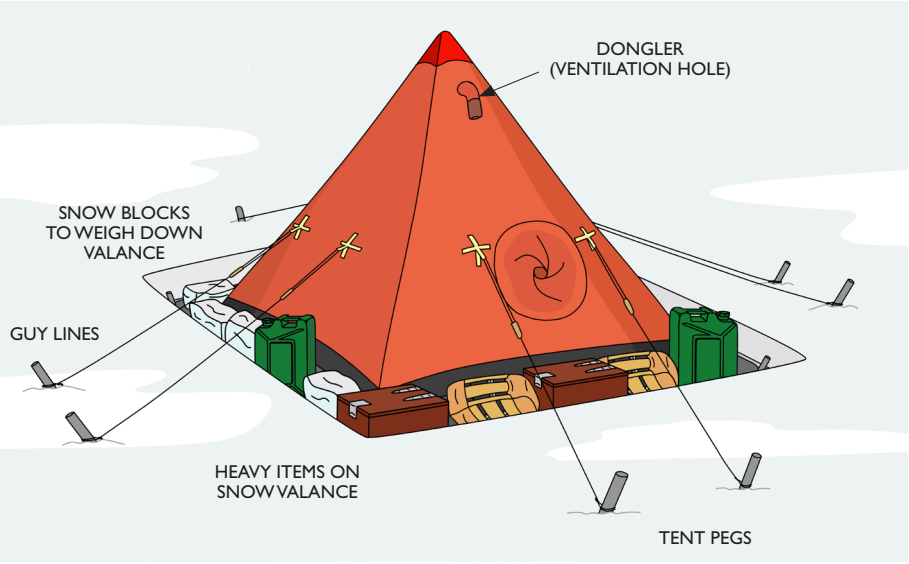


Figure 16 – Pyramid tent

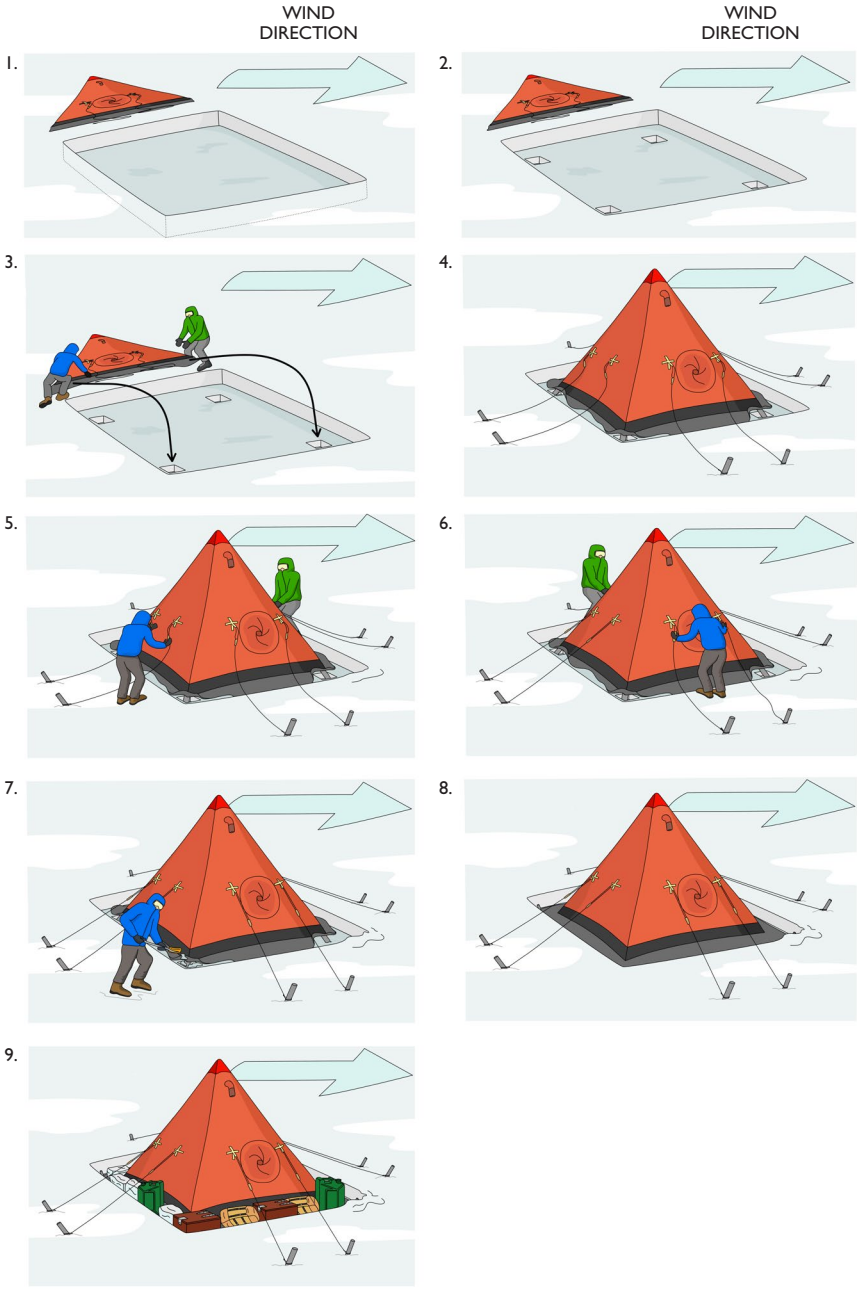


Figure 17 – Pyramid tent pitching process

- Extend the guys
- Put a loop of spare rope around the apex of the tent when it is lying flat. Guy this rope with an Italian hitch to a snow stake upwind of the tent. As the tent is stood erect pay out the rope and tie off once the tent is upright.
- Put the two windward pegs through the two windward guys
- Place the remaining pegs ready for the guys
- Work as a team on either side of the tent. On either side grasp the two poles. Erect the tent, lifting up the leeward poles to ensure they don't dig in. This is the trickiest part of the operation
- One person should hold the windward side of the tent. The other person should peg out the tent; position the boxes on the valance etc.
- Finally the tent can be fine tuned and snow blocks placed on the valance

Storm pitching will result in the tent door being in the lee or at 90° to the wind. This is normal when storm pitching. **18/19**

6.14.3 **Setting up the inside of a pyramid tent**

The quickest method of organising camp is to have an inside and outside person.

- Once the tent is secure the inside person can enter and lay out the groundsheet
- Before the inside equipment is passed in the tent door should be tied open
- The jerry board, sleeping boards, inside boxes, radio and P-bags are then passed in by the outside person. These are laid out by the inside person with both beds made ready. The jerry board should be turned upside down and placed beneath the pots and tent box. This will increase the stability of these boxes and create a much more stable cooking platform. This is much safer than not using the jerry board

The Pots Box and Tent Box are placed in line from the back of the tent to the entrance. A cooking board separates the two boxes. The Inside Food Box is placed crosswise nearest the door. This locks the boxes in place.

- The tent valance is weighed down with the jerries and boxes from the sledge. Snow blocks should

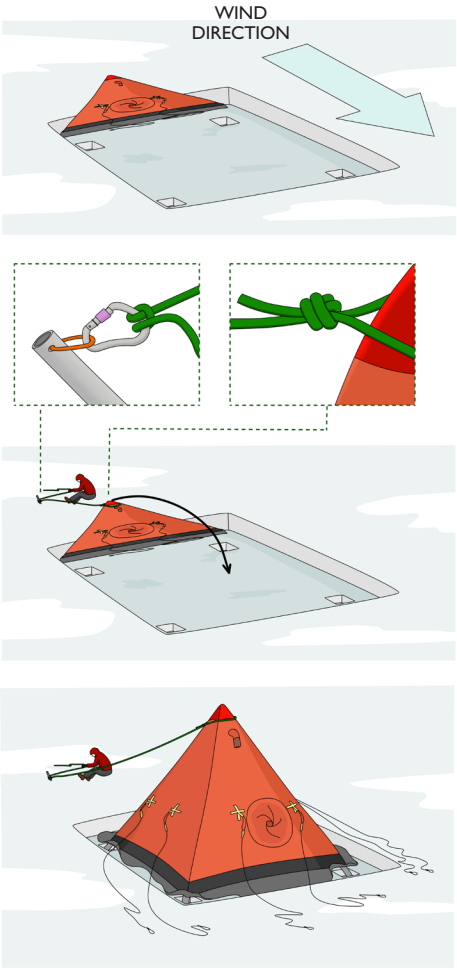


Figure 18 – Storm pitching process

Figure 19 – Tent buried to withstand a severe storm

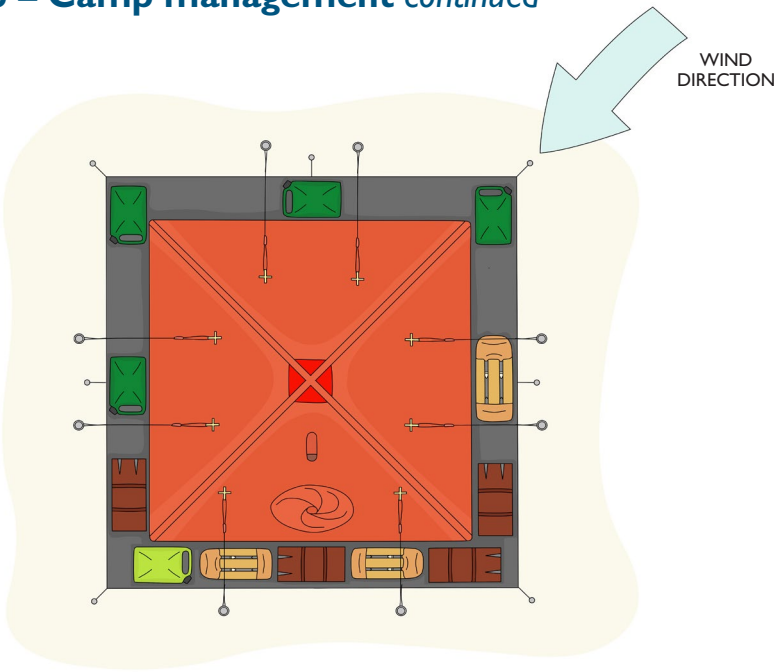


Figure 20 – External pyramid layout

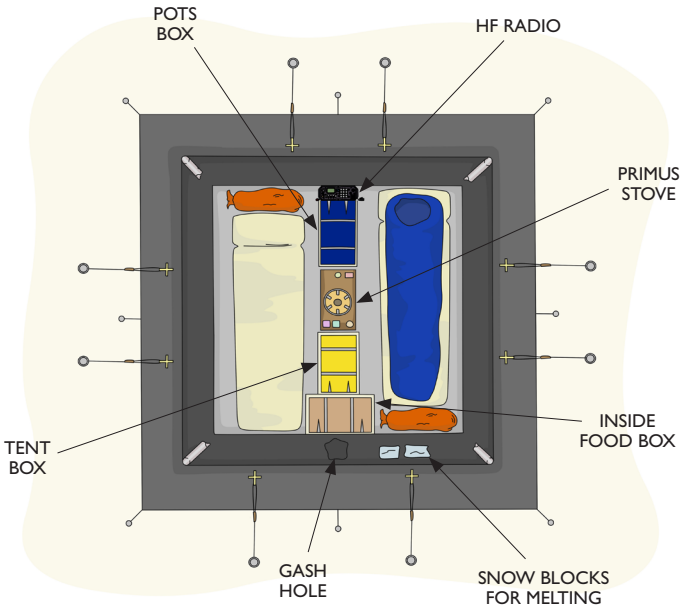


Figure 21 – Internal pyramid layout

be used in addition to the boxes. Make sure the valance is fully covered

- The outside person completes the task of securing the tent, gathers the items needed from the sledge and lashes this securely. The sledge should be anchored in line with the prevailing winds to reduce drifting
- All equipment should be stored so as not to drift up other equipment or the tent
- Make sure all the equipment is well marked with flags
- Ski-doos should be refuelled fully to avoid contamination of the fuel system by condensation and then covered with a tarpaulin
- The radio aerial needs setting up, facing the correct direction, with the coaxial feeder running through the ventilation tube to the radio in the tent. Make sure that nothing is in contact with the tent fabric
- Snow blocks should be cut and placed between the inner and outer tent on the right-hand side looking in. A snow block bag makes carrying blocks easier, keeps storage simple and prevents any contamination. The peg, tent bag and footwear normally sit on the left-hand side. To avoid water contamination it is important to conform to the above guidelines. Different parties use tents and common systems should stop tent fabric causing snow block contamination

  Wate**R** – Right as you look in

  Fue**L** – Left as you look in

- Between the two a small gash pit may be started for wet waste
- Once the outside jobs are complete the outside person (usually the Field Guide) can go indoors to a welcome brew
- It is the Field Guide's responsibility to check outside through the night should the need arise

From arriving to sitting inside with a brew you can normally expect one to two hours to have passed. Breaking camp is only marginally quicker and may take longer if it has snowed. **20/21**

6.15 **Pup tents**

Pup tents are carried in addition to a pyramid tent as an emergency back-up shelter. Pup tents live on the half unit and go with a party while working away from the main camp, in case circumstances dictate that the party cannot return to the main camp.

Pup tents have the additional advantage of being very quick and easy to pitch even in inclement weather.

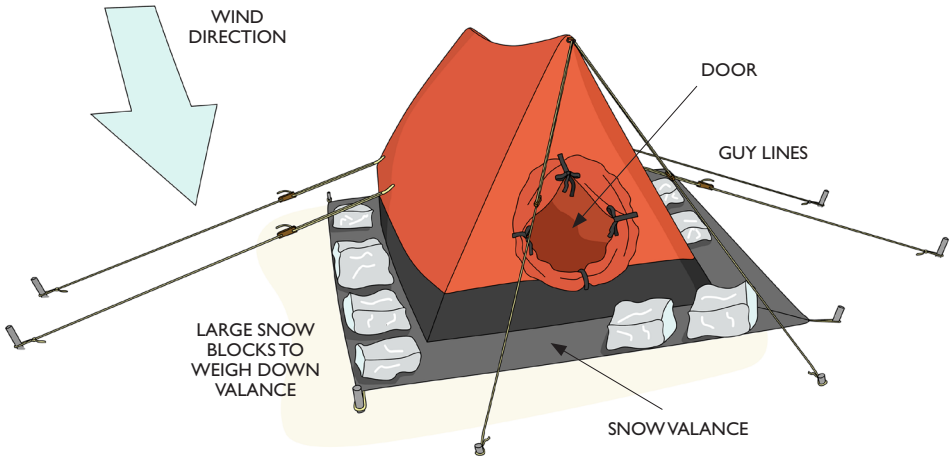


Figure 22 – Pup tent

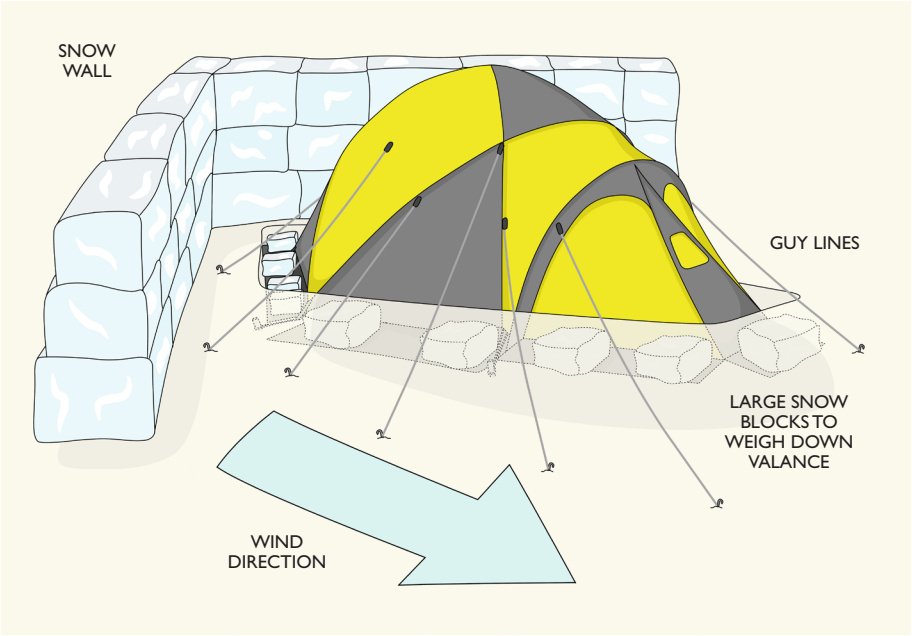


Figure 23 – Mountain tent

Like the pyramids, the pup tents are made from ventile fabric but unlike the pyramids they have a fixed ground sheet and are a single skin so have no porch.

Due to the limited head height in a pup tent extra care needs to be taken while cooking inside pup tents. **22**

6.16 **Mountain tents**

The term 'mountain tents' is used to describe all standard geodesic tents, consisting of an inner and an outer flysheet. Within BAS there are a variety of different models of mountain tent – the most common being the North Face VE25 and Terra Nova Quasar.

As with almost any piece of equipment there are pros and cons of using mountain tents in the field.

The major benefit of a mountain tent is its weight. Being made of modern lightweight fabrics means that you have a substantial shelter suitable of handling extreme weather all in a package that can be carried in a rucksack or pulled easily in a sledge. The obvious trade off with this is durability.

Mountain tents are only used in the deep field when an alternative shelter is also available. They can occasionally be used on their own in the sub-Antarctic. Mountain tents are lightweight by nature and design so are used within the BAS system as emergency accommodation carried by all Twin Otter aircraft. In this context the aircraft serves as the alternative shelter. Mountain tents also have their uses in large camps where a caboose is present and personnel can sleep in mountain tents but do all cooking etc. in a caboose. **23**

6.16.1 **Pitching a mountain tent**

When using mountain tents there are a few key steps that must be followed to ensure the tent will withstand the harsh environment of the Antarctic or Arctic.

Note: One person must be assigned to hold onto the mountain tent at all times during pitching. This person should not assist with the assembling. Take care not to let tent bags etc. blow away.

- Dig out a platform for the tent to sit in, ideally dig until the tent can be placed on a firm surface
- Assemble all the collapsible poles so they are ready to use
- Peg out the inner of the tent in the four main corners
- Feed the poles into the sleeves on the inner tent. Put all poles in before fixing poles into the eyelets
- Drape the outer over the inner and position so that the doors of both inner and outer match up– connect using the overlapping tabs and eyelets
- Insert pole to outer sleeve
- Peg out all remaining attachment corners and guy lines
- Place heavy objects and snow blocks around the valance, ensuring objects do not have sharp edges that could damage the tent. Make sure all of the valance is covered so that wind cannot get between the inner and outer
- Construct a wall on the windward side to protect the tent from wind – obvious downside to this is that you are creating an area of lee where snow will collect and start to bury the tent – this is much preferable to the tent collapsing in strong winds and potentially ripping as poles snap and go through the fabric

6.16.2 **Cooking in a mountain tent**

There are some hazards associated with living in a mountain tent – especially when it comes to cooking. Unlike the pyramid tent, mountain tents have a relatively limited amount of head-height. This means that when using a stove the flame is potentially very close to the fabric, which again unlike the pyramid tent is highly flammable.

The following technique should be adopted at all times when cooking in a mountain tent:

- Dig a pit in the main porch, approximately 60cm deep
- Place stove on stove board in the pit
- Always open part of the tent door for ventilation **24**
- In the polar environment, cooking outdoors is not feasible. The low air temperature prevents the stoves' burner from reaching a temperature capable of vaporizing the fuel into a gas form

6.16.3 **Mountain tent in a storm**

Mountain tents are more than capable of standing up to severe polar storms but require careful management. Snow walls will need to be well constructed and should be regularly monitored throughout the storm. Strong winds can erode even a substantial wall alarmingly quickly – setting an alarm at hourly intervals to go outside and check the tent is recommended. If the storm is very severe, bracing against the tent with your back can improve the strength of the tent but arguably what is required is a bigger snow wall on the windward side. Take great care with regards to carbon monoxide when cooking in mountain tents during a storm as a build-up of snow and ice around the tent can effectively seal the tent from air. A shovel must be kept inside and regular digging out of the door is essential.

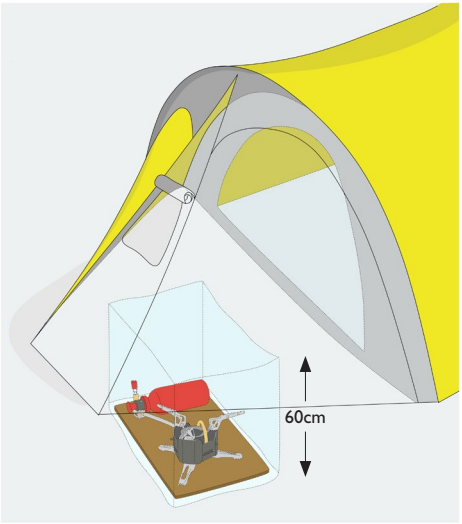


Figure 24 – Cooking in porch of mountain tent

6.17 **Weather Haven**

A company called Weather Haven produces a variety of different tents. BAS uses two tent models from Weather Haven, named Polar Havens and the Series 4. Confusingly, we often refer to both Polar Haven tents and series 4 tents generically as Weather Havens.

Weather Havens are durable, large living and working tents that can cope with prolonged use in the Antarctic environment. Each model has slightly different uses and it is worth checking before taking one out into the field for a project. All Weather Haven tents come in a variety of sizes with the width starting at eight feet and going up in increments of two feet to a maximum of 20 feet. The length of any Weather Haven can be increased indefinitely by adding additional arched sections in 1.2m increments.

Weather Havens are differentiated by their width followed by length in feet. **25**

6.17.1 **Pitching a Polar Haven**

As with any tent, Polar Havens are only able to stand up to the harsh Antarctic weather if pitched correctly. The following steps are key when pitching Polar Havens.

- Dig out a flat platform for the tent to sit in. Dig until you create a flat and firm surface
- The polar havens will work best if assembled on a plywood base (1/4" or 3/8" ply is best to avoid needlessly flying around heavy sheets of wood!) Screw the base together using lengths of dunnage, or similar, underneath the joins. Even if the tent is to be used as a work tent and therefore unlikely to get too warm from stoves etc. it is still worth considering a plywood floor to avoid unnecessary strain on the fabric as the tent begins to melt in

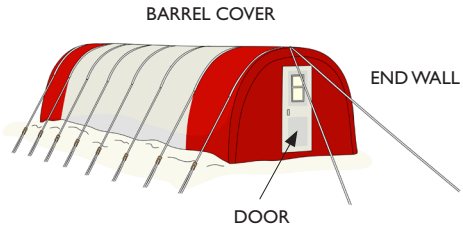


Figure 25 – Polar Haven tent

- If using an insulated floor, lay the floor of the tent out flat on the platform/on top of the ply floor. This is also a suitable time to consider placing any furniture or large objects inside. The remaining tent can then be built around the items
- Assemble the base frame of the tent on top of the floor. The small hooks go to on the inside of the frame
- Use ratchet straps or ropes to hold the base firmly in place and as square as possible. Lots of gash rope will be required for this job
- Assemble the arches, start at one end and work towards the other
- Add roof purlins (straight poles that run the length of the tent), ensuring that these are placed inside the arches as otherwise they can damage the gable ends/barrel cover. Start at one end and work along. In most cases you will need to stand on something to install these – ski-doos work well!
- Once all arches are in position, lash the two gable ends together using more gash rope in a 3:1. This will need to be undone briefly later on as you fit the end wall but it is an important step to stop sections of the frame pinging apart
- Most Polar Havens have vertical bars that fit on the gable ends. These give increased security in windy areas and should be used all the time
- Each step up to this point can be done in less than perfect weather conditions but the next steps will require light winds. In the past people have managed to get the fabric covers on in 20+ knots but this is not advisable and will likely lead to damaging the tent or, if you are lucky, a badly pitched tent that will need re-tensioned once the winds calm down
- The gable end with the door on it should always go directly into the prevailing wind. Polar havens can create huge wind tails so although having a door open into the wind isn't perfect it is a lot more practical than having to relentlessly dig yourself in and out of the tent!
- Fold gable ends over the arches first. Tension the cord that runs through the sleeves and cleat off on the base frame. Next, tension the cord that runs along the bottom of the gable end, running it through the hooks on the base frame

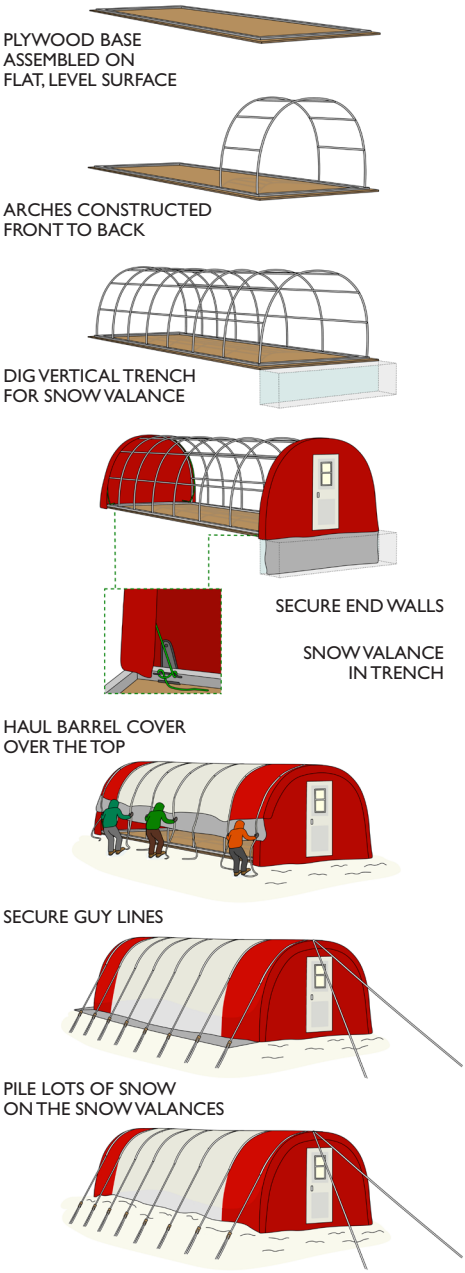


Figure 26 – Polar Haven pitching process

- The valance on the door end of the tent should not be laid flat and covered with snow as on other tents. Instead dig a vertical trench, approximately a shovel blade in depth, and drop the valance down into it so it hangs in place. Now fill the trench in
- Attach barrel cover. To do this you will need three or four people. Tie spare ropes onto the guy point to hoist the barrel cover over the frame. Care must be taken in this step as it is easy to rip the guy points. You will need one or two people inside the tent, standing on top of something to manipulate the cover over the frame and avoid the fabric snagging anywhere and ripping. Pull cover tight along the apex and tension cords over the gable end. This step is made far easier with more hands to spread the weight of the barrel cover
- All polar havens used in the Antarctic should have barrel covers with end guy points and gable ends with a secondary flap to create a good snow seal. Unfortunately some polar havens in the system exist without these features so be sure to check before heading into the field and if going to an area where high winds are likely ensure you take a tent with these features
- Pegging out the Polar Haven. All guy points should be used and anchors should be placed as dead-men and not angled pegs. Ensure that guy lines pull down and not out. This will create quite a steep angle but get the dead-men as deep as possible
- Now pile snow onto the remaining three valances. Don't be shy at this point! A lot of snow is required to make these tents secure. On a large Polar Haven up to a metre of snow is necessary!
- Leave a chisel or similar tool by the door for clearing snow and ice from the frame. The hinges are particularly flimsy and will break! Some doors have locks on them, this is highly unnecessary in the environment we work in so unlock them and get rid of the keys or risk getting locked out when the mechanism freezes up! **26**

6.18 **Clam tents**

Also know as endurance tents, clams are incredibly useful for polar fieldwork. Clams are quick and easy to erect, relatively lightweight and surprisingly sturdy in strong winds. Clams can be used either as sleeping accommodation or more commonly in the BAS

system as a group living tent when on a project with larger numbers.

6.18.1 **Pitching a clam tent**

The following instructions should be read before and followed when pitching a clam tent. As with all tents checking them before you leave station is advised and being familiar with how to put them up will make life a lot easier once you are in the field. **27**

- Having a wooden base for the tent to sit on is highly recommended as the fabric of the clam tents absorbs a significant amount of heat from the sun causing the tent to melt in badly over the course of a field season. As with flooring for Polar Havens 1/4" or 3/8" ply is the most appropriate. First dig out a flat and firm platform for the tent, then assemble the flooring
- The tent should be folded up with the arched pole sections in place. Unfold the tent, unzip the door and crawl in. Next raise the arches into place
- Insert the long tension bars at floor level and extend both sides simultaneously to achieve equal tension on both sides
- The short section that looks like a mini ladder now fits underneath the roof vent
- Peg out all guy lines and pile lots of snow on the valances

Figure 27 – Clam tent

6.19 **Tent anchors**

A variety of different anchors can be used to secure tents. The most effective anchor, and technique to place it will largely depend on surface conditions and the type of tent being used.

6.19.1 **Peg types**

Tubular metal pegs – These pegs are standard for use with pyramids and pup tents but may also be appropriate for use with other tents. They come in two different diameters. The larger ones should be used for guy lines and the narrower ones for pegging out the snow valances. It is recommended to put a double loop around the peg so that it grips better. The peg should be placed angled away from the tent at an approximate angle of 50°. When removing these pegs first loosen the guy line and then stamp them down into the snow to break the ice – now they should pull out easily. In soft snow, warm temperatures or times when solar radiation is high, pegs must be regularly monitored and re-placed if necessary. **28**

Lightweight pegs – These are often made of bamboo and are only used with mountain tents. Alternative lightweight pegs include old poles from mountain tents.

Dead-men – both the tubular metal pegs and the lightweight pegs can be used as dead-men anchors to secure tents. Virtually any item can be used as a

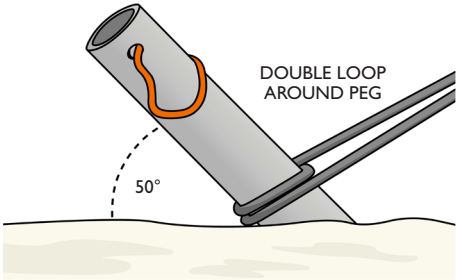


Figure 28 – Tent peg placement

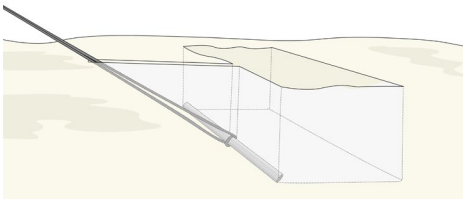


Figure 29 – Horizontal tent peg placement

dead-man and provide a solid anchor. Dig a t-slot deep into the snow and insert the item you wish to use horizontally. This technique is particularly useful in soft snow conditions or with large tents that require additional security. **29**

Buried bags – in particularly soft snow bin bags or similar can be filled with snow and then buried deep down as a deadman.

V-threads – if camping on ice, v-threads are likely to be your best hope of a secure anchor. Question whether camping on ice is really your best/only option as these areas are likely to be subjected to strong winds!

Traditional tent pegs – these are used in snow-free areas on the northern Peninsula or sub-Antarctic islands.

Heavy-duty pegs – steel v-shaped pegs are used for rough ground and are required for windy areas camping off snow.

Rocks – if camping on a snow-free area, rocks can be useful for securing guy lines and snow valances.

6.20 Camping in bad weather

Extreme weather conditions are a fact of life in the Polar Regions. To survive comfortably in a polar storm with only canvas between you and the elements requires an organised and systematic approach. You should always set up camp on the assumption that the weather will turn ugly. This way you will not be caught out by a fast-moving weather system.

6.20.1 **Managing a camp during a storm**

As previously mentioned, organisation is the key to good camp management in bad weather. Having a clear system and a neat camp will make the process during and after a storm a lot easier.

Camp layout

Setting up camp with the same layout every time you pitch means that it is easy to find things even after a storm when most equipment will be fully or partially buried. Orientate all depots, sledges and vehicles into the prevailing wind and mark everything with flags.

Plan ahead

If you know that bad weather is on its way, make sure all fuel bottles for the stove and lamp are filled and have a jerry of kerosene between the inner and outer of the tent. Stock up on snow blocks for melting into water and refill the inside food box. Ensure any loose items around the camp are securely stowed to avoid anything blowing away. This is a problem both in terms of losing important equipment but there is also an environmental issue.

An event that cannot really be guarded against is that of wind-blown ice grains, ice chips or moraine grit. Abrading or even shredding the outer material of the tent can result. Choice of site is therefore important.

Communication

Communication is one of the most important elements of camp management in bad weather. This means communication with the other person in your tent and between the other tents within your camp. Having a VHF radio in each tent is a good way to stay in touch – arrange a regular time throughout a day of lie-up when each tent group switches on their VHF. If you need to go outside to use the toilet, collect snow for water or for another reason, make sure you let the other person in your tent know your intentions and how long you plan to be.

Monitoring tents

During bad weather regular trips outside are necessary to check that tents and equipment remain secure. Strong winds cause drifting and scouring to take place, which can reduce the security of the tent. Don't neglect other tents in the camp; it's easy to forget about the toilet tent or a work tent!

Drifting snow

Drifting has been known to bury tents completely. In a buried tent the risk of carbon monoxide poisoning increases as the tent walls become iced and cease to breathe. Clear the vent regularly and brush off snow and ice. Drifting can also leave you trapped if the tent has been incorrectly pitched with the door in the lee (the wind could of course change direction!). Always keep a shovel handy. It is a good idea to keep a small avalanche shovel in between the inner and the outer.

Scouring snow

Scouring has the opposite problem and can quickly rid the tent valance of any snow. As pyramids do not have fixed ground sheets, once the valance has been scoured of snow the wind can potentially get under and start to lift the tent off like a parachute. It is very

important to keep an eye out for any scouring and add more snow blocks or heavy items to keep the tent secure. Scouring can also leave the whole tent sitting on a pedestal, which is a particularly vulnerable position to be in. It is possible to lower a tent in-situ by shovelling snow out of the door.

Going outside

During a storm you will have to leave the tent at some point to check the security of the tent, go to the toilet and collect snow for water. Plan ahead to minimise how much time you are exposed to the elements for. Make sure you wear appropriate clothing for venturing out, even if you plan to only be out for a short time – goggles are essential. Always inform your tent mate of your plans and if visibility is particularly bad consider setting up a hand line with a rope so that you can find your way back to the tent. Another option is to tie onto a rope and have your tent mate belay you from inside. Each member of the field party should be issued with a whistle, which they should always have on them for such situations. See Chapter 5 – Personal survival for details on personal relocation techniques for if you do become disorientated and lose sight of your tent.

6.20.2 **Tent loss**

It should be stressed that this is a very rare occurrence. Pitched properly and in a suitable location, a tent is a secure and extremely safe living unit (particularly the pyramid tent). Prevention is better than a cure so remain vigilant and self disciplined, as stated above, regular inspection of tents from the outside is necessary during a storm.

If things do go wrong you should at least be prepared. With loss of the tent imminent the following actions might help:

- Melt and store as much water as possible
- Pack away items in boxes but keep food, water, pee bottle and knife handy
- Place your airbed, sleeping bag and sheepskin inside a survival bag along with the radio and satellite phone. Clothing, including boots, should be put on at this stage
- Place an anchor beneath the groundsheet securing yourself and the bivi bag to it. In cases where the wind is trying to lift the tent a rope secured to the apex internally and anchored to the snow inside the tent can give added security – this technique is only possible with a pyramid tent where the groundsheet is not fixed! In an emergency cutting a hole in a mountain tent ground sheet may be a good option
- Secure as many other items as possible

It is a very rare occurrence to lose a tent. However, if you act sensibly, your situation should be one of severe discomfort rather than life threatening.

6.21 **Ventilation**

It is essential to ensure that ventilation is adequate as combustible stoves and lanterns are used inside tents. Different tents have different options for ventilation, the key points are:

- Ensure there is adequate ventilation at all times when a stove or lamp is in use
- Check ventilation frequently to make sure snow/ice is not sealing up the means of ventilation
- Always ensure a carbon monoxide monitor is switched on and working prior to igniting a stove or lamp

6.21.1 **Carbon monoxide monitors**

Good ventilation is essential to stop carbon monoxide build up within the tent. Carbon monoxide monitors should be present in all tents that have a stove or lantern inside. The monitors should be positioned at head-height while sat in the tent. Monitors should be set to alarm at 100ppm in a single spike to draw your attention to high readings and at 200ppm to indicate a dangerous level of CO. It is common for monitors to reach up to 70ppm while priming stoves or lamps but once fully lit the level should return to 20ppm or less. During the lighting of stoves or lamps keep an eye on the monitor. Monitors have long-life batteries and can be left on but check each day to ensure they are still working.

> Caution: Carbon monoxide monitors require annual calibrations to ensure they operate effectively. Check all monitors prior to field deployment and carry a spare.

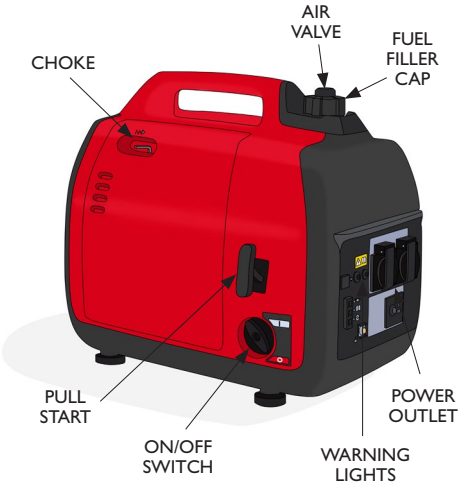


Figure 30 – Honda generator

6.22 **Power in the field**

These days power is virtually essential in the field for charging scientific and communications equipment. The main sources of power are petrol generators, large pre-charged batteries and solar panels. Other sources such as 12V sockets on snowmobiles are useful for charging small items on the move.

6.22.1 **Petrol generators**

By far the most efficient and convenient source of power in the field is a petrol-driven generator. A variety of sizes and power outputs are available but typically a 1000W (1kW) or 2000W (2kW) Honda generator is used for in-field charging. **30**

Start procedure:

- Ensure generator has enough fuel – it's always worth filling up before you start the generator
- Check the oil in the sump with the dipstick on a flat and level surface
- Open air valve on fuel cap
- Turn on/off switch to on position
- If starting from cold slide choke lever to full
- Pull cord to start
- Once started gradually move the choke lever to the off position (left) as it warms up
- Once on leave to idle for a few minutes before adding a big load

Caution: Never operate a generator in a confined space such as a tent due to risks from carbon monoxide.

6.22.2 **Solar panels**

With 24-hour daylight during the polar summers, solar panels are an obvious and relatively lightweight option for charging equipment. They have the advantage of being lightweight but the major downside is the durability.

6.22.3 **Sunlight batteries**

Sunlight batteries are essentially car batteries and can be conveniently re-charged in the field when used in conjunction with a solar panel. They are ridiculously heavy and notoriously difficult to lash to a sledge!

6.23 **Tent living**

The key to comfortable tent living is to be organised and have a well-practiced system. Creating a routine that over time will become second nature will make a long season in the field a lot easier.

6.23.1 **Practical tips for tent living**

- Avoid bringing snow into the tent, keep a brush at the entrance to the tent and remove snow stuck to clothing and boots before entering
- Enter and exit the tent as carefully as possible. Try to avoid putting unnecessary strain on the tent fabric by leaning on guys, the tent outer or entrance tunnel
- Hang as much as is practical in the tent apex to dry but be vigilant to the risk of fire. If using the lantern with clothes hanging in the apex, suspend the lamp at the very end of the hanging cord. The cord should have a slipknot so that the lantern can be raised and lowered. Beware of the lantern hood, it gets very hot and can cause serious burns.

- Don't leave pots boiling as this will lead to condensation and rime ice. Never leave a stove or lantern burning in an empty tent or go to sleep with either burning. Untended appliances greatly increase the risk of fire and carbon monoxide. Take the utmost care while cooking on the stove. If it becomes necessary to move around in the tent with the stove running, take any pans off the stove momentarily
- Prepare for the following morning by melting snow and filling flasks
- At night, place important items that may be needed where they can be easily found
- Store temperature-sensitive items inside your sleeping bag or close by where they can be kept from freezing, e.g. water bottles and batteries
- Place sleeping board under sleeping system to prevent snowmelt and dampness caused by body heat. Similarly use an up-turned jerry board in the centre of the tent for the tent boxes to sit on. This reduces the chance of ablation and boxes becoming unstable
- If the same camp is to be used for a long period the tent may need to be re-pitched at some point. Don't allow the tent to become completely buried by snow or for it to melt in, causing excess strain to the fabric

6.24 **Fuel spills**

See Chapter 20 – Fuel for details of how to deal with fuel spillage.

6.25 **Striking camp**

The process of striking camp is one that becomes slicker with practice. Like most things in the field a logical approach makes the task easier and more efficient. The following outlines a logical approach to striking camp, but is not the only way to do it. This example explains the process when using a traditional two-man set-up with pyramid tent and Nansen sledges pulled by snowmobiles.

Expect to take a minimum of one hour to strike a small camp.

Step 1 – Pack up the inside of the tent. Put all items away in the correct boxes. Pack P-bags away.

Step 2 – Dig out snowmobiles and sledges (if you want to be really efficient this step can be done by one person while the other packs away the boxes inside the tent). Bring the empty full-unit sledge to the door of the tent.

Step 3 – Dig snow off the valance of the tent. Take special care at this point not to damage the tent by being too aggressive with your shovel! Move as much of the snow as you can with your hands, this works best if firm blocks of snow have been used on the valance. Remove other items from valance such as jerries or food boxes.

Step 4 – Disconnect radio aerial and careful pack away antennae. Pack radio into radio box.

Step 5 – Get one person inside the tent to pass all boxes, sleeping boards and P-bags out. The other person can load these items onto the Nansen sledge.

Step 6 – Now is the point to stop and reassess the plan to move camp. If the weather looks like it is closing in or has dramatically changed since you started packing up do not take the tent down! The tent is the last bit of kit to pack away as it gives you the option to get back into shelter if conditions change.

Step 7 – Assuming weather is good and you still intend to travel, carefully lift the corners of the valance and dig out all of the tent legs. If you are too aggressive with your shovel you risk cutting the lines that tension the tent to the poles!

Step 8 – Dig out all tent pegs so they are exposed but still secure. If there is any significant wind leave the upwind pegs in until last. One by one loosen the guy lines and then remove the peg. Stamping down on a peg will break the ice and allow it to come out easily.

Step 9 – This step will require two people. Each grab two legs of the tent and lift upwards towards the centre of the tent. Holding onto both legs bring them together and drop the tent onto its back (door facing up) with the apex pointing into the wind. If you do not first lift the legs out of their holes you can easily bend them as you tip the tent over.

Step 10 – Shorten all guy lines and lay the wooden toggle onto the valance at the bottom of the tent. Do not tie guy lines up as they can freeze and become very difficult to untie.

Step 11 – Position all legs so that they are together and tie a short piece of cord around them to hold together. Roll the tent up; take care not to catch the dongle during this step.

Step 12 – Lay the ground sheet out flat with the side that was up inside the tent now down facing the snow. Lay the rolled up pyramid diagonally across from corner to corner. Fold one side of the ground sheet over the tent and then roll the whole lot up. Finish it off with two or three short lengths of cord tied around the whole lot to stop it unraveling (use easily releasable knots). Ensure the apex of the tent is well covered by the ground sheet for protection. It is important to cover this well. **31**

Step 13 – Slide the tent into its bag.

Step 14 – Gather all tent pegs and bash against a boot to remove snow and ice from the inside. Try to avoid denting the pegs, as this will make them harder to get out in the future. Put all pegs into a separate canvas bag. **32**

Step 15 – Pack the sledge and lash it. See Chapter 14, Section 14.5.1 for more information on packing and lashing a Nansen sledge.

Step 16 – Check the area to make sure you haven't left anything behind. Equipment should only be left in the field if it has been previously agreed with the BAS Environment Office and confirmed on the PEA. If equipment has been lost or is irretrievable, a waypoint of the location should be made and a MAXIMO report submitted on return to station – the Environment Office must also be informed. Ensure that any hazards are marked if you or others are likely to visit the area again. This is particularly important when camping near field depots where aircraft may be landing. Even a relatively small hole from a tent can cause serious damage to a taxiing aircraft. Also mark any soiled areas, especially in low snow accumulation areas.

Note: Pack your equipment away carefully so that when you come to pitch camp again it is ready to go. Do not cut corners, even if you are taking the camp down to return to a station or other camp – weather may force an unplanned camp to be made.

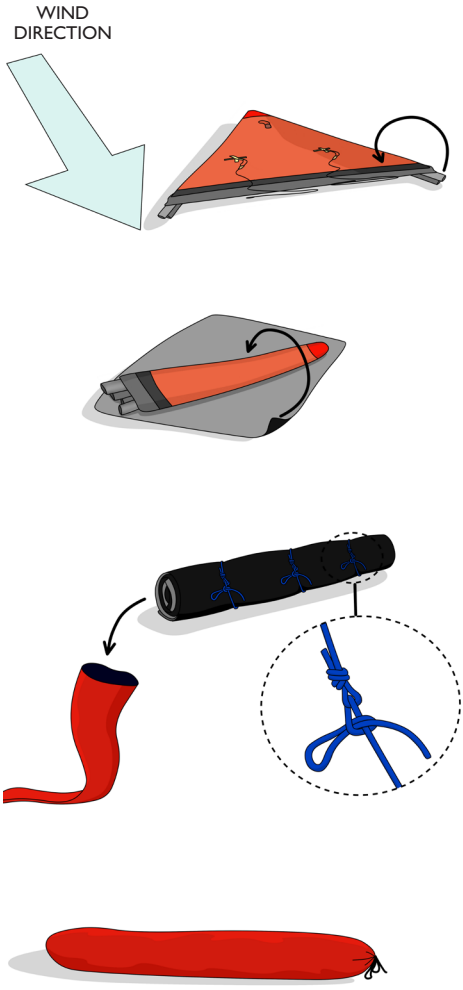


Figure 31 – Packing away a pyramid tent

Figure 32 – Clearing tent pegs

When packing camp up at the end of a project always leave your tent up until either an aircraft is on the ground or a boat has arrived to get you. You can however pack everything else away and have the tent dug out and ready to quickly take down. If weather is marginal pilots will want to load the aircraft as quickly as possible and get back in the air but don't be rushed at the expense of damaging your tent – you may have to use it again before getting back to station!

6.26 **Waste management**

All rubbish should be separated for recycling before being sent back to station. Rubbish should be separated into cardboard, metal, plastic, food waste, packaging contaminated with food and glass (try to avoid taking glass jars/bottles into the field for obvious reasons) and any hazardous wastes (e.g. batteries). Waste food (e.g. peelings, uneaten scraps etc.) can go into the poo bins but packaging soiled with food will have to be bagged separately – both need to be incinerated back on station.

It can be challenging to separate all rubbish in the field, especially while on a travelling project. In such cases where it is simply not practical to have several bags for different rubbish you will need to separate it back on station – do not leave this job for someone else! It is your rubbish and therefore your responsibility to sort. If you think this may be the case with your project discuss with those on station responsible for waste management prior to deployment.

Hazardous wastes must be declared to the pilot in advance so they can determine if they are safe to fly.

For detailed info on this topic refer to the Waste Management Handbook which is available on stations and speak to those employed to manage waste on stations.

6.27 **Conservation of flora and fauna**

Under the Antarctic Act (1994, 2013) the following specialist activities are prohibited without a permit issued by the Foreign, and Commonwealth and Development Office or under delegated authority by BAS:

- Mineral resource activities for the purpose of scientific research
- The taking of, or harmful interference with flora or fauna
- The intentional introduction of non-native species
- Entry into an Antarctic Specially Protected Area (ASPA)
- Entry to a CCAMLR Ecosystem Monitoring Programme (CEMP) site
- Temporarily removing objects from an Antarctic Historic Site and Monument (HSM) for conservation or repair

Conducting activities in Antarctica without first obtaining a permit, or breaching of permit conditions, or breach of a prohibition, is an offence punishable by up to two year's imprisonment and an unlimited fine.

Killing or harmful interference with Antarctic wildlife is prohibited, except in accordance with a permit issued under the Antarctic Act 1994.

- Do not feed, handle, or disturb birds or seals, or approach too closely for photographs (stay at least 5m from wildlife, walk slowly and remain quiet)

- Animal disturbance/handling can only take place as part of an approved BAS science project and in accordance with an Environmental Impact Assessment and Specialist Activities permit issued under the Antarctic Act.
- Do not use vehicles, boats, or aircraft in any way that will disturb wildlife. Avoid taking aircraft, particularly helicopters, within 200m of bird or seal colonies. The noise of low-flying aircraft can cause them to panic
- Do not collect biological or geological specimens (including plants, feathers, eggs, bones, antlers, rocks, meteorites, fossils etc.) unless they are taken as part of an approved BAS science project and in accordance with an Environmental Impact Assessment and Antarctic Act permit. It is illegal to collect or remove any biological or geological specimens unless you have been specifically issued a permit. Items collected under permit and brought back to the UK, such as plant specimens or seal and whalebone, will also require import licenses, which must be arranged in advance of their departure from Antarctica. Ensure that Cambridge and your Station Leader are aware that your project requires such licenses – the lead scientific investigator on a project is ultimately responsible for this
- When walking, use established routes where possible
- Do not walk or drive over extensive areas of moss or lichen
- Prevent light pollution – switch off external lights and close blinds (to prevent bird-strike)
- Do not use an UAV/RPAS in the field, particularly over wildlife, unless the activity has been specifically reviewed and approved as part of an Environmental Impact Assessment
- Do not leave any sign of your visit. This includes cairn building, snow pits, graffiti on rocks etc.
- All field staff should adhere to the BAS Environmental Code of Conduct when operating in the field

6.27.1 **Biosecurity**

- The distribution of many Antarctic plants, invertebrates and microorganisms is limited to a small area on the continent. Field parties may inadvertently transfer species from one part of Antarctica to another which may disrupt established biological communities and compromise scientific activities. Care should therefore be taken not to transfer species into or between sites in Antarctic
- All field guides should be familiar with the relevant provision of the BAS Biosecurity Regulations, particularly those relating to field activities
- All equipment should be clean and free of soil and non-native species before being deployed into the field
- Where possible, camps should be established on areas of permanent snow and ice, and not on ice-free ground. If camping equipment is deployed on ice-free ground, it is likely to become contaminated with dust, mud, soil and possibly guano, all of which may contain biological organisms (seeds, plant material, invertebrates, microorganisms, etc). To avoid inadvertent transportation of these species between field sites and/or research stations, a plan should be developed prior to deployment, in association with the BAS Environment Office through the Preliminary Environmental Assessment process, to minimise the risk of species transfer
- When working in areas of permanent ice and snow (ice sheet, glaciers, etc.) visits to nearby ice-free ground are not to be undertaken unless permitted for essential scientific, environmental management or logistical reasons and detailed within the associated environmental impact assessment. This is to avoid the inadvertent disturbance and contamination of these, often pristine, locations

6.27.2 **Protected areas**

Some areas in the Antarctic require special protection or management because they include outstanding values, historic values or are areas of high human activity where international coordination is needed. The greatest concentration of these sites is on the Antarctic Peninsula and the maritime Antarctic Islands.

Sites that require special protection are:

Antarctic Specially Protected Areas (ASPAs)

These are areas that protect outstanding environmental, scientific, historic, aesthetic or wilderness values that may include:

- Important or unusual animal or plant communities or habitats
- Unusual landforms
- Historic sites

Entry to an ASPA requires a permit that is normally only issued on proof of compelling scientific reasons.

Activities within an ASPA must be conducted in accordance with its Management Plan. ASPAs include all Specially Protected Areas (SPAs) and Sites of Special Scientific Interest (SSSIs), designated by past Antarctic Treaty Consultative Meetings.

Antarctic Specially Managed Areas (ASMAs)

These are areas where human activities need to be coordinated to avoid the risk of mutual interference such as where there are two or more research stations and/or substantial tourism activity. A permit is not required to enter an ASMA but the associated Management Plan directs activities and should be complied with.

Historic Sites and Monuments (HSMs)

These are sites that have been deemed to have historic value and are designated as HSM to preserve and protect them. If these sites are visited, record their condition and inform Cambridge/FOM/SL. The relevant provisions of any Conservation Management Plan must be complied with, as appropriate.

- Do not remove, disturb or damage anything associated with a Historic Site or Monument. Take care of Antarctica's heritage
- If you visit huts make sure windows, shutters and doors are properly closed when you depart. Report any problems. Any significant maintenance at these sites should be done in consultation with Cambridge
- Do not smoke in or around historic huts. Fire is a serious risk and there is no fire protection in these old buildings

To protect all these sites you should:

- Know the locations of ASPAs, ASMAs and HSMs near to where you are working and be aware of their Management Plans or Conservation Management Plans
- A permit is required to enter an ASPA which will be issued by the Environment Office on behalf of the BAS Director or by the Foreign Commonwealth and Development Office. Carry this permit with you in the field. If entering an ASPA, the Management Plan must be adhered to
- Please note that the use of vehicles in most ASPAs is prohibited; this should be stipulated in the Management Plan

Chapter 7 – The BAS system

7.1 Introduction

Equipment is packed into purpose-made wooden boxes that fit onto the Nansen sledges. These boxes are colour-coded for easy identification. Each box contains the same contents to ensure that there is a standard system. Many Field Guides will personalise the contents slightly by adding items they find useful but the base kit always remains the same. The boxes are divided across two sledges, one known as the full unit and the other the half unit. The full unit contains the kit you will use every day and the half unit contains emergency equipment. For additional information on this system and the kit carried on each sledge go to Chapter 14, Section 14.1 – The BAS Field Unit.

For a complete list of the contents of each box see Appendix A2.

7.2 The BAS box system

7.2.1 Tent box – yellow

This box contains domestic items such as bowls, mugs, and cutlery. The tent bag should also be removed from the medical box and put inside the tent box. This gives easy access to commonly used first aid items such as plasters and mild painkillers. This box also has space for adding personal items such as books, iPods etc. If operating in the field as a team of three in one tent, this box will need additional items added to accommodate the extra person. See Contents Lists for more information.

7.2.2 Pots box – blue

The pots box, unsurprisingly (!), contains cooking equipment. The stove, lamp, pots and fuel bottles live in here, along with relevant spare parts. The paraffin lamp with its glass top is obviously delicate so care needs to be taken when packing this box for transportation. The Sigg fuel bottles have also been known to puncture if packed tightly on top of the stove. Ensure bottles containing fuel are the correct type. The BAS aircraft carry a modified pots box on board at all times. This box is adapted from a standard pots box, containing a stove and the items required for basic maintenance and cooking combined with an emergency medical kit. For more Information see Chapter 17 – Aircraft operations

7.2.3 Inside food box – beige

This box is for decanting food from a 'Field Rations box' to have inside the tent. Everyday items such as brew kit, breakfasts, and snacks should go in here along with meals for a couple of nights. It is common to supplement the standard field food with some 'goodies' from station. These can be packed into this box too.

7.2.4 Radio box – red

Contains the high frequency radio used for primary communication between field parties and stations. The box itself is left outside but the radio is set up inside the tent.

7.2.5 Primary healthcare module – white with green cross

Comprehensive medical box including antibiotics and prescription-only painkillers. Most of the items in here should only be used after consulting with a doctor. The first response bag (cold) contains emergency equipment designed to be grabbed quickly and includes everything needed in these situations. Everyone going into the field should complete a training session with the station Doctor prior to deployment.

7.2.6 Spares box – orange

The spares box is essentially a pots box and a tent box combined. It contains a multi-fuel stove as the back-up to your main stove to allow flexibility in all situations. In addition it has a selection of useful parts for a multitude of in-field repairs.

7.2.7 Emergency food – green

The emergency food box contains food for two people for a duration of three weeks – that is 42 individual days' worth of food. The contents of this box are designed to keep you alive until relief arrives or weather improves enough to travel back to station or your main camp. It is assumed that if you are eating the food in this box, work will be suspended so less food is required for energy. The contents of this box will need to be rationed so that it can last the full 21 days. It is very rare that this box needs to be opened and used.

7.2.8 **Snowmobile spares – black**

Comprehensive selection of ski-doo parts that can be replaced in the field. Note that the parts differ depending on the model of snowmobile, so before going into the field make sure you have the spares that match your vehicles! Speak to the Garage for more information.

7.2 **BAS sleeping system (P-bag)**

The sleeping bag and all associated equipment are carried in what is known as a P-bag (personal bag). Before leaving station to go into the field it is each person's responsibility to ensure they have a P-bag with them. On returning to station, individuals should take responsibility to hang up their P-bag to dry and air, before re-packing it ready for their next trip.

The P-bag consists of several items as follows, and should be laid out in this order:

- Foam sleeping mat
  - A simple mat that is the bottom layer of the system
- Thermarest (inflatable sleeping mat)
  - If possible allow the Thermarest to self inflate. Moisture from exhaled breath can damage the internal structure of the mat as it freezes
- Sheepskin rug
  - Comfortable warm layer
- Sleeping bag
  - A variety of models exist within the system for use in different regions; ensure you have a sleeping bag appropriate to temperatures likely to be encountered where you are going
  - Most sleeping bags are down filled as this provides the best warmth to weight ratio. Synthetic filled bags are available for use in wetter areas or for those with allergies
  - Cotton liners are available and used an extra layer to help keep the sleeping bags clean
- Fleece Liner
  - An extra layer of warmth that can be used inside the sleeping bag
  - Often used as a pillow when not needed for additional warmth

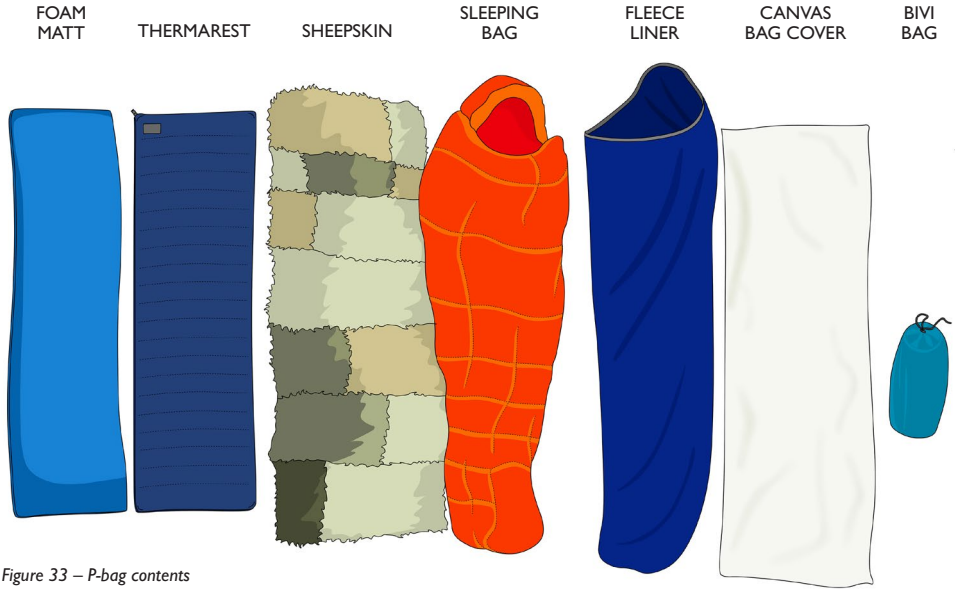


Figure 33 – P-bag contents

- Cotton/canvas sleeping bag cover
  - This must be used at all times over the top of the sleeping bag to protect it from fuel spills and fire damage from the stove **33**
- Bivi bag
  - Emergency shelter kept at the bottom of the P-bag. This is a last resort and a back up in the event that your tent blows away! Very rarely used but an important piece of kit

Other items can be stored in the P-bag, for example down boots, pee bottle and spare clothes and spare boot liners.

To pack the P-bag the foam mat, Thermarest and sheepskin rug should be rolled up and tied together. The other items can then be stuffed into the P-bag. Make sure that the canvas bag is lined with a plastic bag to guarantee your sleeping system remains snow-free and dry. When closing the bag use an extra piece of cord to tie to the top shut.

Chapter 8 – Field huts

8.1 Introduction

BAS uses a variety of field huts and cabooses for accommodation. Some are modular structures that can be taken apart and moved, while others are fixed installations. Some huts are fully equipped while others involve a degree of camping within.

Huts are commonly sited in areas that are frequently visited or even permanently occupied during the summer season. Other huts are found in strategic locations to serve as emergency shelters.

Specific 'operating instructions' for each hut can be found inside the hut itself and on station. Detailed inventories for each hut should be kept on station and are worth consulting before a visit. If time allows, these inventories should be updated after each visit too. Inventories contain useful information such as what food and fuel is at the site.

There is a dedicated policy covering the use of huts in the sub-Antarctic islands (South Georgia, Signy etc). For more information on this consult your Station Leader.

8.2 Considerations when using huts

Regardless of the duration of stay there are certain points to consider when using field huts.

- Do not rely on getting to a hut when travelling! Field parties should always remain independent and carry equipment necessary for camping. This is even more important if visiting a hut that no-one has been to for a while
- Establish areas for going to the toilet and areas for collecting water/snow. Most huts will already have a procedure in place for this so check before using a new area
- Ensure adequate ventilation before igniting any stoves, lanterns or heaters. All huts should also have working carbon monoxide monitors – check these before using stoves etc.
- It is important that huts are always left in a usable condition. This means tidying up before you leave. Remove any rubbish that has accumulated and leave stoves, lanterns and heaters fuelled and ready to light
- Towards the end of a visit document the provisions that are at the hut and note their condition. These records are kept on the relevant station and will need to be updated upon your return to station
- If any essential repairs are required report this to station and if you have the appropriate provisions carry out the repairs
- Leave huts well sealed from the elements. Once wind and snow gain entry to a hut they can quickly be destroyed and rendered unusable. Ensure doors and windows are properly shut and in some cases sealed with tape

8.3 Inventories

All huts should have an up-to-date inventory. These inventories should be consulted prior to a planned visit to a hut as the previous users may have recorded a list of replacement items that need to go in.

Hut inventories can be obtained from the FOM or Station Leader and prior to a visit must be updated. Inventories contain accurate figures of the quantity of food and fuel at the hut and any equipment present (stoves etc.).

8.4 Refleks stoves

Many huts and cabooses are equipped with Refleks stoves to provide heat. These stoves run on either kerosene or at locations where aircraft are regularly passing through leftover aviation fuel (AVTUR).

Refleks stoves provide a fuel-efficient source of heat and can also be used for melting snow for drinking water.

Ignition procedure:

1. Make sure chimney flue is unobstructed. Flues are often left with a cover over the top to prevent snow from blocking them up.
2. Ensure adequate ventilation, turn on carbon monoxide monitor.
3. Check fuel tank has fuel in it. If necessary fill up using the funnel supplied. Do not over-fill the fuel tank; only fill to three-quarters full. Kerosene/paraffin is the standard fuel for use with these stoves but aviation fuel is used in some cases. Check the fuel required before refilling the stove as all stoves vary.

Warning: Never use petrol with Refleks stoves!

4. Turn in-line fuel switch to open position.
5. Give fuel pipes a clean using the in-built cleaning mechanism.
6. On the base of the stove turn the dial to pilot position.
7. Pour approximately 50ml of methylated spirit into the stove through the top lid.
8. Light a match and carefully drop into the stove. Sometimes a piece of scrunched up toilet paper can help the meths light.
9. Check to make sure the meths is alight – close lid and wait five minutes before turning the dial to position 1 and therefore allowing fuel into the stove.
10. To extinguish the stove turn the dial to 'off' position and turn the in-line fuel switch to off.
11. Always allow the stove to cool before attempting to relight. The stove MUST NOT be re-lit when hot.
12. Be aware the flue will get extremely hot and remain so for a long time after the stove has been turned off, take care not to burn yourself. **34**

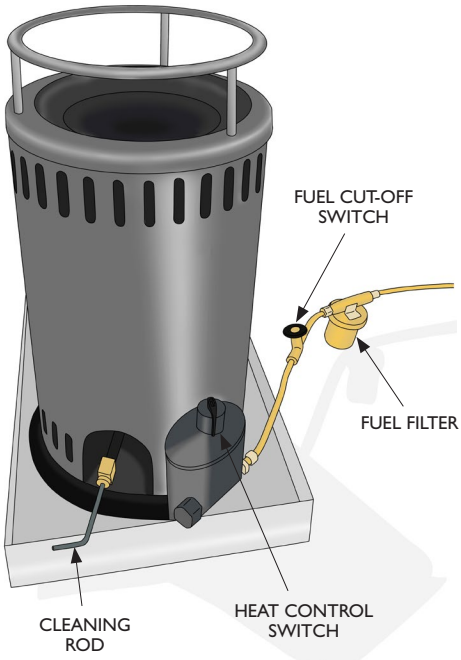


Figure 34 – Refleks stove

8.5 Risks in huts

Staying in a hut in the field presents the same risks as staying in a tent, however there are some risks that are more present with hut living.

8.5.1 Fire

Fire is always a risk when using combustible fuels for cooking and heating. It is of particular concern when staying in huts as many are made of wood or other highly flammable materials. Fire blankets and fire extinguishers are available in all huts and if you noticed that they are not this must be reported to station management.

Combustible appliances should be looked after and given regular maintenance. If something isn't working correctly, fix it or don't use it!

8.5.2 Carbon monoxide

Carbon monoxide is an ever-present risk when using combustible appliances. The risk is increased in huts over tents, as the fabric of the hut is not breathable like a tent. Ensure adequate ventilation at all times when using appliances and never go to sleep with a stove or heater on. Carbon monoxide alarms should be used whenever a stove or heater is on, monitors must also be tested on a regular basis.

8.5.3 Entrapment

Most hut doors open either way but not all do! Beware of the possibilities of snowfall blocking doorways and keep a shovel inside the hut. Alternative exits should also be in place and should be maintained. Cabooses often have an escape hatch on the roof.

Chapter 9 – Stoves, rations and cooking

9.1 Introduction

This chapter gives information on the processes involved in cooking in the field. Included within this chapter is information on the standard stoves used by BAS, and procedures for fault finding and maintenance.

9.2 Field rations

Depending on the nature of a field project there may be a slightly different system for food.

9.2.1 Nutrition

Extreme cold and hard work require a great deal of energy. A person living and working in the field requires about 3,350 calories per day. This figure may increase depending on specific activities being undertaken – for example a person sledge-hauling may require around 5,000 calories. Energy requirements will be affected by other influences such as temperature variations associated with altitude and latitude. Field ration boxes contain food for a balanced and varied diet giving around 3,700 calories per person, per day.

Ample calories are provided from field ration boxes and in an emergency even half rations will provide around 1,900 calories per person, per day. Keep a record of when food boxes are opened and continually assess how many days are left. Stick to the ration.

9.2.2 Field ration boxes

The term 'man-food' goes back to the days when BAS used dog teams in the Antarctic. Food for both people and dogs was carried on sledges and thus differentiated by the terms 'man-food' and 'dog-food'. Although outdated, this term may still occasionally be used as slang.

Now officially named field ration boxes, they contain 20 days' worth of food, although it is intended to be used by a team of two – therefore providing food for 10 days for two people.

The specific contents of a field ration box have changed over the years and will likely continue to change slightly year-on-year. However field ration boxes all contain provisions for breakfast, lunch and dinner.

Most of the food within a standard field ration box is dehydrated as this improves the usable life of the food while also reducing weight.

Field ration boxes cost in the region of £300 per box. It is unacceptable to open a new box just because you don't like the meals left in the open one. It is important that you stick to the ration and make a box last 10 days, only opening a new one when no meals remain in the box. There may be some left over items that haven't been eaten by the end of 10 days and these should be taken back to station. They can be used for training or recreational nights away.

9.2.3 Lifespan of field rations

The contents within a field ration box are designed to have a long, usable lifespan. Each box has a date printed on the outside and this is the date the box was packed. Boxes have a life of five years from the packing date. After this date, boxes should be opened up and any items still usable can be added to stocks for recreational nights away/training. Items that are no longer usable should be disposed of according to BAS waste management policy.

It is important that older boxes are used before newer ones to avoid excessive waste. If leaving food at a depot ensure this is of a newer vintage. In emergency situations it may be necessary to eat older food.

9.2.4 Camp rations (10 people, 24- hours)

Where there is a large group in the field it can be more time and cost effective to use group-cooking boxes. These boxes contain wet rations designed to feed 10 people for a 24-hour period. Wet rations have the disadvantages of weighing considerably more than dehydrated meals and having a shorter shelf life. However, they are significantly cheaper than field ration boxes. Group cooking like this ideally requires large pans and several stoves but is incredibly useful to feed large groups of people

9.2.5 Away day food

Some fieldwork is scheduled as a day trip either by boat or aircraft. The intention for these trips is that the field party will return to station the same day and therefore not have to cook a meal in the field. It is

always a possibility that weather prevents the group returning to station, so on such trips each person should take two away day boxes with them.

Away day boxes are designed to sustain one person for a 24-hour period. The main meals in these ration packs are wet and therefore weigh more and have a shorter life span.

Emergency food provisions are carried on aircraft but the away day boxes should reduce the need to use the emergency rations, and therefore reduce the workload (if used someone needs to check and re-stock any opened emergency rations).

9.2.6 **Supplementary 'goodies'**

A modest amount of 'normal' food can be obtained from the station chefs for a field season. As a guide it is a nice idea to have one proper meal a week instead of dehydrated rations. Specific items will vary depending on the stock levels on station but cheese, bacon, bread and condiments can usually be taken.

Some stations also can vacuum seal leftover food from meals to then be frozen and reheated in the field. These do have the downside of being heavier than dehydrated rations but can give a big morale boost in the field.

9.2.7 **Emergency food**

Both field parties and aircraft carry emergency rations and equipment to cover unplanned days and/or nights spent in the field. It is not an uncommon occurrence for weather to delay a field party uplift or prevent an aircraft from taking off and returning to station.

Aircraft

All Twin Otter field aircraft carry basic survival equipment on every flight. This kit includes a combined medical and food box (this is sealed shut and should only be used in an emergency) and a 30 day field food box if an overnight is planned. Speak with the FOM if a food box is being included for the flight (24hr ration packs are available for day trips). See Chapter 17 – Aircraft operations for more info on emergency boxes carried on aircraft.

Field parties

Every field party must carry an emergency provision of food. This emergency food serves two purposes:

1. Additional food to allow for delays in uplift at the end of the project.
2. Emergency food when travelling away from camp for the day to provide supplies in case circumstances (weather, breakdown, accident) prevent return travel to the main camp that night.

The field party emergency food box is painted green and contains emergency food provisions for two people for three weeks (42 individual days worth of food). Therefore a team of six must take three of these boxes into the field with them. Ensure emergency fuel is factored into planning too.

For more information on emergency provisions for field travel see Chapter 7 – The BAS system, and Chapter 14, Section 14.2 on the BAS field unit. Appendix A2.4 contains a list with the contents of an emergency food box.

9.3 **Specific dietary requirements**

Many people have specific dietary requirements, whether that is through a lifestyle choice or due to an allergy. BAS will make every attempt to accommodate specific dietary requirements in the field providing advanced notice is given.

It is important to be aware of the challenges involved in catering for individual food needs somewhere as remote as the Antarctic or Arctic. Resupply on some stations occurs just once a year, so while BAS will make every effort to accommodate everyone's dietary requirements, where there are limited rations, special arrangements will be prioritised for those with genuine allergies and intolerances.

9.3.1 **Vegetarians**

Vegetarian field ration boxes are available. If you follow a vegetarian diet and are going into the field speak to the Field Guide involved or the Field Operations Manager about these provisions.

9.3.2 **Vegans**

Currently, there are no pre-made vegan field ration boxes. With advance notice, BAS can supply vegan dehydrated meals and supplements alongside the vegetarian field ration boxes for field use. It may not be possible to support a fully vegan diet in the in the field but every effort will be made with sufficient

notice. Speak to your Field Guide or the Field Operations Manager if you intend to follow a vegan diet in the field.

9.3.3 **Food allergies**

BAS aims to accommodate people with food allergies in the field if sufficient notice of these allergies is given. If you suffer from food allergies it is important that you make yourself known to the Field Operations Manager who will endeavor to source appropriate food supplies for time spent in the field. Food allergies will also need to be passed on to the medical unit (BASMU), the catering team for the station you will be working through, and the Field Guide associated with your field project.

Whilst BAS will make every effort to cater for people with allergies in the field, sourcing allergen-free food that fits the logistics constraints of the field programme is not always possible. If you have food allergies you must take responsibility for managing them and support others in the field team to do the same.

9.4 **Fluid intake**

In the field water is most commonly sourced by melting snow. Snow for drinking and cooking should be collected from a designated clean area within camp. Site toilets down wind of tents and collect water up wind – make sure areas are clearly marked and that everyone in camp is aware of the clean zone. If working in commonly visited areas be careful not to source clean snow from an old toilet site and if it is likely that people will revisit the area after you, leave flags indicating toilet sites.

Watch out for glacial dirt often present in glacier ice and do not consume water from melt pools and streams at the base of glaciers, as these will contain glacial sediment.

If collecting drinking water from a river or burn ensure it is fast flowing and not stagnant. Also watch out for contamination from wildlife.

Dehydration is a serious concern in the polar environment. The air can be very dry causing your body to lose considerably more moisture through the act of breathing alone, never mind when you are exerting yourself shoveling snow or pulling a sledge!

You should avoid drinks that have a strong diuretic effect, particularly alcohol and strong coffee. The simplest method of checking if your fluid intake is sufficient is by the colour of your urine – it should be colourless or a slight straw colour. If it is not then drink more water!

9.5 **Alcohol in the field**

BAS field parties can be deployed for up to three months at a time, often over the festive period. Some alcohol may be taken into the field, but any consumption must be moderate and appropriate to the isolated and hazardous nature of fieldwork.

The amount of alcohol will be limited in accordance with BAS and station policy, and any leftovers at the end of a field deployment must be returned to station management in accordance with local policies.

Requests for alcohol to take into the field should go through station management and the FOM. Ship-deployed field parties may need to source alcohol before departure and entrust it to the Ship's Master until input.

You are never 'off duty' in the field; you must always be able to respond to any incident and remember your responsibilities to yourself and other field party members.

Anyone impaired by the consumption of alcohol in the field endangers themselves and others and will face disciplinary action.

9.6 **Cooking inside tents**

The extreme nature of the polar environment makes it necessary to cook within the tent. There are a number of serious yet manageable risks associated with cooking inside a tent. The most obvious risk is that of fire, burns and scalds. In addition to this carbon monoxide presents arguably the most serious risk.

9.6.1 **Why do we cook inside tents?**

Prevention is better than cure so why cook inside tents when there is a risk? In the polar environment it is not an option to cook outside. The air temperature prohibits the stove from getting warm enough to vaporise the fuel into its gas form. Combine this with regular and often prolonged storms it is simply not

practical to cook outside. The BAS system has been developed over many years and; when adhered to, provides a safe system for cooking within tents.

In addition to the above rationale cooking inside the tent has other benefits such as warming the tent and helping to dry off damp clothing.

9.6.2 **Recognising and managing the risks**

As mentioned above, the risks of cooking inside a tent are that of fire, burns and scalds and carbon monoxide poisoning. The first step to cooking safely in a confined space is to understand and accept these risks. Managed correctly these risks are minimal.

Fire, burns and scalds

- Never operate the stove inside the tent without first creating a stable platform for the stove to sit on
- Do not overfill the stove with fuel
- Use a stove board that the stove is either fixed to or is held captive
- Do not keep fuel bottles near the stove, keep them either inside the pots box or by the door
- Keep movement to a minimum while the stove is being used and always let the others in the tent know when lighting the stove as the priming stage is silent
- Do not leave pan handles attached or the pump handle extended as this increases your chances of knocking something over
- Do not operate a stove that is not working properly, a well maintained stove is much less likely to flare up. Be vigilant of any leaks and repair as soon as you notice something that is not right
- Ensure fire blanket is removed from pots box and close at hand

Carbon monoxide

- Ensure adequate ventilation in the tent at all times, keep dongler on pyramid tent clear of snow/ice build up
- When possible increase ventilation by opening tent door. If conditions do not allow then as a minimum keep the inner tent door tied open
- Keep the stove/lamp well maintained
- Ensure carbon monoxide alarm is on and functioning correctly – do not ignore a high reading on monitor, it more than likely means the stove isn't running properly or ventilation is inadequate
- Learn to recognise and fix faults, particularly incomplete combustion and leaks
- Change worn fuel jets – worn jets do not allow the correct fuel flow/air mix and cause incomplete combustion
- Always try to start the process of melting snow with a little water rather than snow in a dry pan
- Use clean fuel in the stove, if you notice issues with the fuel switch to a different fuel source
- Do not run the stove with the flame too low
- Use the lantern for heat instead of the stove as generally they burn cleaner than the stoves
- Always use new style pot rings on the stove – old ones leave the pan too close to the flame and increase carbon monoxide production (they should have all been removed from service but occasionally an old one turns up in a box!)

Actions for dealing with fire, burns, scalds and carbon monoxide poisoning:

- If a fire occurs attempt to put it out before it develops by using the fire blanket provided in the pots box
- For burns and scalds cool the affected body part instantly using snow – consult the Doctor for further advice once first aid has been carried out
- If carbon monoxide poisoning is suspected get the victim into fresh air immediately. Extinguish the source of the carbon monoxide (turn off stove/ lamp) and consult the Doctor on station for further information

9.7 **Fuel**

Both the traditional Primus stove and the multi-fuel stove should be run on kerosene, with meths used to prime the stove. In emergency situations AVTUR can be used as a substitute for kerosene. AVTUR is kerosene-based but with additives for aviation use that may cause harmful gases when burnt in a confined space. It should therefore only be used in real emergency situations when no other fuel is available.

Petrol should never be used in the traditional Primus stoves and should only be used in the multi-fuel stove when kerosene or AVTUR are not available.

On some larger projects and on PistenBully traverses, gas stoves are sometimes used. There is little maintenance required on a gas stove, although it should be noted that in the cold the gas bottle might require to be shaken to prevent the gas from separating within the canister.

See Chapter 20 – Fuel for more information on fuels used by BAS.

9.8 Traditional Primus stove

The traditional Primus stove may look like an antique, better suited in a museum, but its place as the primary field stove in the Antarctic is well deserved. The Primus stove is efficient, robust and easy to repair and maintain in the field.

The Primus stove works with liquid fuel and requires to be pre-heated so that the liquid fuel can be vaporised to a gas. **35**

9.8.1 Igniting

The process of igniting a Primus stove is simple but requires a set procedure to be followed.

1. First assemble the stove and place on a stable and level surface.
2. Fill stove with fuel (kerosene/paraffin).
3. Ensure CO monitor is on.
4. Clean stove jet with the pricker.
5. Ensure air valve is open.
6. Add meths to the spirit cup (exact quantity depends on the temperature experienced and will be learnt with experience but it is a good idea to always put in a little more than you think to ensure stove pre-heats enough to avoid a flare-up)
7. Light the meths with a match (in cold temperatures the meths needs to be warmed a little before it will catch, in this case hold a lit match underneath the spirit cup)
8. Wait until almost all of the meths has burnt off, close the air valve and begin to pressurise the tank using the pump.
9. Do not over-pressurise the stove initially, once the stove has lit stop pumping air into the tank and examine the stove – ideally there should be an even blue flame. Look out for any fuel leaks around the burner and if any issues are detected extinguish the stove by opening the air valve – fix the problem and start again. **36**

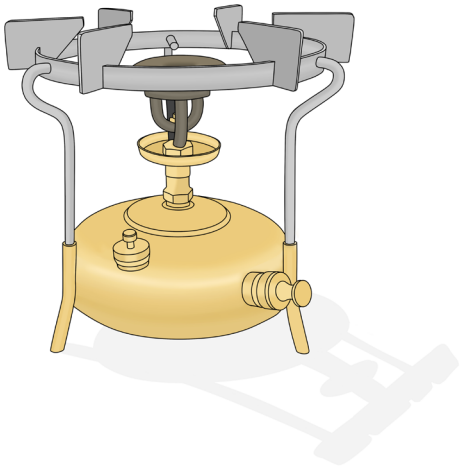


Figure 35 – Primus stove

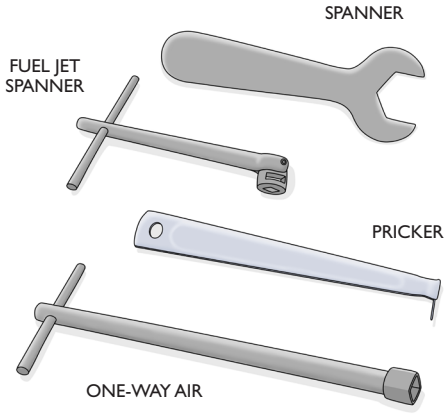


Figure 36 – Important Primus tools

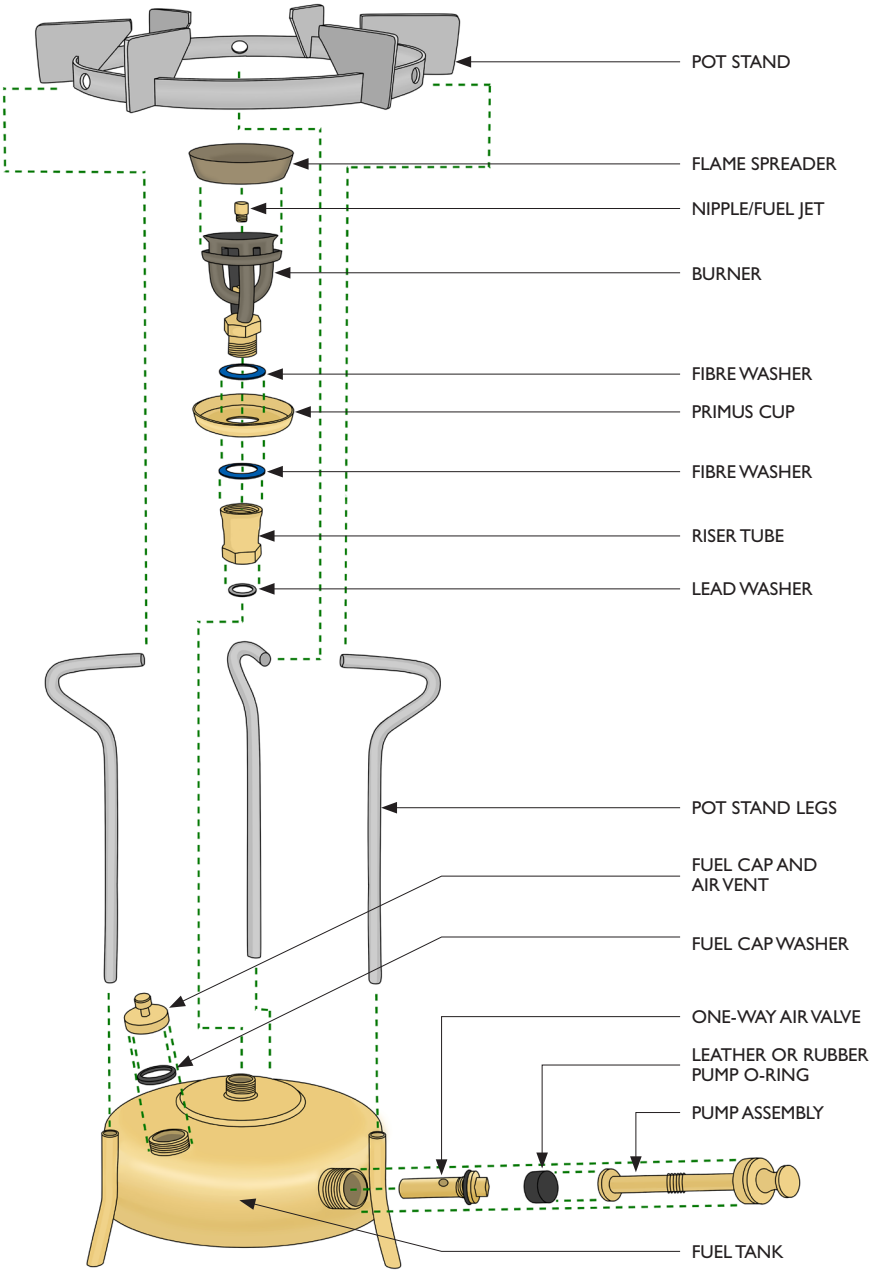


Figure 37 – Primus parts diagram

9.8.2 **Basic fault-finding and maintenance**

The following chart should help with solving some common basic issues with Primus stoves. **37**

Problem	Cause	Solution
Flame not burning evenly or spluttering	Fuel jet blocked	Try cleaning with the pricker – it may be necessary to clean while the stove is pressurised. This will obviously extinguish the flame so have a match on hand to reignite.
Burner excessively sooting-up	Dirty or contamin-ated fuel	Drain fuel tank and start again with a new fuel source (drain into an appropriate fuel container and label as contaminated fuel)
Stove not pressurising	Tank not sealing correctly	Rubber washer on air valve needs replaced
Flare-up occurs even when properly pre-heated	Nipple/fuel jet is worn out causing increased flow of fuel	Replace brass fuel jet
Pump hard to operate	Rubber seal around pump or leather o-ring dry	Lubricate rubber seal or leather o-ring
Smoke or leaking fuel from burner	Fibre washers in burner perished	Replace fibre washers in burner

9.9 **Multi-fuel stove**

A multi-fuel stove is carried in the field as a spare stove. It usually lives in the Spares box on the half- unit sledge. At the time of writing the MSR XGK is the model used for this purpose. However, other models do exist, but the methods of use and fault finding are similar. By having a multi- fuel stove as the spare, it allows a degree of flexibility should petrol be the only fuel available. It should be stressed that kerosene/ paraffin is the primary fuel for all stoves and petrol should be used only as a last resort.

The MSR XGK has two different fuel jets depending on what fuel is being used. One is labeled 'GK' and the other 'X.' The GK jet is used for white gas, kerosene, petrol, and aviation gas. The X jet is for jet fuel and diesel. **38**

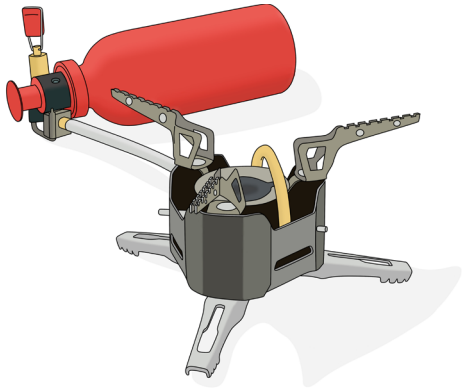


Figure 38 – MSR XGK stove

9.9.1 **Igniting**

The MSR XGK works on a similar principle to the traditional Primus stove but requires a slightly different procedure to light.

1. Prepare the fuel bottle. Fill to 'fill line' only and not beyond! An air gap in the bottle is essential. Insert pump and tighten. Close the control switch and pump the bottle 20-30 times (more if fuel bottle is not full).
2. The MSR XGK has a shaker needle for cleaning the jet. Shake the stove up and down to clear the fuel jet.
3. Set up stove board and assemble stove. Connect stove and pump.
4. Squirt approximately half a tablespoon of meths into the priming cup/onto the priming pad and light with a match.
5. Wait for the pre-heat flame to reduce in size and slowly open the valve on the pump/fuel bottle.

9.9.2 **Basic fault-finding and maintenance** 39

Problem	Cause	Solution
Leaking fuel at pump/ fuel bottle connection	Damaged or missing pump seal	Replace pump seal
Leaking fuel at pump/ fuel line connection	Damaged or missing fuel tube o-ring	Replace fuel tube o-ring
Leaking fuel at air control valve stem	Damaged or missing control valve o-ring	Replace control valve o-ring
Leaking fuel in pump plunger chamber	Obstructed check valve	Clean check valve cavity
Erratic yellow flames	Stove not pre-heated sufficiently	Repeat priming procedure
Pump not pressurising fuel bottle	Damaged pump cup	Replace pump cup
Plunger hard to pump	Dry pump cup	Lubricate pump cup
Diminished flames	Low fuel bottle pressure	Pump the plunger
Slow boil times	Clogged jet or fuel line	Clean jet and clean fuel line

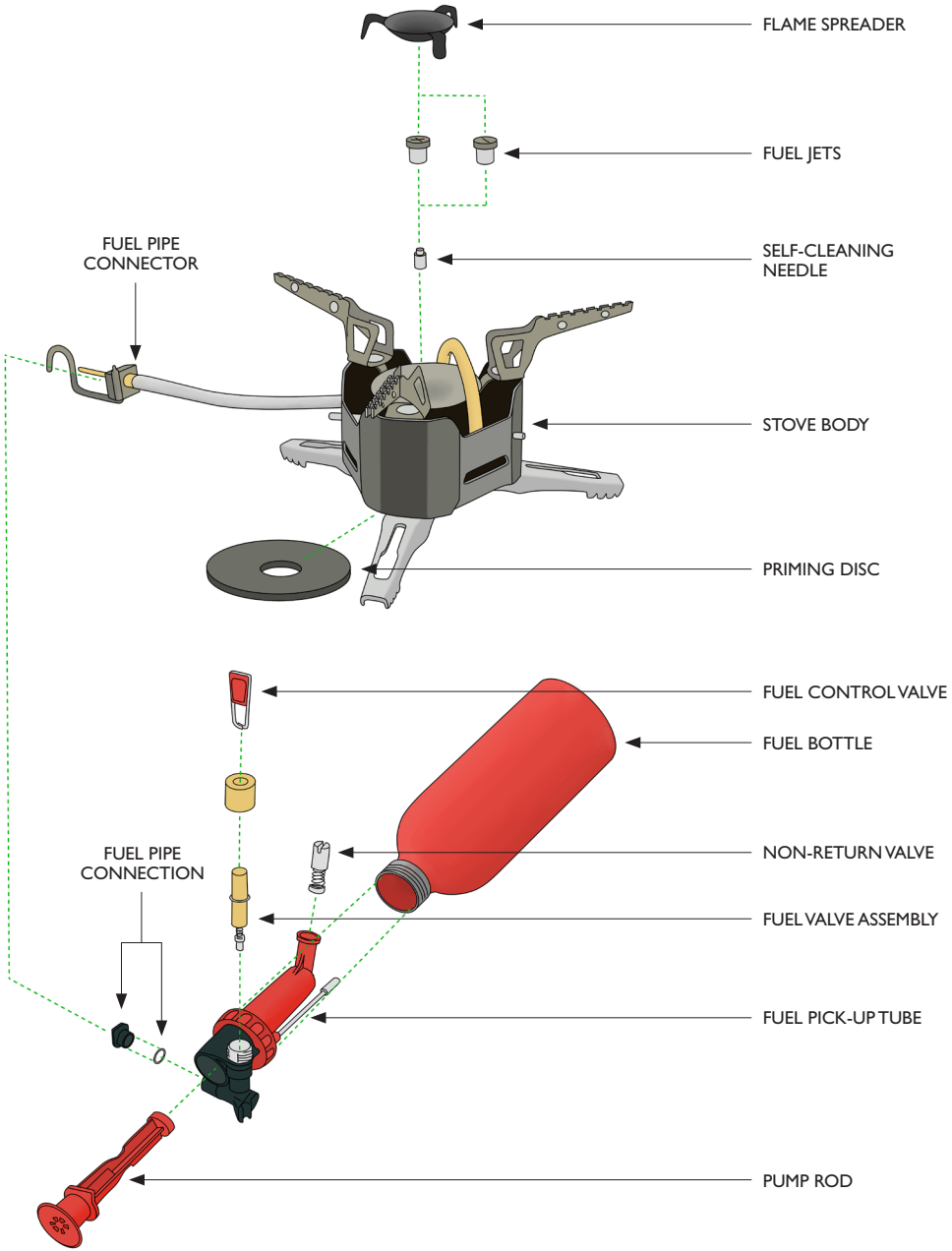


Figure 39 – MSR XGK parts diagram

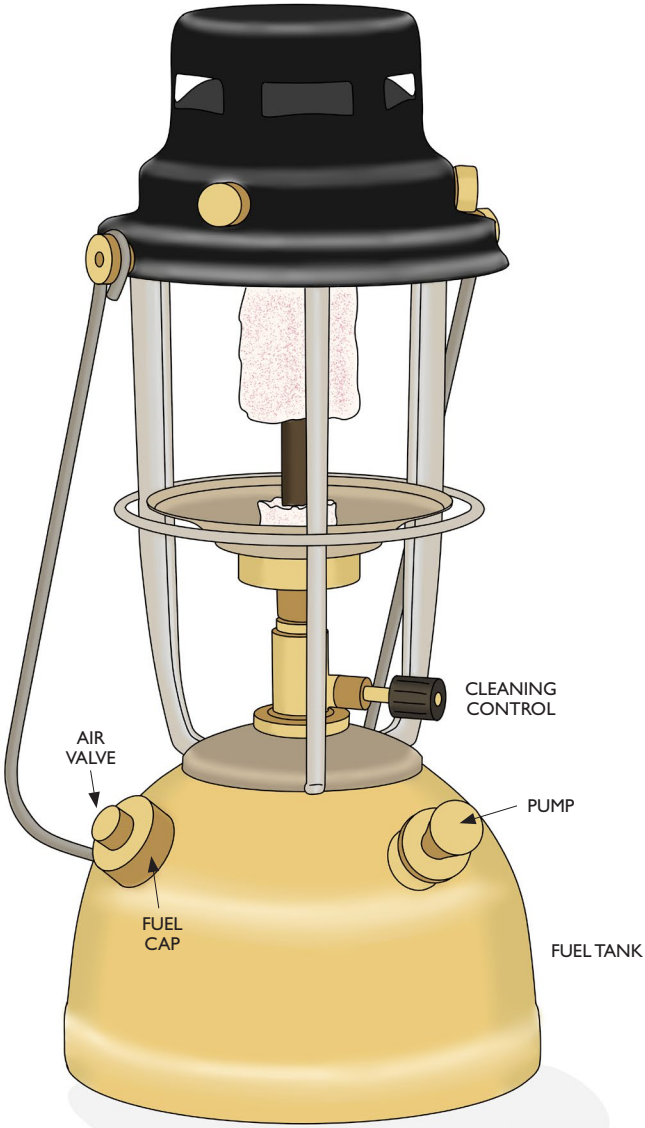


Figure 40 – Vapalux lamp

9.10 Lanterns

Paraffin lamps are used to provide heat and light within the pyramid for comfort and for drying clothing. Known within BAS generically as 'Tilley Lamps', the actual lamps used are made by a company called Vapalux. **40/41**

9.10.1 Igniting

The ignition procedure of the lanterns is similar to that of the traditional Primus stoves but with a couple of key differences.

1. Ensure lamp has fuel in the tank.
2. Check condition of mantle – any holes/tears will require it to be replaced otherwise glass could be damaged.
3. Operate the cleaning switch by turning right to left three or four times, then return switch fully to the left position.
4. Ensure air-valve is open.
5. Fill priming cup with meths – quantity of meths will depend on temperatures but approximately half to three-quarters full. Light meths with a match.
6. Raise priming cup with stand (some models do not have this stand). A used match can be effective in its place.
7. Wait for liquid in priming cup to evaporate, close the air valve and begin to pressurise the lamp.
8. Mantle should make popping sound and begin to glow brightly.
9. Wait for remainder of meths in the wick to burn off before pressurising further.

9.10.2 Basic fault-finding and maintenance **42**

Problem	Cause	Solution
Hole in mantle	Damaged during transport-ation or just old and worn out	Replace the mantle
Mantle pulsing	Low on fuel or blocked vaporizer	Turn off and fill with fuel, reignite lamp. Clean wire inside vaporiser or replace vaporiser.
Lamp not pressurising	Tank not sealing correctly	Rubber washer on air valve needs replacing
Pump hard to operate	Rubber seal around pump or leather o-ring dry	Lubricate rubber seal or leather o-ring

Figure 41 – Vapalux lamp maintenance tools

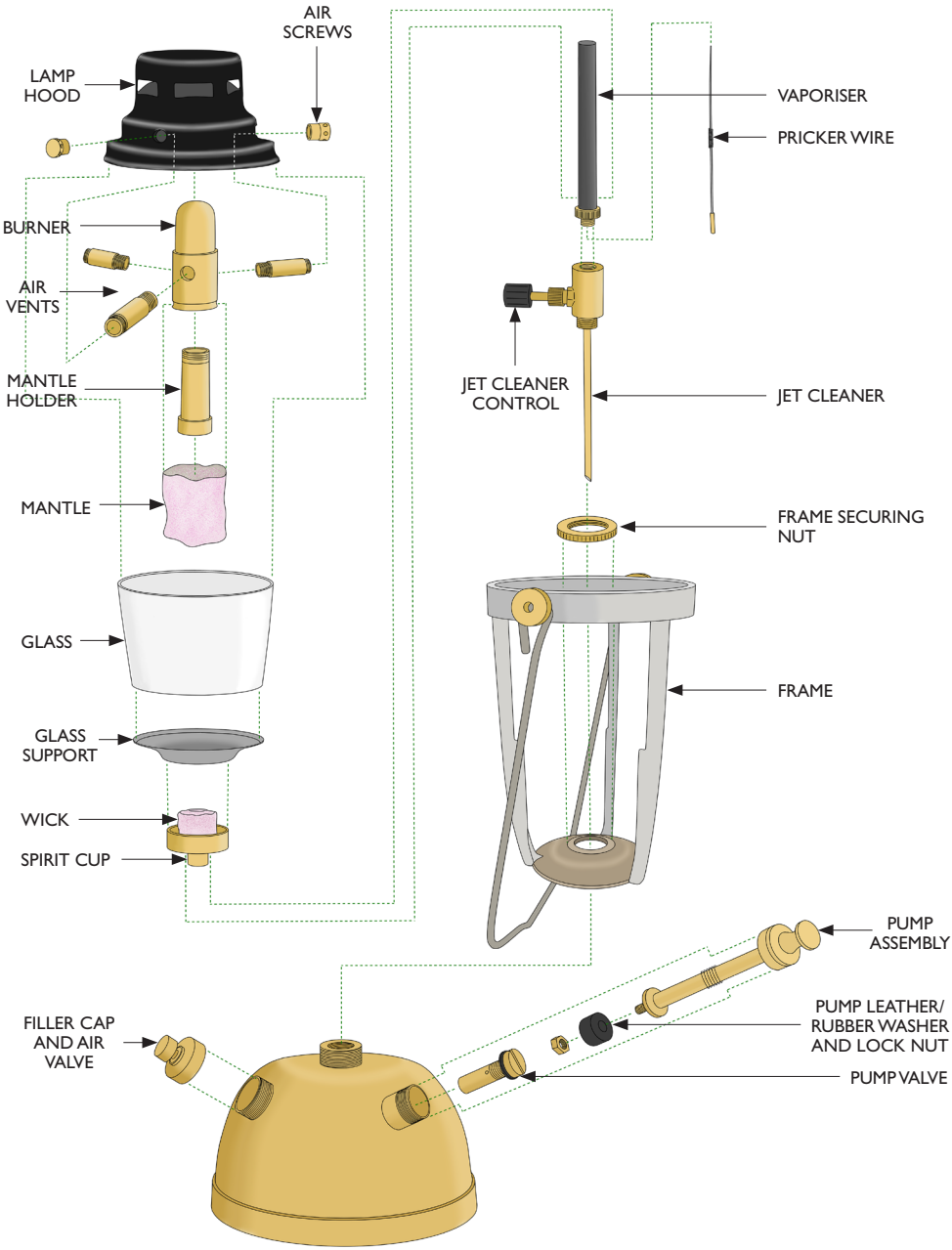


Figure 42 – Vapalux lamp parts diagram

Chapter 10 – Navigation

10.1 **Introduction**

The Polar Regions are amongst the least-explored and least-mapped areas on Earth. Only recently have satellite imagery and modern survey techniques improved the accuracy of the Polar Region's maps. Add to this the flat featureless nature of some areas and the changeable nature of glaciated terrain on an annual basis and you can begin to see the challenge!

A variety of tools are available to enable accurate navigation and route planning to be undertaken. These include maps, compass, GPS, aerial photographs, satellite images and travel reports.

It is very difficult to spot crevassing without good contrast. It is therefore BAS policy that field travel, particularly when vehicles are involved, is carried out in suitable conditions. Of course given the highly changeable nature of the Antarctic climate you may find yourself out in less than perfect weather with the need to navigate back to camp or station. Emergency equipment should be carried at all times and if the conditions are really unsuitable a temporary camp may be required until the weather improves.

This section gives a brief outline of navigation techniques pertinent to BAS field operations. It is beyond the scope of this manual to teach the basics of map work.

Good navigational skills are essential for operating safely and efficiently in the field.

10.2 **Polar maps**

BAS have a mapping department who are responsible for producing maps for field parties. The scales of maps produced vary considerably and some small-scale maps are more suited for a general overview rather than accurate navigational purposes. Before a field project, contact should be made with a representative within the MAGIC (Mapping and Geographic Information Centre) team regarding the provision of maps – ensure this contact is made well in advance of the project. Field Guides should check with the FOM once they have been assigned to a project regarding the provision for maps.

10.3 **Latitude and longitude**

Lines of latitude (the horizontal lines across a map) and longitude (the vertical lines) are used to refer to positions on maps. By using this global grid system it is possible to give an accurate position at any point on the Earth's surface.

The units of measurement are degrees, decimal minutes. Positions are stated as latitude and then longitude (the opposite of how you would give a UK grid reference).

> Note: Be very careful not to pass longitude then latitude, especially when operating on the Antarctic Peninsula as the figures are very similar in this area but will put your position way out!

Latitude positions can be north or south of the equator and longitude can be east or west of the Greenwich Meridian, hence the terms East and West Antarctica.

When decimal minutes are noted they are given as a three figure decimal. This should be installed as part of the GPS set-up.

Latitude and longitude can be presented in a variety of formats:

- Degrees, minutes and seconds – D° M' S"
- Degrees, decimal minutes (this is the format used within BAS) – D° M.M'
- Decimal degrees – D.D°

> Caution: BAS uses hddd°mm.mmm' as the standard position format. Ensure your GPS is set up to use this format to avoid any confusion when passing a location. MAGIC maps however will use Decimal degrees as standard but will support conversions if necessary.

One degree of latitude (but not longitude) equals approximately 60 nautical miles and one minute equals one nautical mile (1.85km). Because the latitude scale on the map relates to distance, it is relatively simple to plot latitude positions. Plotting longitude is more complex. One degree of longitude will be a much greater distance at the equator than it will be at the South Pole. To plot longitude it is necessary to divide up the scale at the base of the map. The most commonly used projection for polar regions is the polar stereographic projection (In our

case WGS 1984 Antarctic Polar Stereographic). It is used because it preserves shapes (i.e. it is conformal) BUT distortion of area and distance increases away from the origin.

The projection depends on the scale. Polar Stereographic for 1:1,000,000 and smaller, Lambert Conformal Conic for medium-scale and UTM zones for large-scale maps (i.e. small mapping areas such as stations). All maps produced and supplied by MAGIC will have the projection clearly stated and will be chosen to limit distortion as much as possible. Please contact MAGIC for any support.

10.4 **Compass**

The compass is an essential piece of field equipment. Silva Expedition 54 models are most commonly used. Ensure compasses are weighted correctly for the hemisphere you are operating in – on Silva brand compasses the letters 'MS' or 'MN' can be seen on the underside of the bezel, this indicates whether the compass is suitable for use in the northern or southern hemisphere. In South Georgia southern magnetic equator compasses are necessary – these are marked 'SME'.

Gimbaled compasses are fitted to most field ski-doos and provide a useful navigational aid. Be aware that the engine will interfere with the compass needle. The ski-doo compass should therefore be used as part of the navigational process and not relied upon entirely. The exact compass degree of travel can be ignored but use it as a rough gauge to check GPS hasn't suddenly encountered a major problem.

10.5 **Magnetic variation**

There is a difference between north on the map and north that the compass points to. This difference is known as magnetic variation.

Magnetic variation is the difference in angle between the Magnetic North Pole and the Geographic North Pole (True North). A compass needle points to the Magnetic North Pole, and the lines of longitude on a map run through the geographic poles.

Magnetic variation alters relative to your position on the Earth's surface. In the areas of the Antarctic, covered by BAS operations, the lines of magnetic variation change are closely spaced.

It is essential that you know the magnetic variation for the area you are travelling in, otherwise the compass could be useless. This can be found from a variation chart. It can also be found from the GPS. Magnetic variation must be factored in when going between the map and the compass. **43**

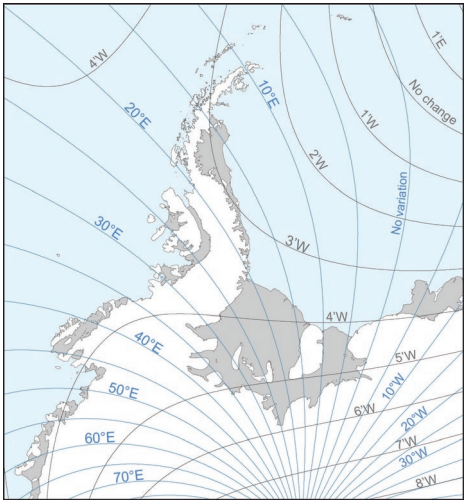


Figure 43 – Magnetic declination

10.6 **Global Positioning System (GPS)**

GPS is an extremely useful tool in the field but it does have its limitations. GPS should not be relied upon as the only method of navigation. Other reference points should be considered to ensure you are still travelling in the intended direction. This could be a compass bearing, a ground feature, the position of the sun in the sky or the wind direction. If one or more of these references alter you should stop and confirm that the GPS is still functioning correctly.

GPS satellite signals in the Polar Regions are becoming more accurate and reliable but occasionally you may find yourself in a 'black spot'. These outages are often only temporary but it could be enough to throw you off course and into some potentially dangerous terrain if you are not paying attention. The further towards either pole you go, the smaller the angle between the satellites and the horizon. This can cause

issues with positioning owing to sub-optimal satellite and receiver geometry.

BAS use a variety of different models of GPS for navigating in the field. There is no point in going into specifics for each model as this will continue to change as old models become obsolete and new models are brought into service, but before deploying into the field it is important that you are well practiced and familiar with how your chosen unit functions.

At the end of a field project GPS data showing routes travelled must be saved and attached to the field report to assist with future projects to the same area. If using old GPS data from a previous project be aware that locations will have shifted due to glacier and ice-shelf flow. The rates of movement will vary from place to place.

10.7 **Geographical Information Systems (GIS)**

GIS is used by the Field Operations Manager and Head of Field operations while in the planning stages of fieldwork. It is used to plan fieldwork, prepare data, and manage depot locations. Waypoints are also uploaded and kept using this software for Field and Air unit use. Field guides may also use GIS software in certain situations or projects, and training will be given by MAGIC prior to deployment. If support is needed, then a MAGIC team member can be emailed for support.

10.8 **Marking routes with flags**

Assessed routes can be marked with flags if they are to be travelled frequently. This allows a pre-checked route to be followed closely in less than perfect conditions. Travelling in the polar environment is dynamic and hazards not present on one journey may be there on another day so this is not a foolproof method and Field Guides must be vigilant even when travelling in a known area. See Chapter 4, Section 4.2 – Heuristics and Chapter 17, Section 14.7.5 – Terrain assessment for more information.

As a general rule red flags are used to mark hazards and black flags used to show an assessed travel route. Two crossed flags also mark a hazard.

10.9 **Remote sensing**

Satellite images are an invaluable tool for route planning. Some basic images at low 10m resolutions may can be accessed at short notice, but other images at higher resolutions will require some pre-arrangement to get hold of. If travelling in an area with limited knowledge of previous routes discuss the option of getting up-to-date satellite imagery with the FOM.

Be aware of old satellite images, which may not reflect the current terrain of an area. Satellite images should be date stamped so check that it is of a recent vintage before making any crucial planning decisions on travel.

Radar imagery (also called SAR - Synthetic Aperture Radar) such as Sentinel-1 has proven useful at a coarse scale for highlighting areas of crevassing. In some cases, you can also access very high-resolution (less then 1 m pixel size) optical and radar satellite imagery via the BAS MAGIC Team, which can be used to identify surface conditions and create high-quality mapping products including elevation information

10.10 **Aerial photography**

Aerial photography can be very helpful for route planning. Formal aerial photographs captured during a season of aero-surveys are sometimes available via MAGIC. Pilots can often also take good photographs while flying over a particular area if weather conditions allow. Speak to the FOM if you think a recce flight of an area could be useful for new field sites in potentially hazardous locations.

10.11 **Navigating on snowmobile**

Accurately navigating in the field by snowmobile can be challenging. In theory it isn't any different to navigating on foot, however in practice it is very different! Travelling at average speeds of 15-20km/h means that in a very short space of time you can end up large distances away from your intended travel route. Driving linked up while pulling sledges also requires a large amount of concentration and quick decision making to steer the sledge over the smoothest ground. Doing all this while navigating accurately and constantly looking ahead for any hazards (terrain change, wind scoops, crevasses etc.) is a skill that takes time to develop.

All travelling by snowmobile in the field must be carried out in suitable conditions. Good contrast is needed to spot subtle evidence of crevassing. Strong winds and drifting/blowing snow will limit visibility and make this difficult. Field Guides should never feel pressurised into travelling in sub-optimal conditions. If you have any doubts, stay put until conditions improve. Some form of shelter should be carried at all times during field travel – be this the full unit or the half unit. If conditions dictate, stop and erect camp until things improve.

Most navigation on snowmobile is done using ground features and pre-planned GPS routes. At least one spare GPS and several sets of batteries must be carried at all times to allow for a unit failure. Specific set-up of the GPS and the visible data fields are largely down to personal preference. The following data is however useful for accurate travel on a GPS route: bearing, track, course, distance off-course, distance to next waypoint or destination.

Some field snowmobiles are equipped with compasses but be aware the engine affects these compasses and this deviation can be different depending on the revs. The snowmobile compass is useful as part of a navigational system but should not be relied upon solely.

If all else fails navigation can be effectively carried out by using the following procedure:

- Put out two flags that align with the bearing you need to travel on
- Line up on the flags and drive towards them at a constant speed. This speed should reflect the speed you will be travelling
- Once you are lined up and driving at the correct speed, read the bearing off the snowmobile compass. This is what you should drive on for that leg. If your speed and engine revs change, it may alter the snowmobile compass and your heading
- Stop at regular intervals and take a back bearing down your tracks to check your line. Make sure you step off the snowmobile to take a bearing with the handheld compass
- At the start of a leg, don't forget to zero the snowmobile odometer
- Where a vehicle is used for an outward and return journey, mark the route with flags at strategic places and regular intervals
- Note bearings, distances and times between flags in a notebook (journeys in poor conditions will take longer than in good conditions)
- Do not attempt to retrace complicated routes in poor conditions on vehicles
- The sun can be used as aid to navigation in featureless places, but don't forget that it moves at 15°per hour
- Old snowmobile tracks from the inward route may be followed. Turn the snowmobile at the end of a journey, so that it lies in or across the outward tracks. The outward trip tracks are therefore more easily picked up in poorer contrast

Chapter 11 – Communications

11.1 **Introduction**

Effective communication between field parties and the station is essential to safe and efficient operations – this applies equally to local travel as it does remote fieldwork.

A variety of different modes of communication are available depending on the location and the nature of the work. This chapter covers all modes of field communication used within BAS. Specifics on equipment set-up and limitations are also discussed. For further information see the Communications Manual – a copy of this should be in each HF radio box.

11.2 **Overview**

Despite the advancement of technology, and some availability of internet access in the field, the HF radio is still considered to be the primary method of communication for field parties and the satellite phone is the secondary option. Email is becoming more heavily used in the field as a means of communication for logistics purposes as information such as weather forecasts can easily be referred to and there is no risk of information being miscommunicated due to a bad radio signal. Other items such as satellite trackers are becoming more commonplace and may become part of standard field comms kit in the not too distant future.

11.2.1 **Radio protocol**

There are a number of official radio protocols that must be adhered to when using any form of communication device.

- Due to the large amounts of radio traffic in and out of the stations, the information passed should be clear and precise. Do not send superfluous signals
- With HF, the base station or aircraft will normally contact the field party first. With the volume of radio traffic the station has to deal with, it can be very disruptive if parties 'jump in' at unexpected times
- Observe proper radio etiquette. When using HF or VHF radios, you should remember that your transmissions could be picked up by other radio users – in some cases all around the world. Bad language, indiscreet personal gossip and confidential information should not be passed over the radio

11.2.2 **Daily scheds**

Field parties are required to communicate with the station once a day. The purpose of this is to pass essential information such as field party location and intentions for the following day. In addition, field parties will receive useful information such as weather forecasts and the proposed aircraft operations in their area for the coming day.

Daily scheds are normally in the evening, although in some cases a morning sched is more appropriate. The time and frequency for daily scheds is pre-arranged prior to deployment by the operations team.

Daily scheds are primarily carried out through HF radio as standard. However, they may also be through a video call via an internet connection if the service is available. In the event of a communications failure, the iridium satellite phone is to be used as the secondary option.

While providing an opportunity for important information to be passed between station and field parties, daily scheds are also an opportunity to chat to someone different back at base and receive news updates etc. During a long field season this can help to boost morale.

11.2.3 **Procedure for a missed sched**

A sched may be missed for a number of reasons. Most commonly due to a radio fault or work/travel occurring during the pre-arranged sched time.

If a sched is missed it is the responsibility of the Field Guide/Field Coordinator/camp manager/traverse leader in charge of a project to make contact with the station as soon as is practical to do so. Every effort should be made to communicate with the station at the designated sched time and it is not acceptable to routinely miss scheds and phone in when it suits you. Work should be planned in such a way that someone is available to report in at sched time.

> Warning: If no contact has been made within 24 hours of missing a sched then a search and rescue response will be initiated – this may happen before 24 hours has passed depending on the particular situation.

It is therefore very important that you do everything possible to make contact with the station at the designated sched time. If HF is not working, use the satellite phone and call the relevant number. If a sched has been missed due to losing track of time, call in using the satellite phone as soon as possible. If you're struggling to get through due to atmospheric interferences, wait for a short time and continue to try. Failure to make contact could result in a huge waste of time, money and unnecessary stress if an aircraft is sent out without good reason.

11.2.4 **Radio language**

Regardless of the means of communication being used, correspondence must always be clear, concise and polite.

At times when communication is difficult, the following words are used to make it easier to understand each other, words can also be spelled out using the phonetic alphabet.

Word	Meaning
Wilco	Understood and I will comply
Roger	Understood
Affirmative	Yes
Negative	No

A	Alpha	**N**	November
B	Bravo	**O**	Oscar
C	Charlie	**P**	Papa
D	Delta	**Q**	Quebec
E	Echo	**R**	Romeo
F	Foxtrot	**S**	Sierra
G	Golf	**T**	Tango
H	Hotel	**U**	Uniform
I	India	**V**	Victor
J	Juliet	**W**	Whiskey
K	Kilo	**X**	X-ray
L	Lima	**Y**	Yankee
M	Mike	**Z**	Zulu

11.3 **HF radios**

HF radios are the primary mode of communication while operating in the field with BAS (with the exception of operations around KEP, Bird Island and Signy stations). As with any communication device they have pros and cons but the HF still provides a reliable and cost-effective means of communication over long distances.

HF radios are affected by disturbances in the ionosphere, principally due to the sun. During periods of intense solar activity HF may not work well, or not at all.

On initial deployment, a tent and HF radio must be set up and communication established with the station before the aircraft can leave your location. It is essential to check and test your HF radio prior to leaving the station – however the winter Electronics Engineer should have already done this. If there is a fault with the radio that can't be repaired then the field party must contact the FOM for further information prior to the aircraft departing. Field Guides must travel with the HF radio on initial input, uplift and relocation flights.

For a list of HF frequencies and there use see Appendix A6.

Note: It is worth being aware that the power output of a portable HF radio is significantly less than that of a station set. In some cases you may be able to hear the station very clearly but they might be struggling to hear you.

11.3.1 **HF models**

BAS currently use Codan 2110 HF radios for field parties and iCom IC-718 base units for more permanent field camps/cabooses.

11.3.2 **Codan 2110 set-up and operation**

Set-up

44/45/46/47/48

Tuning

Once the radio is set up according to the steps above you must tune the radio to the required frequency:

- Press the channel navigation arrows until the desired pre-set channel is displayed on the screen
- Press the number '1' button (also says 'tune' in blue text)
- The screen will now display 'PTT Tunes' followed by a length in metres – this is the total length the radio wants the dipole antennae to be.
- The screen will also display an 'SWR' reading which will be '---' at this point
- Press the PTT button on the radio handset once while on this screen and it will tune the antennae. The SWR will now display a value. For effective operation of the radio this value must be less than two. If it is not then the antennae must be adjusted before repeating the steps above again
- Ensure display now shows the symbol for the dipole antennae and not the long wire/whip

Operation

- Radio is now ready for use, hold the PTT button down, wait a second and then begin your transmission, once finished you should say "over" to indicate to the receiving party that it is their turn to speak
- Release the PTT and listen, once the other party says "over" it is now your turn to speak again

Figure 44 – Components of Codan HF

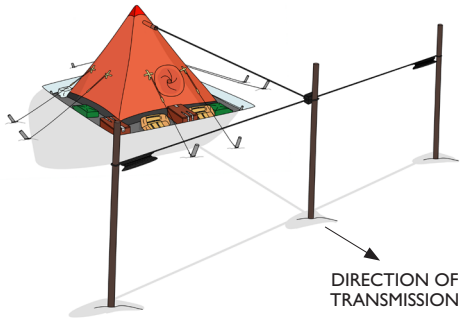


Figure 45 – Setting up dipole antenna

Figure 46 – Connecting co-ax and handset

Figure 47 – Connecting battery to radio

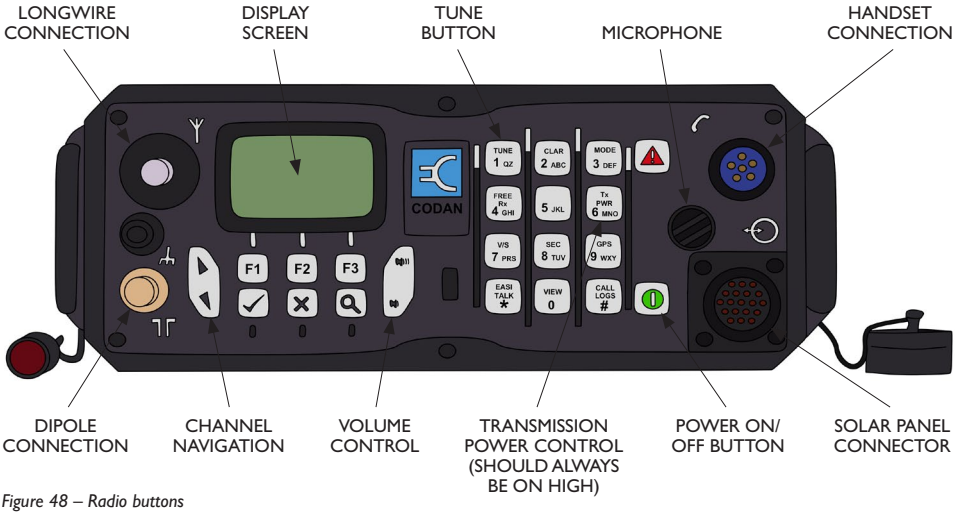


Figure 48 – Radio buttons

Note: When operating HF radios ensure that no-one is near or touching the antennae as this can result in very serious burns! Everyone in the field must be made aware of this fact. In large camps it is a good idea to flag an area around the antennae as a reminder to people.

11.3.3 **Fault-finding and field repairs for Codan 2110 HF**

A diagnostic prompt sheet with corresponding repair tips should be present in the radio box.

The most common faults usually relate to power and antenna problems. Batteries can be checked using the charge indicator on the radio or by using the multi-meter in the radio box.

Symptoms	Fault	Solution
Radio won't turn on	Battery is most likely dead	Swap out with second battery or connect solar panel and leave in sunlight to charge
Radio won't transmit (look out for the 'TX' symbol in the top left of the screen when you push the PTT on handset, if not working it will continue to say 'RX' for receive)	Handset may be damaged	Replace with spare handset
Base can be heard clearly but they don't seem to be hearing you	Handset could be damaged or antenna isn't tuned correctly	Replace handset with spare or re-tune antenna to get lower SWR read out

Symptoms	Fault	Solution
Radio doesn't transmit or receive anything	Most likely a fault with the antenna. Look out for this symbol:  If this is displayed then the radio is trying to tune to the long wire and not the dipole, which indicates a fault with either the co-ax or the dipole antenna or the balun connector	Check continuity on co-ax, balun and dipole using multi-metre. Replace necessary component with spare. It may be as simple as snow/ice in a connector so check this too

11.3.4 **Charging Codan batteries**

Unlike some older models of HF radio used by BAS, the Codan batteries do not need to be 'deep discharged' before recharging. Each Codan is supplied with a solar panel that attaches onto the 19-pin expansion connector on the front of the radio. The solar panel can be connected while the radio is in use. The battery will charge best if the solar panel is positioned in direct, strong sunlight. **49**

Figure 49 – Connecting solar panel to charge battery

The Codan batteries hold up to 80 hours of charge so if fully charged before heading into the field, two batteries should last the duration of most field seasons. However do not rely on this, keep an eye on the battery indicator on the Codan display screen and charge the battery before it completely runs out.

11.4 **Satellite phones**

Satellite phones are the secondary means of communication in the field with BAS operations. The iridium should be carried with a field party at all times. While away from camp with the half unit the satellite phone should be carried in the rucksack of the person on the second snowmobile. The iridium is for use when HF communications are poor and/or communication is required outside the designated sched time.

In the event of an emergency the satellite phone becomes the primary means of communication. Remember that HF is open for anyone to tune in to, so sensitive discussions such as medical issues must be carried out using the satellite phone.

A laminated list of important phone numbers is kept with each satellite phone. Please note that from time to time some numbers may change so check this list is correct prior to deployment into the field.

11.4.1 **Models**

All satellite phones within BAS operate on the Iridium satellite network. This is the only network that provides coverage in the Polar Regions. There are currently multiple different models of satellite phone in use within BAS – most iridium phones look the same but have different batteries that are not compatible with one another. Check the batteries are correct and charged prior to deploying to the field.

Ensure all members of a field party are familiar with the model(s) you will have with you before leaving the station. **50**

11.4.2 **Set-up**

Satellite phones require very little set-up and are generally very intuitive in their operation. Satellite phones will not work inside buildings or cabooses but should work well inside a tent. External aerials are

Figure 50 – Satellite phone

provided with each handset and provide the option to use the phones inside.

Phone numbers should be pre-set into the phone's memory by the Engineering team, and as a back-up there should be a laminated sheet with each phone detailing emergency numbers. All numbers dialed from Iridium in the field must be pre-fixed with '00' or '+' followed by the country code (44 for a UK number) then by the phone number. Speak with the tower/station prior to doing a test call, confirm all the numbers loaded into the handset are correct when doing this.

Before leaving station check that the batteries are all fully charged and that the sim card has been registered – to do this let the IT team know and phone the comms iridium.

Note that there is often a delay on satellite phone calls. If asking a question be patient and wait for the answer to come back rather than repeating yourself as this can cause confusion. Occasionally you will experience a 'black spot' where signal will temporarily disappear, this may result in ongoing calls being disconnected – if this happens you may have to wait until signal comes back before attempting the call again. It is unusual for these issues to persist for more than a few minutes.

> Caution: To avoid both parties trying to call each other at the same time the procedure for a drop out via satellite phone is for the field party to phone the station, not the other way around.

11.4.3 **Charging batteries**

All models of satellite phone can be charged either by a standard 240V socket or 12V charger – both are supplied with each handset. Some of the newer models can also be charged via USB. Familiarise yourself with the charging process before leaving the station, as not all models are capable of being charged via USB.

It is worth always keeping one spare fully charged battery on your person, so that it stays warm and is ready for use in an emergency.

11.4.4 **Personal usage**

It is acceptable for field staff to use the Iridium satellite phone for modest personal use..

11.5 **Low earth orbit satellites (LEO)**

These satellites orbit close to earth and provide access to the internet in remote areas, as it no longer relies on a traditional connection. These satellites connect to hardware on the ground and allow remote locations to have access to the internet similar to connecting to Wi-Fi at home. While still currently in its infancy in the Polar regions, it is now being extensively used on stations, at logistics hubs, and on the tractor traverse for operations and science – There is also the ability to use this system for small field projects. The hardware used creates a wireless hotspot allowing other devices to be connected and access high speed internet. This allows facilities such as emails, internet cloud services and audio/video calls to be used in the field. Bandwidth limits per user may be imposed to limit cost. Users can expect to have an allowance of 1-2GB per day, but this value may change depending on unexpected changes from the service providers.

If internet access is needed in the field for scientific research, discuss this with the FOM with plenty of time prior to deployment. Setup and troubleshooting information can be found by contacting the supporting station Electronics Engineer or Head of communications and engineering. **51/52**

Figure 51 – Low-Earth orbit satellite receiver

11.6 **Email**

Email is used extensively in the field for both scientific and logistical purposes. Email access is provided via either an Iridium satellite phone connected to a laptop or using the Iridium Go! device. Small attachments can be sent and received when using the Iridium Go! but attachments must be avoided when connecting directly via a handset.

11.6.1 **Set-up using satellite phone**

A laptop must be configured by the IT team before field deployment – ensure the required laptop is given to the Electronics Engineer long before field deployment and be aware that not all operating systems are supported. The laptop will be set up with a unique field party email address and will be configured to work with the phone number of a particular satellite phone (i.e. if a field party has more than one satellite phone only one will work with email. If there is a requirement for more than one email address, discuss this with the Electronics Engineer before deployment).

Note: Emails should be written offline and 'send later' option used to add the message to the outbox. It is important that emails are sent in groups to minimise the amount of time connected to the network.

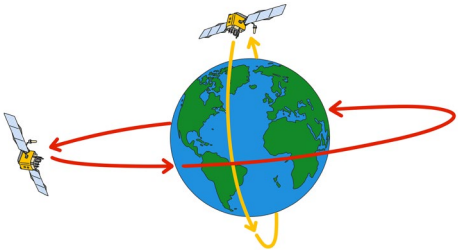


Figure 52 – Low-Earth orbit satellites

When ready to send, connect the satellite phone to the laptop using the USB cable supplied, open the dial-up connector from the desktop and click connect. Ensure the email client is open and click 'send all unsent messages'. Remember to disconnect once all emails have been sent/received as it will continue to charge as long as it is connected.

Sometimes the connection times out meaning that you have to reconnect and start again. If possible do not leave the laptop unattended while it is trying to send or receive, as it can be easy to forget about it and leave the device connected.

11.6.2 **Iridium Go!**

The Iridium Go! device provides a wireless hotspot using the iridium network which can support both data and voice calls. BAS supplies field parties using the Iridium Go! with a tablet and a smartphone. The tablet is to be used for emails and the phone for voice calls. In practice the quality of voice calls at the receiving end while using this device is poor but it serves as a good back-up to the satellite phone. Data using the Iridium Go! is however excellent and larger files can be sent quickly and easily using this system. Unlike the email connection via a normal satellite phone the Iridium Go! does not have to start from the beginning if the connection is lost mid-way through sending or receiving, it will pause and continue from where it left off once reconnected. **53**

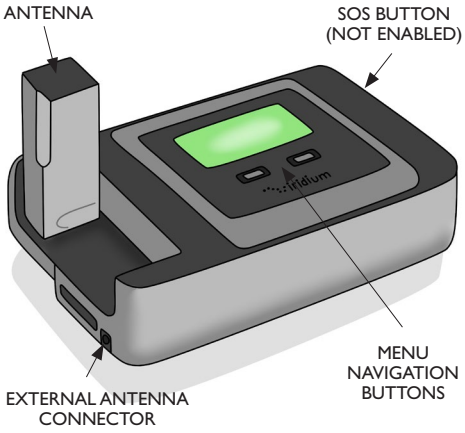


Figure 53 – Iridium Go!

11.6.3 **Personal usage**

Email facilities can be used for personal communications with family and friends back home. If using the Iridium Go a personal email must be set up before deploying to the field to allow personal use. Modest personal use is accepted and supported by BAS.

11.7 **Garmin inReach satellite tracker**

The line of Delorme inReach devices are satellite communicators and trackers. Allowing short text messages to be sent and received as well as providing accurate positioning reports and tracking features which can be monitored from stations. Pre-set messages can be used to inform the station that everything is ok if a sched is missed or all other modes of communication are unavailable. The inReach operates on the Iridium network. These devices are used extensively by pilots and on the sub-Antarctic islands for tracking remote field parties, lone working and as a backup to Marine VHF. Messages can take up to 20 minutes to send so be patient and leave the device on until the message has definitely been sent. **54**

Figure 54 – Garmin inReach mini

11.8 **Marine VHF radios**

VHF radios essentially work on a line of site only principle. Handheld units are available and larger, more powerful fixed base station units can be found in cabooses, stations and summer only camps such as Sky Blu and Fossil Bluff.

Stations normally operate using either VHF channel 1 or 18. Any channel other than 16 that does not display 'dup' can be used for communication in field.

> Caution: Channel 16 on a marine VHF is the designated international distress frequency. It must not be used in a non-emergency situation and will normally only be useful if contacting a ship.

The range of marine VHFs can be extended and also cover potential black spots through the use of repeaters to bounce a signal. Ensure you know of any potential black spots in your area.

When operating in the field around KEP, Bird Island and Signy, marine VHF is often the primary mode of communication, with satellite phones or InReach devices being the back up.

11.8.1 **Handheld marine VHFs**

Handheld VHF's are commonly used on field projects for work where either two parties are close to each other but working separately or for where a group are working close by to camp with others staying at the camp.

There are many different makes and models of VHF – ensure you are familiar with the operation of the models you are using, consider taking the user manual with you in the field. The cold reduces the battery effectiveness so take plenty of spares and the necessary equipment for charging – check that the spare batteries and charging unit are compatible with the model being used.

To operate a handheld marine VHF:

- Switch the set on and select the correct channel. Some models of radio have a channel lock and you should know how to override this and change channels
- Turn the squelch knob/button until static can be heard (on some newer models the squelch may be automatic)
- Adjust the volume to the correct level
- Adjust the squelch until no static is heard
- Ensure handset is on high power mode, note that channel lock does not prevent the power button from being used and radios often change between high, mid and low power accidentally.
- Use the PTT (press to talk button) to transmit
- Release the PTT button to receive a signal **55**

Figure 55 – Handheld marine VHF

11.8.2 **Simplex vs. duplex**

If transmitting on a duplex channel the signal will be automatically sent to a repeater and then from the repeater back to all other VHF radios in range. This means that if you are trying to communicate in the field where there are no repeaters between two handheld VHF's it will not work if you are on a duplex channel! In this example you will have to make sure you are operating on a simplex channel. Channels are pre-set as either simplex or duplex, duplex channels are identified with the letters 'DUP' on the display, simplex channels will be blank in place of this.

11.8.3 **Base station marine VHFs**

Fixed base station units operate in a very similar manner to the handheld VHF's but output a higher power and have a separate handset. **56**

Figure 56 – Base station VHF

11.8.4 **Whip antenna**

A whip antenna can be used to boost the signal of a marine VHF handheld radio. This can be particularly useful when operating around Halley and are commonly fitted to huts on the sub-Antarctic islands.

11.9 **Communication with aircraft**

Aircraft can be communicated with in field using Aero VHF, HF or Iridium satellite phone.

Normally the aircraft or base station will initiate the first contact with field parties. If field parties need to speak to aircraft, they should listen for a couple of minutes on the frequency to ensure they are not breaking over another conversation.

The pilot should be given time to reply and should not be called when approaching finals unless safety is compromised by not calling.

11.9.1 **Aero VHF**

Aero VHF is the best way to communicate with an aircraft that is nearby. On a field project with significant aircraft activity, i.e. numerous input and uplift flights it is worth taking aero VHF.

The aero VHF frequency is 118.1 MHz.

Aircraft will often call up prior to finals for landing to get an updated ground wind speed or to clarify any details regarding ski-way or camp location.

11.9.2 **HF**

The standard field Codan HF radio can be used to communicate directly with aircraft although depending on the frequency the field party is operating on, the antenna length may require adjusting.

For a list of HF frequencies and their use see Appendix A6.

11.9.3 **Iridium**

If you have a particularly urgent need to speak to an aircraft or a specific pilot they can be contacted on Iridium. A list of Iridium numbers for aircraft should be kept with the field party's satellite phone, ensure this list is up-to-date prior to deployment into the field.

A laminated list of important, emergency and welfare phone numbers is kept with each satellite phone. Please note that from time to time some numbers may change so check this list is correct prior to deployment into the field.

11.10 Field Party Requests (FPRs)

Items can be requested over the radio if an aircraft is heading your way. This should not be used as a get-out clause for poor planning and preparation.

Requests should be restricted to essential items, not long lists of luxuries. If a 'goodies box' is wanted at a resupply, the field party should have packed it prior to deployment.

Aircraft loads are limited by weight. Don't expect the FOM to be impressed by excessive requests for slabs of beer and boxes of chocolate.

The Field Guide on station will have to devote a significant amount of time to source, pack and dispatch your order correctly. Don't wait until eight o'clock at night to pass on a request for the following day's flight when it could have been given two days previously. See the field work manual for further details and more information.

11.11 Emergency communications protocol

In the event of an emergency in the field you must make contact with the controlling station (that is the station or ship you were deployed from and communicate with at your daily sched).

The most efficient means of communication in the event of an emergency is to use the Iridium satellite phone. In an emergency the satellite phone becomes the primary means of communication instead of the HF.

> Caution: Before field deployment ensure that the pre-programmed emergency numbers are in the phone and are the correct numbers – confirm this with the IT team. Also ensure that the laminated card with these numbers on is with the phone and is also up-to-date.

If after trying the controlling station there is no response try other nearby stations, then the 'Ops on call' number. Control will be returned to the controlling station as soon as possible.

For more information on dealing with an emergency situation in the field please refer to Chapter 21 – Emergency procedures.

Chapter 12 – Weather

12.1 **Introduction**

Any aircraft flying to, near, or from your location will need meteorological observations (met obs) from your location to ensure it is safe to fly. A met ob is a simple account of current wind, weather and cloud conditions. The pilot and forecaster will require obs from you well before the plane takes off. The decision on whether or not they fly will then be based on the weather forecast and your obs. It is therefore important that the obs are as accurate as possible.

Timing

- Met obs are required every hour (at least) until the aircraft has landed
- At the start of your season your party will be allocated a time at which to transmit your ob to operations. You will need to be ready with your ob and waiting by the radio at this time
- Give yourself plenty of time to produce an accurate observation
- If the plane is leaving your location you will be required to continue obs until you are stood down by operations
- Never stand yourself down
- Always keep an eye on the weather in between scheduled observations. If there is a significant deterioration in the weather you will need to submit a special ob immediately (see Section 12.12). Do not wait for the next scheduled ob

Location

- The observation must be made from outside the tent, with a full view of the sky. It is not acceptable to take obs from inside the tent because conditions may vary in different directions
- Ideally the ob will be taken from the skiway (if this is not at the same location as the camp). If the skiway is some distance from the camp then it is usual to do the first few obs of the day from the camp and then move to the skiway once the plane is inbound

How

- Unlike Fossil Bluff and Sky Blu, no instruments are provided for field party met obs; all weather information is obtained through human observation
- Write the ob on one of the weather observation forms provided (Figure 60)
- Keep at least three previous obs visible on your form, so you can observe any trends
- Operations will call you up on the radio and ask you to transmit your ob
- Speak clearly and slowly. Remember, the radio operator may not be able to hear you as clearly as you can hear them
- Always read your ob out in the correct order. This will help operations follow your ob in case of bad transmission
- Use radio speak where possible (examples to follow)
- For each row of the form, read the title of the row followed by your ob, e.g. "Wind speed, zero-five knots"

Training

- Initial training will take place on station, will be carried out by one of the meteorologists and will consist of an hour long presentation followed by practice obs
- It is down to the individual how many practice obs you carry out but please be aware that field met obs are hard and it takes practice to produce accurate obs

The following diagram shows a field party met ob form. There is then a section describing how to obtain each variable on the form. **57**

Time	1050 Zulu	UTC = GMT = Z = Rothera Local Time + 3hrs.
Wind direction	0 6 0 degrees	Magnetic wind direction. To nearest 10 degrees – read out 3 digits (010-360).
Wind speed	0 5 knots	To nearest knot-read out 2 digits. If speed less than 5 knots, read "Wind – Calm". If windy, is there blowing or drifting snow? If so, add it in 'Present Weather'.
Gusting	2 5 knots	Is the instantaneous wind speed, at times, above 20 knots and 10 knots above the average? If so, report it here. To nearest knot-read out 2 digits.
Visibility	2000m to West, 6 km to North, Unlimited elsewhere	Max of 3 values in different directions (N, NE, E, SE, S, SW, W, NW). Last direction reported being 'elsewhere'. Use the discreet values listed on the visibility chart on the panorama. Above 50km – Unlimited. If visibility is less than 10km, you MUST report present weather in 'Present Weather' and/or weather at a distance in 'Comments'.
Present weather	Slight intermittent snow Drifting snow	Snow, Blowing snow – is it restricting visibility? If so, does your 'Visibility' reflect this? Is the snowfall intermittent? Slight (visibility greater than 1000m), Moderate (visibility between 200m and 1000m), Heavy (visibility less than 200m)
		Drifting snow – below eye level, does not affect visibility Mist - uniform visibility between 1000m and 10km in all directions. Make sure your 'Visibility' reflects this. Fog – visibility less than 1000m in all directions. Make sure your 'Visibility' reflects this.
Contrast	Nil - Poor	Nil, Nil-Poor, Poor, Poor-Mod, Mod, Mod-Good, Good. Max of 3 values in different directions (N, NE, E, SE, S, SW, W, NW). Last direction reported being 'elsewhere'.
Horizontal definition	Nil to West, Poor elsewhere	Nil, Nil-Poor, Poor, Poor-Mod, Mod, Mod-Good, Good. Max of 3 values in different directions (N, NE, E, SE, S, SW, W, NW). Last direction reported being 'elsewhere'.
Total cloud	8 oktas	If 'Sky Obscured', don't report any cloud here or below, but report a present weather (snow, fog, mist, blowing snow) in 'Present Weather'
Consisting of	4 @ 0 1 0 7 @ 0 7 0 @ @ LA	Amount in 8ths and cloud base height ABOVE SKIWAY LEVEL of each layer. Read out 3 digits for height. See cloud height chart on panorama. Report lowest cloud base height first then the next highest and so on. Max of 4 cloud heights. Layers Above (LA) if necessary i.e. there is cloud above but the amount and height is indistinguishable due to a lower cloud layer obscuring almost all of it.
Temperature	- 0 7 °C	To nearest °C – read out 2 digits. Read out 'minus' if below zero, no need for sign for zero or above.
Dewpoint	- 1 5 °C	To nearest °C – read out 2 digits. Read out 'minus' if below zero, no need for sign for zero or above.
QNH	9 7 3 hPa	QNH pressure. Round DOWN to nearest hPa, 973.9hPa = 973hPa. Read out 3 digits if less than 1000hPa, 4 digits if equal to or greater than 1000hPa
How copy? / With comments to follow, how copy?		
Comments	Fog 2000m to West Sun Disk Visible Lenticular cloud	Is there weather at any distance? i.e. Fog (uniform bank of white / grey) or Snow (light and dark 'curtains')? Which direction is it in? How far away is it? Are there Lenticular Clouds? Is the Sun Disk Visible?
Do all the elements tie in together and make sense? **Keep an eye on the weather- if it deteriorates between scheduled obs – RADIO OPS!**		

Figure 57 – Field party weather observations form

12.2 **Time**

This is the time at which the observation was made. The time must be Greenwich Mean Time (GMT) – also known as Universal Time (UTC) – generally referred to as Zulu time. Rothera local time is three hours behind GMT, so 07:50 Rothera local time is 10:50 Zulu.

12.3 **Wind**

12.3.1 **Wind direction**

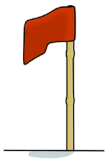
This is the direction from which the wind is blowing, e.g. 360 degrees if the wind is blowing from the north. The direction is always **magnetic**, i.e. the direction according to your compass rather than according to your map. Wind direction should be given as a bearing to the nearest 10 degrees if possible (if not, use the compass directions N, NE, E, SE, S, SW, W, NW.) It should also be read out as three digits.

Example: Read out "Wind direction: zero-six-zero degrees"

12.3.2 **Wind speed**

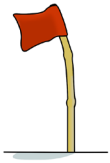
Wind speed is given in knots. This may be estimated from the state of a bamboo flag and how much it is deformed by the wind (Figure 58). If the snow on the ground is loose and dry, the wind speed may also be estimated from the amount of snow being picked up by the wind. If the snow surface is compact or wet, this method is unreliable, because less snow is picked up by the wind.

If the wind speed is less than five knots and from no definite direction, it may be reported as "light and variable". If the wind speed is less than three knots, it may be reported as "calm". If the wind, at times, is gusting more than 20 knots and 10 knots higher than the 10 minute average then pass this information on.



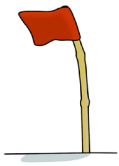
0-10 KNOTS

NO SNOW RAISED FROM SURFACE BY WIND



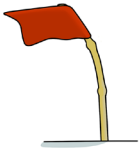
10-15 KNOTS

SNOW BEGINS TO MOVE ACROSS SURFACE



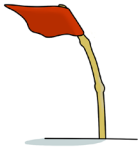
15-20 KNOTS

LOW GROUND DRIFTING SNOW



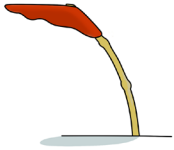
20-25 KNOTS

DRIFTING SNOW BECOMING BLOWING SNOW BUT NOT ABOVE EYE LEVEL



25-35 KNOTS

BLOWING SNOW RESTRICTING USABILITY



>35 KNOTS

BLIZZARD CONDITIONS VISIBILITY <200m

Figure 58 – Bamboos wind speed gauge

This may be really difficult to quantify in the field so if it feels gusty just try and estimate the wind gust speed.

Always read out the wind speed and gusts as two digits, rounded to the nearest five knots. (If it is windy, is there drifting or blowing snow associated with this? If so, this must also be reported in the 'present weather', see Section 12.5). **58**

Example: Read out "Wind speed: zero-five knots, gusting two-five knots"

12.4 **Visibility**

This is how far you can see horizontally in kilometres or metres. For weather observations, visibility is reduced by weather (snow, blowing snow, mist, fog) not by topography (mountains, etc.) In mountainous regions, visibility is most easily estimated from which features such as mountains and crags can be seen; the distances of these features can be found from a map. If you can see a mountain clearly at a known distance the visibility is **at least** that distance. If the mountain is very clear you have to judge how far beyond that you would be able to see and report that figure as the visibility. On ice shelves, where there are no such features, a line of flags at known distances can be observed.

If the visibility is varying in different directions, you should report a different visibility for each direction, starting with the worst first. Report a maximum of three values in different directions using the cardinal points (N, NE, E, SE, S, SW, W, NW). The last direction reported being 'elsewhere'.

If the visibility is greater than 50km then you may report "unlimited".

Visibilities should be reported using the discreet values on the Horizontal Visibility Chart **59**. If the visibility is equal to or greater than 5km, then report in kilometres. If it is below 5km then report in metres.

Horizontal Visibility Chart

Visibility
50m
100m
200m
300m
400m
500m
600m
700m
800m
900m
1,000m
1,100m
1,200m
1,300m
1,400m
1,500m
1,600m
1,700m
1,800m
1,900m
2,000m

Visibility
2,100m
2,200m
2,300m
2,400m
2,500m
3,000m
3,500m
4,000m
4,500m
5,000m
6km
7km
8km
9km
10km
11km
12km
13km
14km
15km
16km

Visibility
17km
18km
19km
20km
25km
30km
35km
40km
45km
50km

If visibility or cloud height moves between colour groups consider making a special observation

When visibility is greater than 50km record as 'unlimited'

Figure 59 – Horizontal Visibility Chart

If the visibility is less than 10km you must report a 'present weather' as well (see Section 10.5) to justify this. You can however report a present weather if the visibility is greater than 10km, i.e. if there is slight snow.

Example: Read out "Visibility: two-thousand metres to the west, six kilometres to the north, unlimited elsewhere"

12.5 **Present weather**

This is the weather occurring at your location. This may be:

Snow	Falling from cloud
Drifting snow	Snow blown along the ground below eye level
Blowing snow	Snow blown from the ground to above eye level
Mist	Approximate uniform visibility in all directions between 1,000m and 10km
Fog	Visibility in all directions less than 1,000m

Both mist and fog are cloud at ground level.

For **snow** and **blowing snow** only also report the **intensity**:

Slight	Visibility more than 1,000m
Moderate	Visibility between 200m and 1,000m
Heavy	Visibility less than 200m

For **snow** only: the duration is assumed to be continuous unless reported as:

Intermittent	Stopping and starting over the last hour

Make sure your 'visibility' reflects your 'present weather' if appropriate.

If there is no weather at your location (i.e. no snow, drifting snow, blowing snow, mist or fog), report the present weather as "**nil**".

Example: Read out "Present weather: slight intermittent snow, drifting snow"

12.6 **Contrast**

This is the ease with which features can be seen on the snow surface. In the field this is very important in crevassed areas. It also help the pilots to identify sastrugi on the skiway. Contrast is reduced by thick cloud cover, which diffuses the sunlight. Contrast is reported as follows (see Figure 60 for examples):

Nil	Footprints, ski-doo tracks, etc. become indistinct at more than 50m
Nil to Poor	
Poor	Footprints, ski-doo tracks, etc. become indistinct at more than a few kilometres
Poor to Moderate	
Moderate	Surface features are visible as far as the eye can see, but not clearly defined
Moderate to Good	
Good	Surface features are visible as far as the eye can see and are clearly defined

If the contrast is varying as clouds pass overhead, or if the contrast falls between two of the above definitions, it may be reported as "moderate to good", etc. You can also report contrast in different directions. Keep to a maximum of three values in different directions using the cardinal points (N, NE, E, SE, S, SW, W, NW). Last direction reported being "elsewhere". **60**

Example: Read out "Contrast: nil to poor"

Figure 60 – Contrast

12.7 **Horizontal definition**

This is the ease with which the sky can be distinguished from the land, i.e. the ease with which the horizon can be seen. This is very important on ice shelves. Horizontal definition is reported as follows (see Figure 61 for examples):

Nil	Sky and land appear as one, no horizon visible
Nil to Poor	
Poor	Sky can be distinguished from land, but no distinct horizon
Poor to Moderate	
Moderate	Sky can be distinguished from land, horizon visible
Moderate to Good	
Good	Obvious difference between sky and land, horizon distinct

If the horizontal definition falls between two of the above definitions, it can be reported as "moderate to good", etc. You can also report horizontal definition in different directions. Try to keep to a maximum of three values in different directions using the cardinal points (N, NE, E, SE, S, SW, W, NW). Last direction reported being "elsewhere". **61**

Figure 61 – Horizontal definition

Example: Read out "Horizontal definition: Nil to the West, poor elsewhere"

12.8 **Total cloud**

This is the number of oktas, or eighths, of the sky covered with cloud. Imagine all the clouds collected together in a single part of the sky, and estimate the number of eighths of the sky covered.

If the sky is completely covered with cloud **report 8 Oktas**

If there is the smallest gap in the cloud (7 or < 8 oktas cloud cover) **report 7 Oktas**

If there is the smallest amount of cloud (> 0 or <= 1 okta cloud cover) **report 1 Oktas**

If the sky is completely cloud free **report 0 Oktas**

Remember to scan the horizon and mountains for low cloud and include this in the total.

If it is impossible to determine the amount and height of cloud because of moderate or heavy snow/blowing snow, mist or fog then you may report "**Sky Obscured**" instead of inputting any cloud information. Remember to add a present weather in the 'present weather' section of the observation and make sure the 'visibility' ties in if this is the case.

Example: Read out "Total cloud: eight oktas"

12.9 **Consisting of…**

Report the number of oktas and height in feet of each layer of cloud that you observe. Cloud base height is reported ABOVE SKIWAY LEVEL. Report the lowest layer first then the next highest layer and so on. Only report a maximum of four layers. In mountainous regions, cloud base height can be estimated from the heights of the surrounding mountains found from a map, remember to convert the height to feet from metres. When using this method it is extremely important to subtract the height of the skiway from the height of the mountain. For example, if the skiway is at 2,000 feet, and there is a layer of the cloud level with the summit of a mountain at 3,000 feet, then the cloud should be reported as being at 1,000 feet (010), meaning that it is 1,000 feet above the skiway. On ice shelves, cloud heights can be very difficult to estimate and you must use other clues to estimate the height. The cloud height must be estimated from such clues as the size of the elements (the smaller the cloud elements appear, the higher the cloud) and the speed of the cloud (the faster the cloud seems to move, the lower the cloud). See Figure 62 for details of the typical heights of clouds. **62**

IMPORTANT – make every effort to pass accurate cloud heights to the aircraft, but if you are having problems determining the cloud height due to the nature of the surrounding terrain (flat ice shelves) give an estimate to the best of your ability and then report cloud base as estimated e.g. '4 @ 008 feet estimated'. It is important to accurately determine the heights of low cloud.

Use the three digit code to report the cloud base height. Only report the discreet values that appear on the Cloud Height Chart **63**. Note that the total amount for the different layers might add up to more than eight because the layers might overlap but the amount of each individual layer should not exceed the total amount of cloud.

12.9.1 **Layers above**

You may be able to see some cloud above the final layer through a small gap but because the lower cloud is obscuring most of it, the highest cloud layer cannot be determined. In this instance you may use 'layers above (LA)'.

Example: Read out "Four at zero-one-zero, seven at zero-seven-zero with layers above"

At this point if you have nothing more to add to the observation just read out "How copy?" If you have additional comment to make then say "With comments to follow, how copy?". Once operations are happy with the previous information in the observation they will prompt you to pass your comments.

High clouds	**Cirrus**	15,000-20,000 feet	• Fibrous and wispy • Often seen on good weather days • Form in bands • Often in hook shapes
	Cirrocumulus	15,000-20,000 feet	• Organised units of puffy cloud • Units appear very small, almost like fish skin or honeycomb • Rarely seen cloud type • Often seen with cirrus or cirrostratus
	Cirrostratus	15,000-20,000 feet	• Very thin • Milky' veil across the sky • Commonly produce halos or other optical phenomena • Sun clearly seen through the cloud
Mid clouds	**Lenticulars**	5,000-15,000 feet	• Smooth standalone clouds • Often form over mountain tops • Described as 'almond' or 'UFO' like
	Altocumulus	5,000-15,000 feet	• Organised units of puffy clouds • Units are smaller and more organised than stratocumulus • Often arrange in bands • Can be semi-transparent or an opaque dense layer
	Altostratus	5,000-15,000 feet	• Featureless • Flat • Will feel 'higher' and 'thinner' than stratus • Can often see the sun's disk through the cloud, or a faint halo • Sun's light looks like it is shining through glass
Low clouds	**Stratocumulus**	0-5,000 feet	• Rounded masses of cloud that appears in layers • Have a puffy nature and can take many different forms • Well defined base, that can often be a dark grey • Very common
	Stratus	0-5,000 feet (often below 3,000 feet)	• Featureless • Flat light • Feel 'low' to the ground and 'damp' • Blanket of white and/or grey • May produce light snow • Referred to as fog or mist if they are at ground level • When cloud is thin the outline of sun can be visible but often complete blocked out

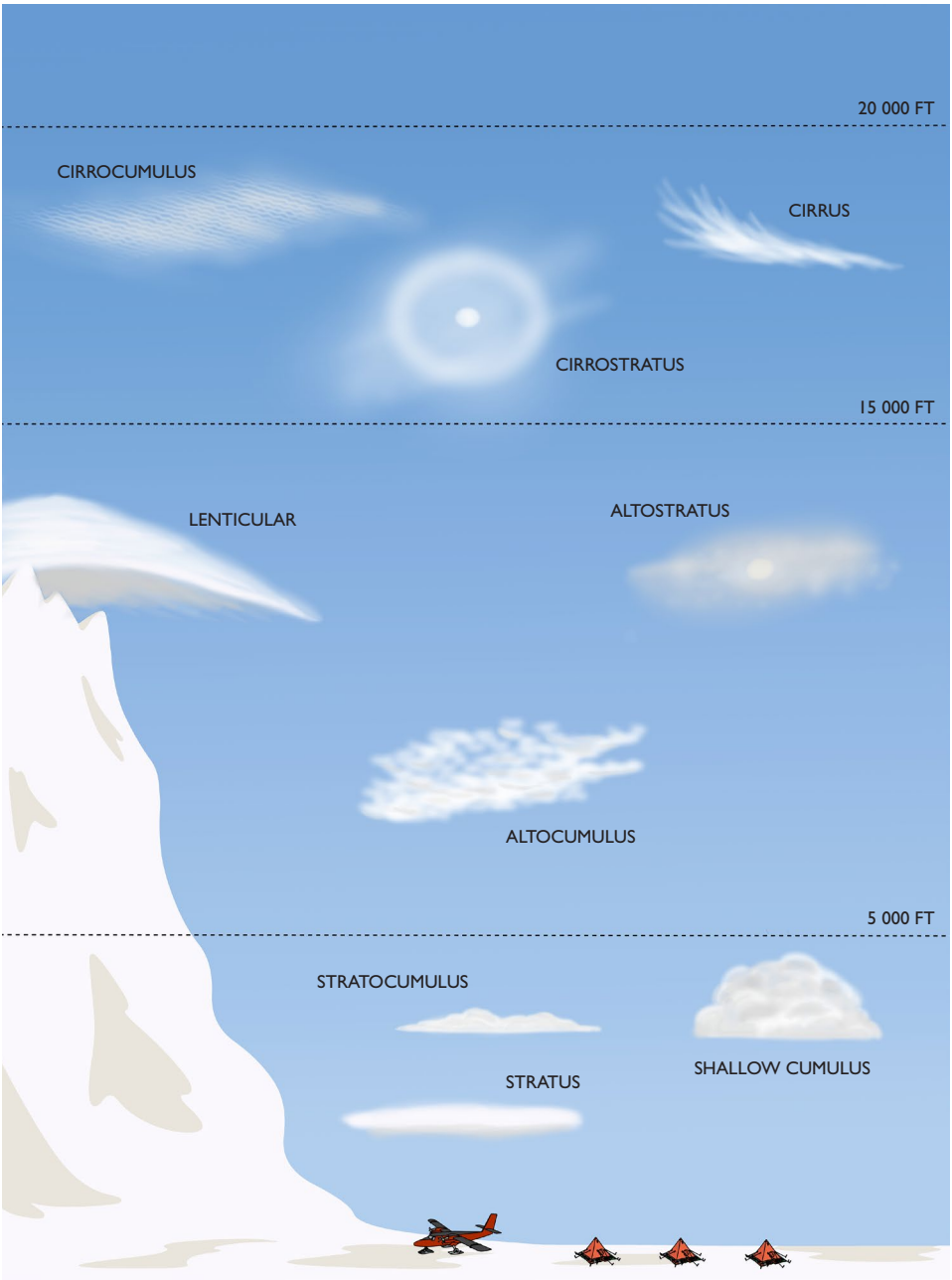


Figure 62 – Cloud heights

Cloud height above ski-way level

Cloud height (feet)	3-digit code
20,000	**200**
19,000	**190**
18,000	**180**
17,000	**170**
16,000	**160**
15,000	**150**
14,000	**140**
13,000	**130**
12,000	**120**
11,000	**110**
10,000	**100**
9,500	**095**
9,000	**090**
8,500	**085**
8,000	**080**
7,500	**075**
7,000	**070**
6,500	**065**
6,000	**060**
5,500	**055**
5,000	**050**
4,900	**049**
4,800	**048**
4,700	**047**
4,600	**046**
4,500	**045**
4,400	**044**
4,300	**043**
4,200	**042**
4,100	**041**

Cloud height (feet)	3-digit code
4,000	**040**
3,900	**039**
3,800	**038**
3,700	**037**
3,600	**036**
3,500	**035**
3,400	**034**
3,300	**033**
3,200	**032**
3,100	**031**
3,000	**030**
2,900	**029**
2,800	**028**
2,700	**027**
2,600	**026**
2,500	**025**
2,400	**024**
2,300	**023**
2,200	**022**
2,100	**021**
2,000	**020**
1,900	**019**
1,800	**018**
1,700	**017**
1,600	**016**
1,500	**015**
1,400	**014**
1,300	**013**
1,200	**012**
1,100	**011**

Cloud height (feet)	3-digit code
1,000	**010**
900	**009**
800	**008**
700	**007**
600	**006**
500	**005**
400	**004**
300	**003**
200	**002**
100	**001**

Figure 63 – Cloud Height Chart

12.10 **Comments**

IMPORTANT – WEATHER AT A DISTANCE. If there is no weather at your location BUT there is weather at a distance, report the weather, most likely snow or fog, in the 'comments' section and make sure your 'visibility' reflects this, if appropriate. Snow will look like light and dark 'curtains' in the distance (you may be able to see features behind it) whereas fog will look like a white/grey uniform bank. Report the direction and distance to it. This is especially important if the weather is in the direction in which the wind is blowing from as it may well make its way towards your location. The pilot will want to know this information especially if the aircraft is on its way. Any early indication of what the weather may have in store is valuable so keep a look out, and study what is on the horizon.

Are there lenticular clouds? These indicate turbulence.

Is the sun disk visible through the cloud? This indicates that although there is extensive cloud cover, it may be thin in places and the contrast may be helped by the weak sunshine.

Information about the general situation may also be reported, particularly trends in the weather, i.e. whether it is improving or deteriorating.

12.11 **Review**

Do all the elements of the weather observation make sense and tie in with each other? Does the 'Visibility' tie in with 'present weather'? Do the 'contrast' and 'horizontal definition' tie in with cloud cover? If it's windy, is there blowing or drifting snow?

Have you made any mistakes? Did you make any mistakes in your last observation? Tell operations if you did.

Try to keep the last three observations on the sheet to look back on, and to see any trends developing and to check for mistakes. It is fine to change your mind but say you have done so in 'comments'.

Note: Ideally the same person should give observations through the day for consistency.

12.12 **Special observations**

Keep an eye on the weather at all times when on obs. If the weather deteriorates significantly between scheduled observations, carry out a full weather observation immediately and radio operations as soon as you can. Submit a special weather observation if:

Visibility

If the visibility changes significantly below 10km. Use the Visibility Chart (Figure 61) and consider issuing a special weather observation if the visibility changes between the coloured groups.

Weather

Fog or moderate/heavy snow commences at your location or at a distance (give a distance and direction).

The onset of drifting or blowing snow.

Cloud base

If the cloud base (five oktas or more) significantly changes below 1,500ft. Use the Cloud Height Chart (Figure 64) and consider issuing a special weather observation if the visibility changes between the coloured groups.

More importantly – use your common sense. If it looks like the weather is getting considerably worse tell operations immediately!

If the weather improves beyond the limits above then wait for 10 minutes of improvement before carrying out a full weather observation and radioing operations with a special weather observation.

12.13 **Key points**

- Always keep an eye on the conditions in between scheduled obs and submit a special ob immediately if necessary
- Talk to the pilots once they have landed to get more accurate information about cloud heights and conditions. This is one of the best ways to improve your obs.
- It is fine to change your mind but make sure you are clear on this in the comments
- Just give your observations, not your opinions and don't be swayed by what the forecast says the weather is supposed to do
- Horizontal plane (visibility) is in kilometers, vertical plane (cloud height) is in feet

Chapter 13 – Techniques for travelling in glaciated terrain

13.1 **Introduction**

The obvious hazard of travelling in glaciated terrain is that of crevasses. To travel safely in glaciated areas, we must be roped together in a team. A minimum of two people are required to do this safely but more people increases safety – three is the ideal number.

This chapter covers the necessary skills and techniques to travel safely on glaciated terrain on foot. For more information on the hazards present in the polar environment see Chapter 4 – Risk management and hazards. For more information on glacier travel using snowmobiles and skis see Chapters 14 and 15.

The information contained in this chapter is not exhaustive, and of course there are many different and equally safe ways to carry out glacier travel. There may be situations where a slightly different technique to those described here is more appropriate and a degree of experience is expected from Field Guides operating in the polar environment.

13.2 **Glaciers and crevasses**

A glacier is a large mass of ice that gradually flows downhill under the influence of gravity. Glaciers are affected by the topography around and beneath them. This topography can cause stress and tension in the ice which leads to crevassing – cracks in the ice; commonly referred to as 'slots'. **64**

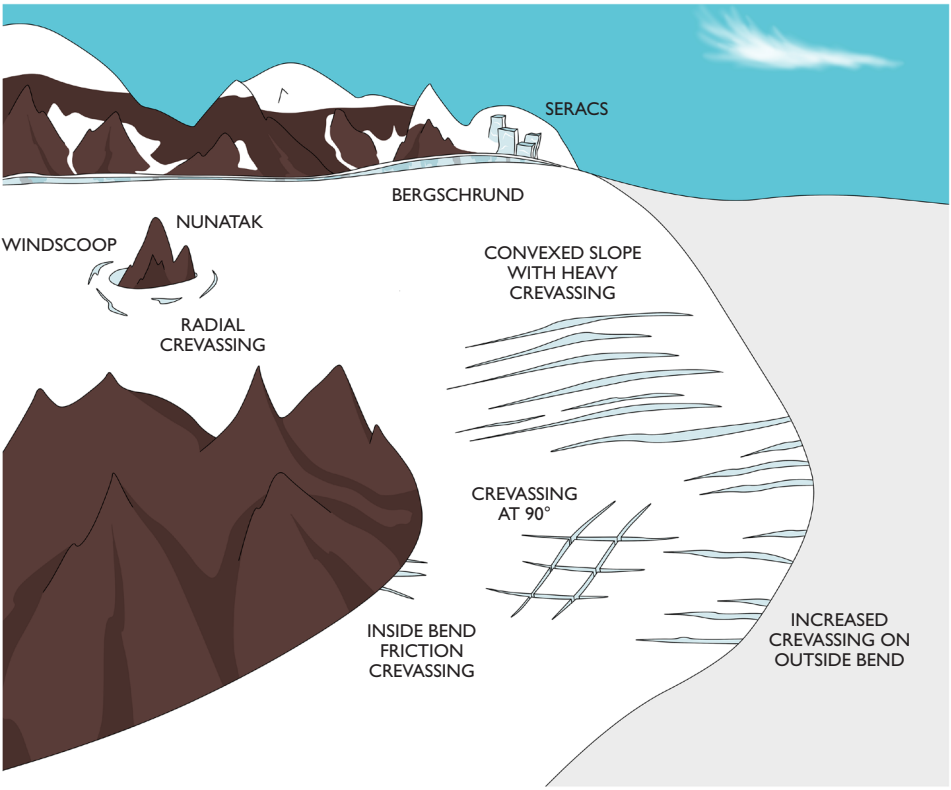


Figure 64 – Glacier hazards scene

13.2.1 **Crevasses**

Crevasses can form anywhere that there is tension in the ice. The most common areas for crevassing are on areas of convexity (a sharp change in slope angle). The outside of a bend in a glacier also causes increased stress to the ice and is more likely to result in large crevasses. Crevasses are also possible on the inside of a bend due to friction where the ice meets the edge of a mountain.

Crevasses are particularly hazardous when snow falls and covers over them, making it hard and sometimes impossible to spot them on the surface. When snow covers over a crevasse it forms what is known as a bridge. Sometimes the bridge can consolidate and become weight bearing, at other times the bridge is not capable of supporting a person and they may fall through into the crevasse beneath.

13.2.2 **Bergschrunds**

Where a glacier separates from a static ice field or a slope of a mountain you get a large crevasse known as a bergschrund. Bergschrunds can sometimes be impossible to cross.

13.2.3 **Seracs**

Large blocks or towers of ice that form on a crevassed slope. Seracs are particularly hazardous and can collapse with little or no warning. It is best to avoid being in the line of fire of seracs for any length of time. A collapsing serac can also trigger avalanches if there is instability within the snowpack.

13.2.4 **Nunataks**

A small mountaintop may protrude through a glacier, creating an isolated area of land, surrounded by glacier ice. Nunataks can offer a safe spot to stop without the risk of crevassing, however they have their own hazards. Windscoops often form on the windward side of nunataks and radial crevassing is common around the top edges of a windscoop.

Additionally, serious crevasse fields can form where a nunatak hasn't quite pushed through the glacier ice. These crevasses often run at 90 degrees to one another.

13.3 **Ice sheets and ice shelves**

Glaciers are not the only areas in which the threat of crevassing is present while operating in the Polar Regions. A large amount of polar fieldwork is conducted on ice sheets and ice shelves.

13.3.1 **Ice sheets**

An ice sheet is in essence a glacier, however in order to be termed an ice sheet the mass of ice must cover over 50,000km^2! The same hazards present on a mountainous glacier will be seen on ice sheets.

13.3.2 **Ice shelves**

Ice shelves are large floating masses of ice, created when a glacier or an ice sheet flows off the land and onto the sea. Ice shelves do not form seasonally and differ from sea ice in the fact that the ice began on the land and has flown onto the sea under the forces of gravity, rather than forming as a result of the surface layer of water freezing (therefore ice shelves are made of fresh water and sea ice is saline). Sea ice is typically less than 3m thick, whereas ice shelves can be between 100m and 1,000m plus in thicknesss!

When on a large ice shelf it is not obvious that you are on an area of floating ice. The horizon is generally very featureless and the terrain can appear benign, however there are many hazards specific to ice shelves. **65**

Shear margins

Shear margins, sometimes called the shear zone, are points where there is a sudden change in the flow of the ice. Most commonly these areas form on the boundaries of an ice shelf and the landmass where a large body of slow moving ice meets faster moving ice, for example where an ice sheet passes by a mountain range.

Grounding line

The point at which a glacier/ice sheet begins to float is known as the grounding line. It is possible that crevasses present themselves on the surface at this point due to increased tension in the ice. Where the tidal range is high, thin cracks open and close at the surface with the falling and rising tides. These are known as strand cracks and are rarely more than a few centimetres wide.

Chapter 13 – Techniques for travelling in glaciated terrain *continued*

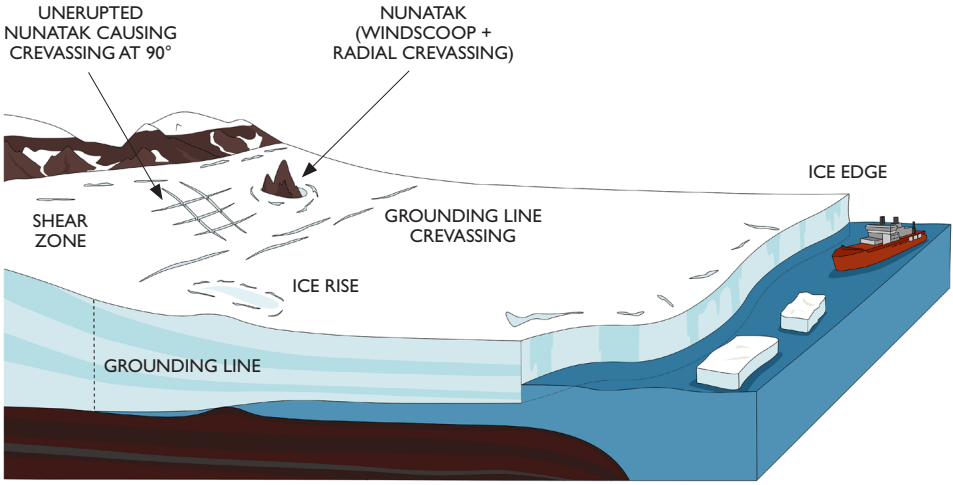


Figure 65 – Ice-shelf hazards scene

Ice rises

An ice rise can form where there is a rise in topography under the ocean surface that causes floating ice to re-ground. The area of ice that has essentially run aground is now very slow moving, with its own independent, radial ice-flow pattern, while the ice around it that is still floating continues to move at the original speed. Ice rises are typically a few hundred metres higher than the surrounding ice shelf. Around the edges of an ice rise you will get a new, localised grounding line. When travelling on and off of ice rises you should be on the lookout for any evidence of crevassing.

Ice rumples

Ice rumples are created in a similar way to ice rises but are formed from much smaller topographical features. An ice shelf will flow straight over the top of an ice rumple and only raise the surface elevation by approximately 30m or less. Never-the-less increased tension in the ice surface is created and crevassing is likely.

Shelf edge

The edge of an ice shelf can be particularly hazardous. Where the shelf ends, and the open sea starts there can be a large ice cliff up to 50m in height. This is also where icebergs are created as a result of large chunks from the shelf calving off into the ocean. These areas are particularly volatile and large cracks in the ice are common.

13.4 **Equipment**

There is a huge range of different mountaineering equipment available for glacier travel. BAS has a standardised system, designed to be easy for non-climbers/mountaineers to learn and operate. It is essential when travelling in an area with a risk of crevassing that all party members are roped together, have the necessary equipment to hand and know how to use it!

All mountaineering equipment is subject to yearly formal PPE (Personal Protective Equipment) checks – as stated in government legislation. In addition to formal annual inspections all PPE must have a pre-use check. Any equipment identified as being potentially unfit for use must be quarantined until a full inspection has been carried out by a competent person. See the Fieldwork Manual for guidelines on PPE inspections.

Figure 66 – Equipment for glacier travel

Chapter 13 – Techniques for travelling in glaciated terrain *continued*

Technical equipment required for glacier travel (as part of the BAS system): **66**

#	Item of gear	Quantity	Notes
1	**Harness**	1 per person	A suitably-sized mountaineering harness
2	**Rope**	1 per group (max group 5)	50m or 60m, single dynamic climbing rope
3	**Helmet**	1 per person	Climbing/mountaineering helmet
4	**Crampons**	1 pair per person	12 point, steel mountaineering crampons sized to individuals boots
5	**Ice axe**	1 per person	General purpose mountaineering axe
6	**Hammer**	1 per person	Axe with hammer instead of adze
7	**Snow stakes**	2 per person	Either V-shaped with wire for mid-clip, or T-shaped top clip
8	**Jumars**	2 per person	A left and a right jumar both with short slings attached with maillons and one with a foot stirrup made of accessory cord
9	**Pulleys**	4 per person	Rescue style pulleys
10	**Screw-gate karabiners**	13 per person	Petzl Am'D karabiners are compatible with the jumars
11	**240cm sling**	X 2	Multi-purpose, building anchors
12	**120cm sling**	X 2	Multi-purpose, building anchors
13	**Ice screws**	X 3	Anchors for on a firm, icy glacier with shallow snow pack
14	**Belay device**	X 1	Used for abseiling
15	**'Dog bone' quickdraw**	X 1	Used as a spacer for abseiling
16	**Prusiks**	X 3	Back-up for abseiling and to replace jumar if one is lost
17	**Pegs**	X 4	Optional depending on project to trip type
18	**Whistle**	X 1	For attracting help if operating near another group
19	**Knife**	X 1	For cutting cord for a variety of purposes or rescuing a ski-doo driver from a crevasse – see Chapter 14
20	**Cord**	X 1	10m 7/8mm cord to assist in rescues if needed

Chapter 13 – Techniques for travelling in glaciated terrain *continued*

13.4.1 **Ropes**

The rope is the fundamental link in a glacier travel system.

Broadly speaking there are two main classifications of ropes – dynamic and static. The rope used for linking people during glacier travel must always be dynamic! A minimum of a 30m rope should be used for glacier travel, but in the context of BAS fieldwork, 60m is standard.

Dynamic ropes

Dynamic ropes have shock-absorbing capabilities and should be used in all situations where there is the potential for a person to shock load the rope – that is to fall onto the rope. Dynamic ropes must be used for glacier travel, climbing and mountaineering activities.

Static ropes

As the name suggests a static rope does not have the same elastic properties that a dynamic rope has. All ropes, even static ropes, have a degree of elasticity but static ropes should not be used for activities where a shock load is possible. Static ropes are used in situations where the stretch of a dynamic rope would work against you, i.e. for planned abseils, ascending a rope or rescue situations.

13.4.2 **Harnesses**

When travelling on glaciers every member of the party should wear a harness. The harness is the main attachment point for roping up but it also makes rescuing someone who has fallen into a crevasse unroped significantly easier.

> Caution: In reality if there is any doubt over the safety of the terrain the team must rope-up so there should be no risk of someone falling down a crevasse unroped, but if this unlikely scenario did occur it would be a very difficult task to rescue someone who is not wearing a harness and may potentially have ended up in a position where it is not possible to put one on.

Exceptions to this statement would be local areas to some stations where a marked area is regularly checked for crevassing and deemed to be safe. **67**

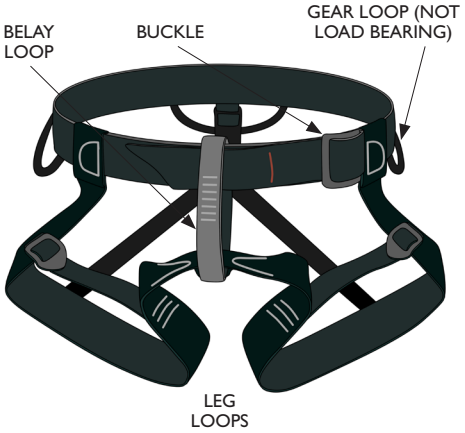


Figure 67 – Mountaineering harness

13.4.3 **Karabiners**

Within the BAS system only screw-gate karabiners are used. The Petzl Am'D karabiners are the main model in use. Their 'D' shape makes them very compatible with other equipment used in the system – such as jumars. Larger pear shaped 'HMS' karabiners (e.g. the Petzl William) are used for specific purposes such as abseiling and when multiple items are to be attached to the same karabiner.

13.4.4 **Jumars**

Jumars wouldn't generally be considered part of standard glacier/crevasse rescue equipment, however in the BAS system they are! Jumars can be used to replace prusiks in a self-rescue system and in an unassisted hoist. The advantages of using jumars instead of prusiks is the ease of use and the reduced risk of them being attached incorrectly. More knowledge and experience is required to tie a prusik in comparison to attaching a jumar to the rope. Jumars also increase the efficiency of any hauling or ascending system, with the obvious penalty being their weight.

13.4.5 **Slings**

Webbing slings are highly useful and multi-functional (i.e. can be used for linking anchors, as quickdraws, as safety lanyards and for many improvised rescue purposes), however understanding their limitations is vital.

Two main sizes will be found in the BAS system – 120cm and 240cm. Slings can be either nylon or dyneema.

> Note: Confusingly 120cm slings are sometimes referred to as eight-foot slings and 240cm slings are 16-foot slings. When talked about in feet the measurement is the total unstitched length of sling. In centimetres it is the usable length when in a loop.

13.4.6 **Pulleys**

A pulley is used to reduce the friction on a hauling system in a crevasse rescue scenario. Lightweight rescue pulleys are used in the BAS system.

13.4.7 **Belay devices**

Friction devices are used for abseiling and protecting a lead climber. BAS don't use mechanical belay devices such as Gri Gri's or older-style friction devices such as figure of eights.

13.4.8 **Snow stakes**

Snow stakes (a.k.a. pickets) are carried as the primary anchor for use on snow. Snow stakes come in a variety of forms and you will see mid-clip 'V' stakes as well as top clip 'T' shaped. All stakes can be placed just off the vertical or horizontally as a dead-man. As with any snow anchor, an understanding of the snow pack is essential for assessing its overall strength – this understanding only comes with time and experience.

13.4.9 **Ice screws**

On firm icy glacier surfaces with a shallow snowpack ice screws may be the only option for an anchor. As with snow stakes, ice screws require a judgment call to be made regarding the quality of the ice and therefore the overall holding power of the anchor.

13.4.10 **Ice axes**

An ice axe is an essential piece of equipment for any glacier travel. It is the main tool for arresting a fall, is used to create an anchor and can itself be used as the anchor. As a minimum each person should carry an axe with adze. An additional axe with a hammer should also be carried for placing snow stakes – although in extremis this can be done with a standard axe but it may damage the axe if hammering into firm snow.

13.4.11 **Crampons**

When travelling on foot across glaciated terrain crampons should be worn. A standard set of steel 12-point mountaineering crampons is best. Without crampons on, self-rescue from a crevasse is difficult and holding a fall is also made easier when wearing crampons.

13.4.12 **Helmets**

A climbing/mountaineering helmet must be worn for glacier travel. If you were to unexpectedly fall into a crevasse there is high chance you will either hit your head as you fall in or have a lump of snow/ice fall onto you from the collapsing snow bridge.

13.5 **Roping-up**

The purpose of roping-up is to safeguard party members against crevasse falls. The most experienced party member leads the way and selects an appropriate route. On descent the more experienced person will stay at the back to safeguard the other member(s) of the team. In the event of the leader falling into a crevasse, the second person will arrest the fall and take the necessary action to retrieve the leader.

> Caution: It is most common for the first person to fall into a crevasse but not always! Sometimes it is the second person as the first person over a crevasse may have weakened the snow bridge.

Roping-up for glacier travel always involves 'portioning off the rope'. This is sometimes referred to as a rule of thirds. One-third of the rope should be between the two people, another third coiled around person one and the final third coiled around person two. When there are more than two people on the rope there is a slightly different procedure, which will be discussed further on in the chapter.

The exact distance between the two people can vary and will depend on the nature of the terrain. If large crevasses are to be crossed the distance should be increased. No less than 15m, and 15m-20m being the norm.

13.5.1 **Roping-up as a team of two**

Three or four people on a rope is ideal and makes glacier travel safer as rescues become significantly simpler. However, there are many situations where there will only be two people available.

Key considerations for roping-up as a team of two for glacier travel:

- Size of the crevasses to be crossed
- Surface conditions – how soft is the snow?
- Angle of the terrain? Are there any slopes to be ascended or descended?
- Is there a size or weight disparity between members of the party?

The above questions will help you to decide on how much rope is required between the two people.

> Warning: A minimum distance of 15m is required between people in a two-person team and this distance should be increased depending on the severity of the terrain. This does however mean each member of the party will not have enough coiled rope to reach the other if the distance is increased more than 20m.

Knots on the rope

Knots can be tied on the rope between two people to increase stopping power. The bulky nature of the knots cut into the lip of the crevasse creating more friction and subsequently slowing and stopping a slip or fall.

Standard practice for a team of two within BAS is to have four ENSA knots on the rope while crossing glaciated terrain. The knots should be placed on the rope at 4 meters and the next 1-2 meters in front of the last.

Knots have the obvious downside of making crevasse rescue more complicated. When travelling with knots in the rope ensure both party members are well practiced in the appropriate techniques required to recover themselves and an injured person from a crevasse.

In a team of three, ENSA knots in the rope are still recommended as in some situations it is not guaranteed that two people alone can hold a fall; therefore, the same four ENSA knots should be placed on the rope in the same spacings as for a pair with the middle person not requiring any extra knots.

A team of Four or more does not normally require knots in the rope as there is deemed to be enough rope between the team to sufficiently hold a fall of one member.

Knots can potentially cause a hindrance when transitioning from glacier to rock and back again in quick succession. Adding and/or removing knots in this scenario may be something to consider as it may reduce the overall risk to the party. **68/69/70/71/72/73**

13.5.2 **Roping-up as a team of three or more**

When roping-up with three or more people for glacier travel the distances between each person can be reduced; 10-15m is acceptable between each person. The front and back people on the rope will tie in using a standard rethreaded figure-of-eight as shown. The middle person will tie in differently and will not take any coils. **74**

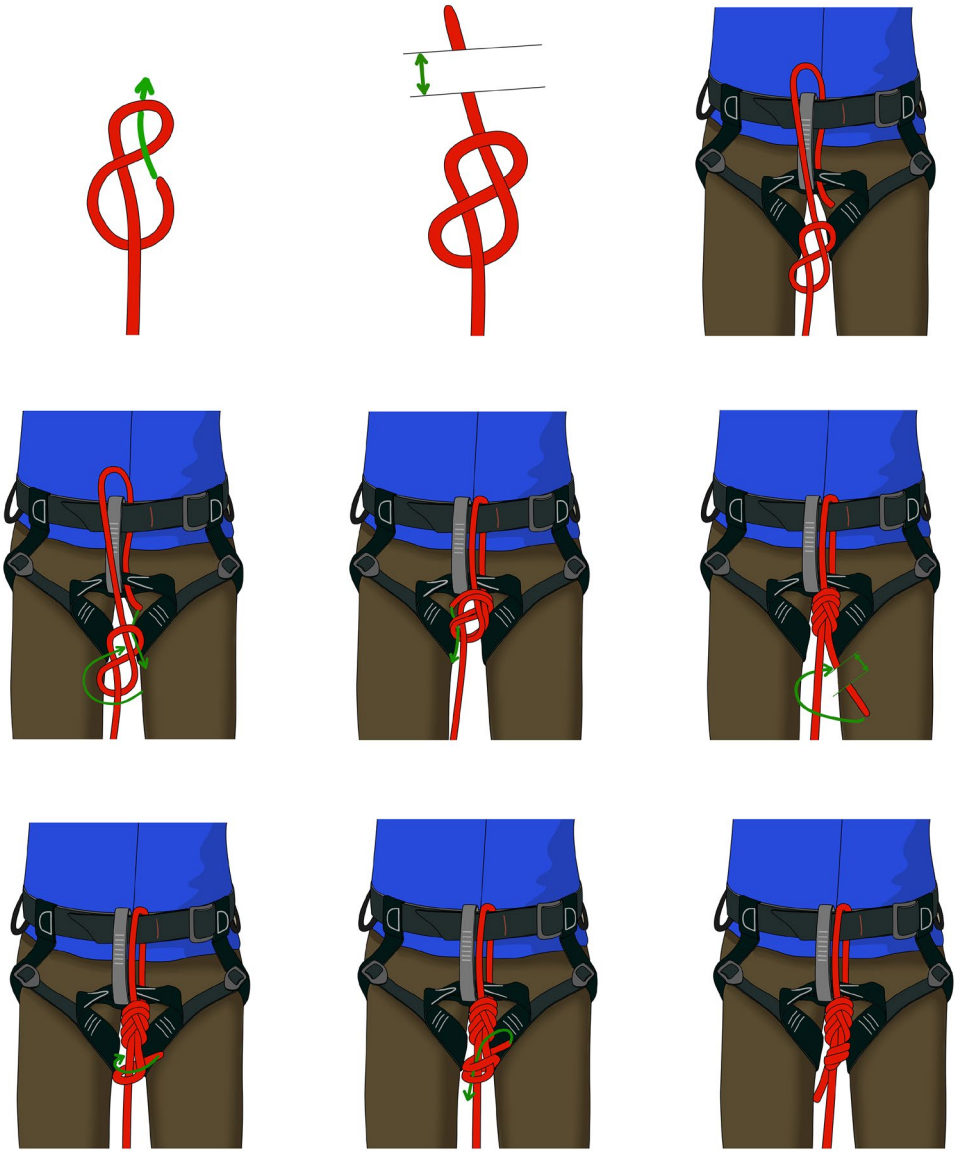


Figure 68 – Tying into the rope (re-threaded figure of eight)

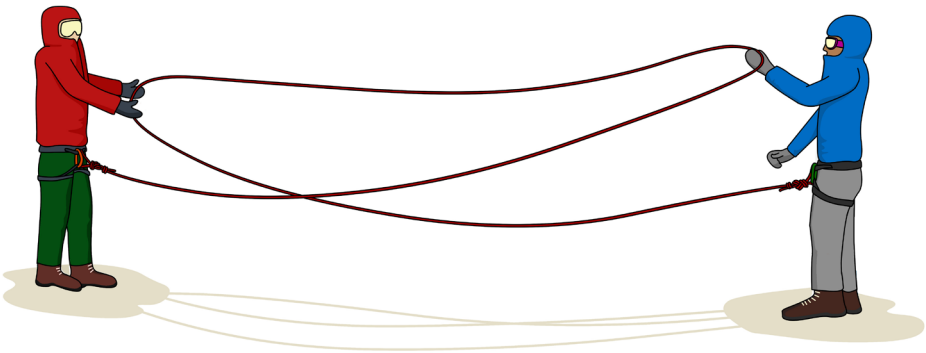


Figure 69 – Measuring rope into thirds

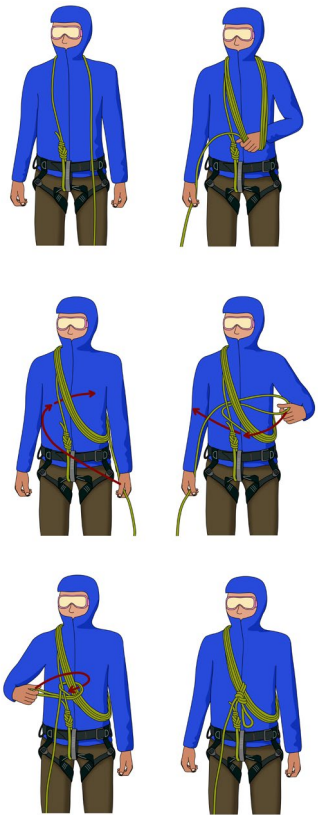


Figure 70 – Taking coils 1

Figure 71 – Taking coils 2

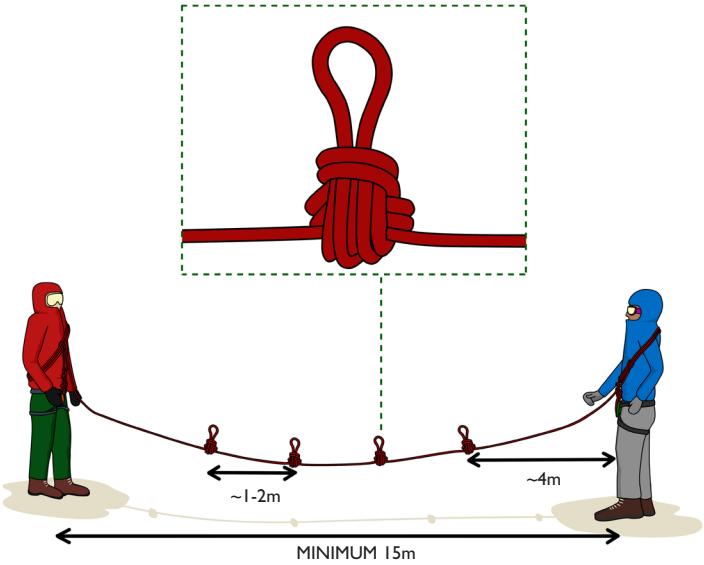


Figure 72 – Knots on the rope

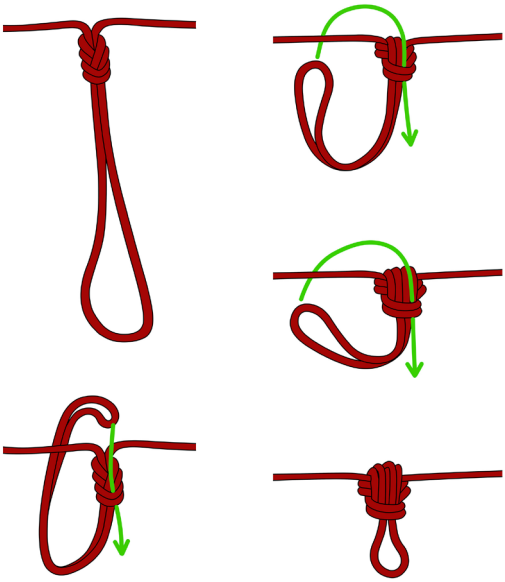


Figure 73 – Tying an ENSA knot

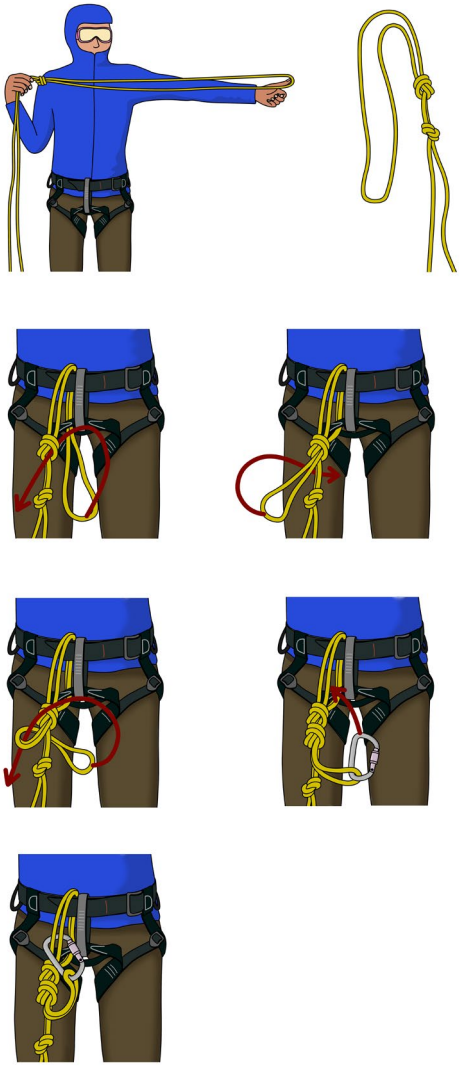


Figure 74 – Middle person tying in to rope

To measure distances start from the middle by tying above the loop. Use arm spans to measure out desired distance of rope in both directions. If more than three people are on the rope then tie overhand loops at appropriate spots during measuring.

For a party of three the following system can be used to divide the rope into 5 parts – coils for the front and back person, plus ~15m between each person. **75**

> Caution: When roping up in a team of three or more, 10m between people is the minimum distance. This limits the maximum number of people to one rope of six if using a 60m rope and five if using a 50m rope – this will leave no spare rope for coils. In a situation like this it is wise to carry a spare rope in the pack of the rear person for rescue purposes.

13.5.3 **Moving while roped-up**

All party members must move at the same steady speed to allow the rope to remain snug at all times. Any slack in the system will allow momentum to build in the event of someone falling into a crevasse. It is not practical to move with the rope tight as the front person will end up working very hard!

Crevasses must be crossed at 90° to their orientation to reduce the risk of the whole party ending up on the same snow bridge.

Under no circumstances should hand coils be carried while moving on a glacier!

13.6 **Route choice**

Choosing a good route through glaciated terrain on foot is essential and will greatly increase efficiency and safety. In complicated terrain it is worth having the most experienced person at the front picking a safe route through. When travelling downhill the most experienced person is of more use at the back as they will be the most likely to be able to arrest a fall into a crevasse, against the forces of gravity.

13.6.1 **Spotting crevasses**

Where crevasses are covered with snow and hard to see on the ground it is important to be able to

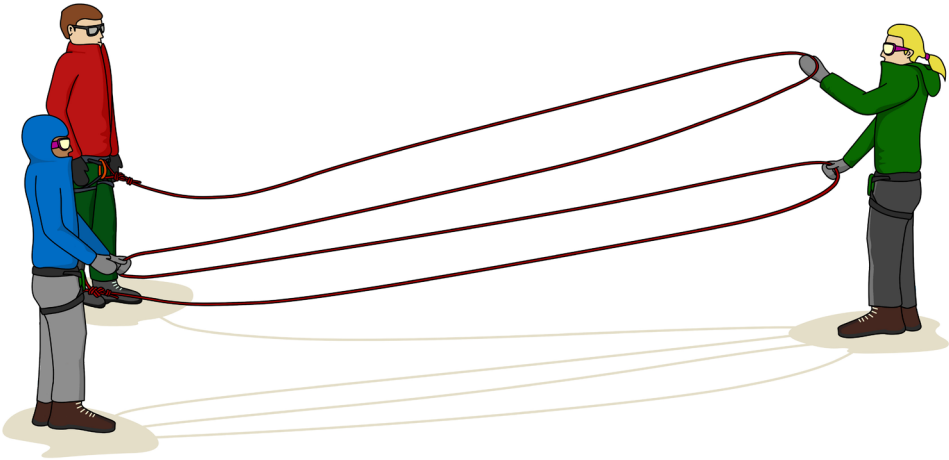


Figure 75 – Measuring rope into four for three-person team

assess their likely position and orientation. Crevasses form where the ice is under tension. This tension is primarily caused by the topography underneath the ice. Where a glacier flows over a change in angle, this stresses the ice and leads to cracks opening up (crevasses!). Crevasses are most commonly found on areas of convexity and also on the outside edges of a bend in the glacier. **76**

> Caution: Glaciers in the Polar Regions (particularly Antarctica) can be very slow moving. On a faster moving glacier, crevasses will open up over areas of tension and then close up once they flow past this area. On a slow moving glacier, such as those found in Antarctica, crevasses can take longer to close up after such areas resulting in the presence of large crevasses in areas that you wouldn't normally expect to see them!

Crevasses with weak snow bridges are often visible in good light conditions as faint linear depressions. Travelling over crevassed terrain with poor contrast increases the risks and the likelihood of ending up down a slot! Gaining a vantage point can help with spotting crevassing and planning a route through. Prior to field deployment gather as much information as you can for the area(s) you intend to travel in. Aerial photographs and satellite imagery are incredibly useful tools. If flying over the area you are travelling in during deployment discuss options with the FOM and the pilot regarding low-level flight of suspect areas.

13.7 Crevasse rescue

In the event of someone falling into a crevasse it is essential that everyone in the party knows what to do.

13.7.1 Arresting the fall

The first action in all scenarios involving a person going into a crevasse is to hold the fall – known as arresting the fall. To do this effectively all party members must be alert and paying attention to the hazards at all times. As soon as a person breaks through a weak crevasse bridge the remaining team member(s) must hit the ground and adopt an ice axe arrest position, face down in the snow. Once the momentum has stopped, dig feet into the snow to create a stable 'braced' position. Arresting the fall will be easier in soft snow as the rope often 'cheese wires' into the edge of the crevasse. In firmer conditions or in descent it can be more problematic. **77**

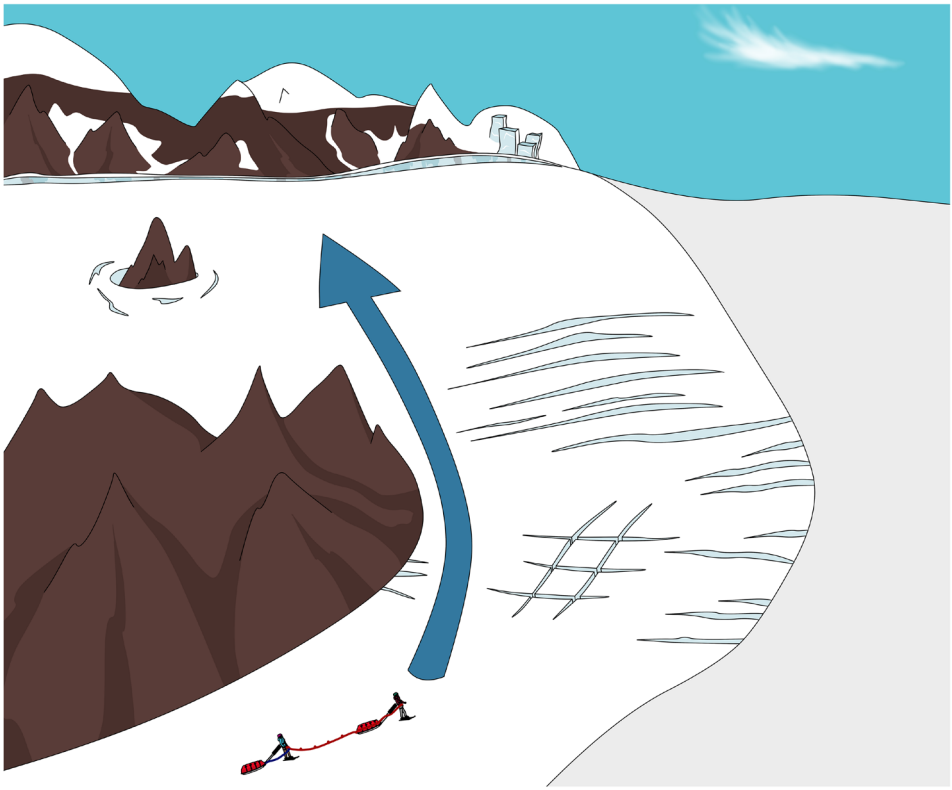


Figure 76 – Glacier travel route choice

13.7.2 **Snow and ice anchors**

Safe and effective crevasse rescue relies entirely on good anchors. The exact choice of anchor will depend on the terrain and the quality of the snow, and will therefore vary in every situation. The following anchors are the most commonly used.

> Warning: All snow and ice anchors rely on the quality of the snow/ice they are placed in. The ability to assess and make a judgment of the most appropriate type of anchor and also assess the snowpack is essential to creating safe anchors for crevasse rescue. This is a skill that can only be developed through practice and experience.

Snow stakes

Snow stakes come in two different forms – mid clip and top clip. Mid clip stakes have a swaged wire attached to the middle of the stake and when driven in 'cheese-wire' their way through the snow. A top clip stake is placed as far into the snow pack as possible and then clipped at the closest point to the surface. Snow stakes also come in different shapes, 'V' and 'T'. V-shaped stakes are placed with the point of the V towards the load, with the exception of when it is a V-shaped stake with a mid-clip wire attached – in this case the open side goes towards the load! T-shaped stakes are always placed with the vertical part of the T towards the load. **78**

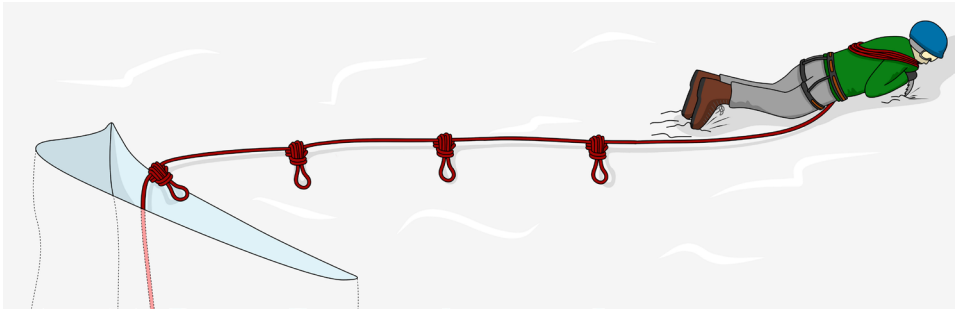


Figure 77 – Holding crevasse fall

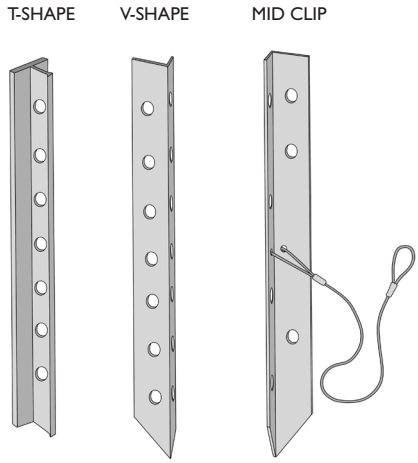


Figure 78 – Types of snow stake

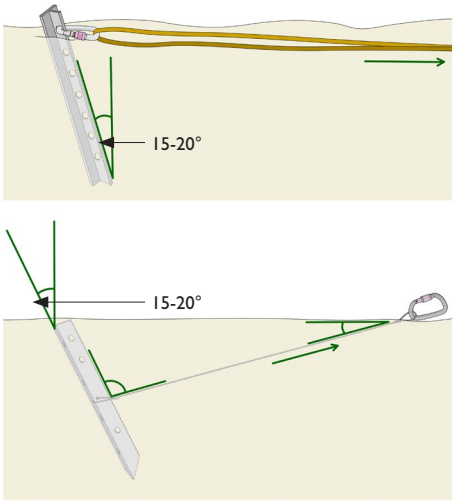


Figure 79 – Placement of top- and mid-clip stakes

To place a snow stake, first identify the version you have and orientate correctly towards the intended load. The snow stake should then be driven into the snow with approximately a 15°-20° lean away from the load. **79**

A minimum of two snow stakes should be used for an anchor in a crevasse rescue situation but in suspect snow more will be needed. Snow stakes should not be placed too close to each other or on the same linear plane. **80**

Dead-man

A dead-man anchor refers to any item buried horizontally in the snow. This could be a ski, an ice axe, a snow stake placed horizontally or a variety of other items. It is very difficult to construct a solid dead-man anchor while holding someone who is hanging in a crevasse so this is most appropriate when there are three or more people on the rope or two separate rope teams.

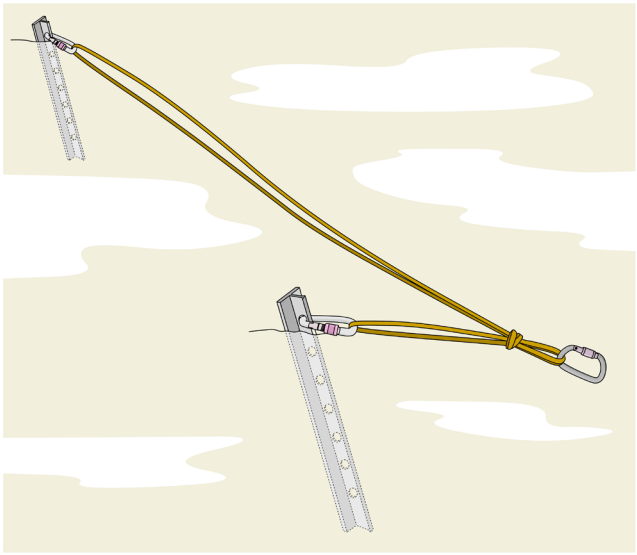


Figure 80 – Offset snow stakes

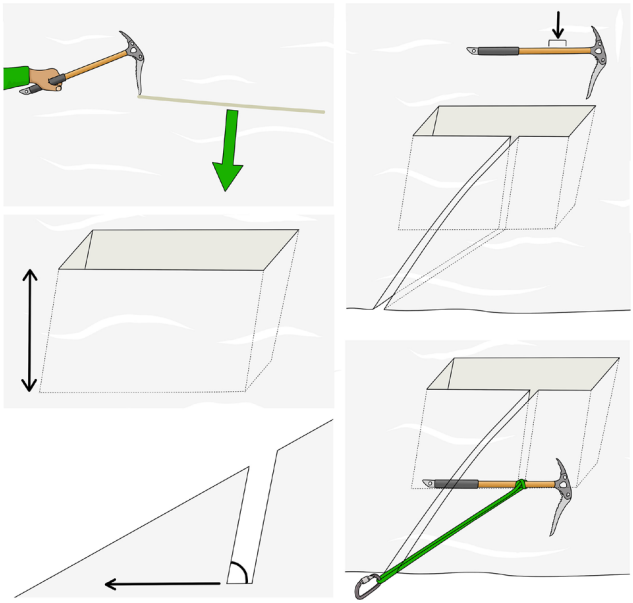


Figure 81 – Dead-man anchor slot

Chapter 13 – Techniques for travelling in glaciated terrain *continued*

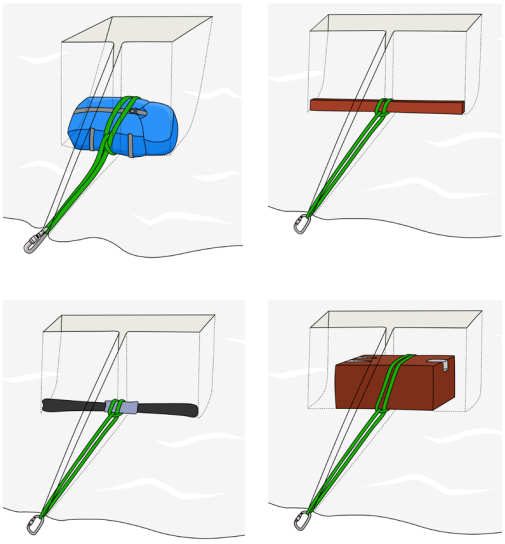


Figure 82 – Various dead man items

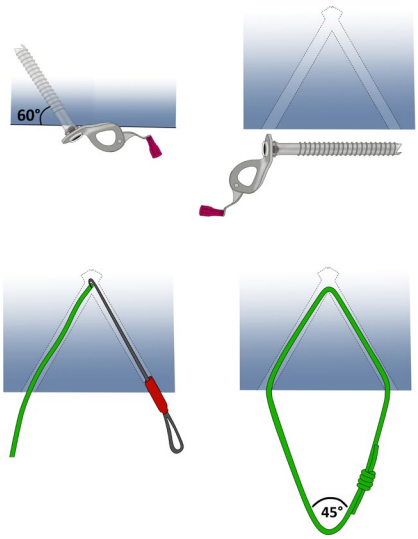


Figure 83 – Constructing a V thread

A slot will be dug perpendicular to the crevasse. The depth is determined by the quality of the snowpack (in soft snow it will need to be deeper and the item larger!). The item is then inserted into the slot with a sling attached. A T-shaped slot needs to be created for the sling to sit in. This creates a direct pull onto the anchor rather than lifting it upwards and out of the slot. **81/82**

The strength of this anchor comes from the snow on-front of the anchor. While operating around the anchor take care not to disturb this area of snow.

Ice-screws

On dry glaciers or terrain with a very shallow snowpack, ice screws may be the most appropriate anchor. Ice screws are placed by first clearing away any snow or cruddy ice with the adze of an axe. The screw is then positioned at right angles to the surface, downward pressure needs to be applied to the top at the same time as rotating the screw clock-wise into the ice. A minimum of two screws must be used for an anchor and they should be placed off-set and approx. 30cm apart.

Abalakov Thread – V Thread

More commonly known as a V-Thread, this ice anchor is created by drilling two intersecting holes in the ice at angles that form an equilateral triangle. This produces a hollowed out 'V' shape in the ice.

To create a V-thread, first drill a hole at 60° to the surface ensuring the ice quality surrounding the placement is good. A second hole is then created a screw length away from the first hole. This creates the largest triangle possible. Care needs to be taken with the placement of the second hole to ensure the two intersect. Placing a threading tool in the original hole can help with the alignment. Once the holes intersect, place some cord or rope down one and hook it with a threading tool to pull it through the other. Tie off the cord in a loop with a double fisherman's knot and ensure it is not too tight. The ideal angle being 45° once weighted.

This type of anchor can be adapted to work in rock and can also be made larger and therefore stronger in ice by using a drill and a long bit. Ensure there is a sufficiently long threader for the hole drilled. A climbing sling can be used to pull rope through, but this is fiddly. **83**

Chapter 13 – Techniques for travelling in glaciated terrain *continued*

Linking anchors

The anchor must be linked together in a fashion that ensure all pieces are solid, independent of one another, loaded in an appropriate direction, equally loaded and angled at less than 60 degrees. **84**

The acronym 'IDEAS' is useful for remembering this:

I = Independent

D = Directional

E = Equalised

A = Angle

S = Solid

Independent – all arms of the anchor need to be independent to one another. Appropriate knots can achieve this

Directional – all anchors need to point correctly in the direction of pull

Equalised – the load needs to pull equally across all the arms of the anchor

Angle – the angle between all the arms needs to be less than 60°

Solid – the pieces making up the anchor need to be solid and capable of withstanding the forces required

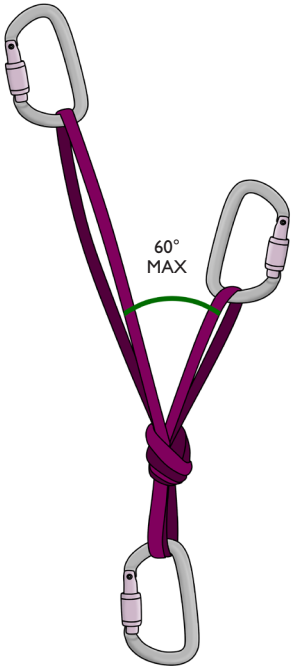


Figure 84 – Linking anchors

Figure 85 – Transferring load to anchor

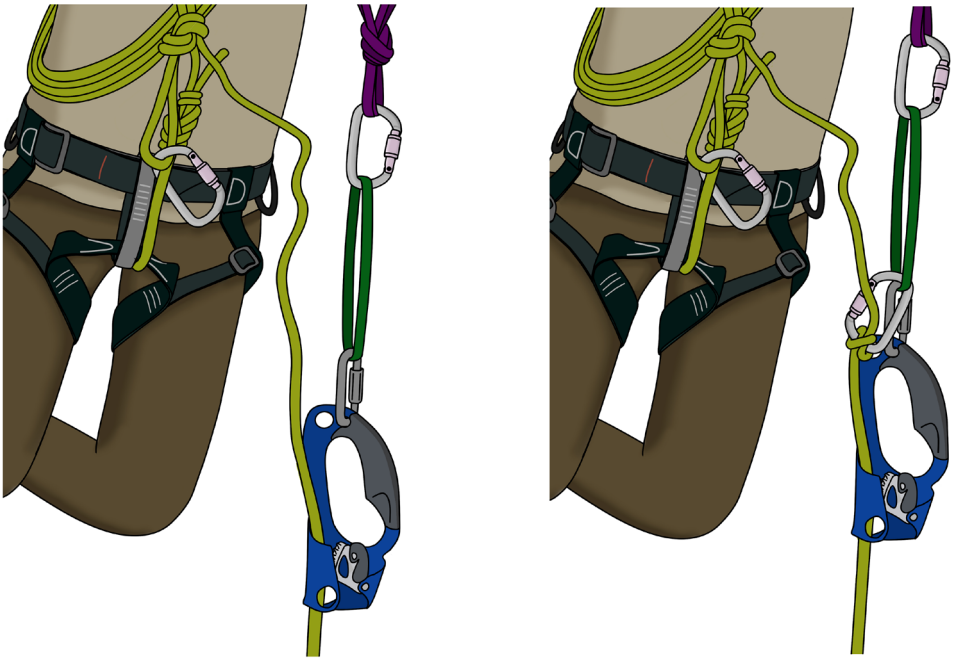


Figure 86 – Backing up jumar

13.7.3 **Escaping the system**

Once the anchors have been constructed and linked you can escape the system. To do this you will need one jumar. The jumar is connected to the tight rope leading to the 'victim'. The short sling attached to the jumar is then connected into the loop in the anchor. Slowly ease your weight towards the edge of the crevasse to transfer the load to the anchor – it is important that this is done slowly so that the anchor is not suddenly shock-loaded. If the anchor was to show signs of failing the person is still in a position to arrest the fall as before. Ensure an ice axe is always on hand during this process. **85**

Once the weight is off the person and onto the anchor, a back-up must be tied into the anchor to safeguard against the jumar slipping, which can occur on icy ropes. A clove hitch should be tied in the slack rope and attached to the anchor. It may be necessary to remove a coil in order to do this but be aware that as soon as the coils are untied you are vulnerable if the anchor was to fail, as your coils are no longer locked off and if they became tight they would tighten around your body and impair your ability to breathe! There should be enough rope to attach a back-up clove hitch to the short sling on the jumar without the need to undo coils. **86**

13.7.4 **Self rescue (ascending the rope)**

If the person who has fallen into the crevasse can extricate themselves, it makes the whole process much easier and quicker. A set of jumars is carried by each person while travelling over crevassed terrain. Although heavy they are the most efficient way of ascending a rope. Both jumars are connected to the belay loop on the harness via the short sewn slings and screwgate karabiners. The jumar with an additional long foot-loop is positioned as the lower of the two jumars. It is very important that a back-up is tied below the two jumars in case the device(s) slip, which can occur while using icy ropes. The back-up consists of a clove hitch which can be manipulated through after every metre or so of upward progression.

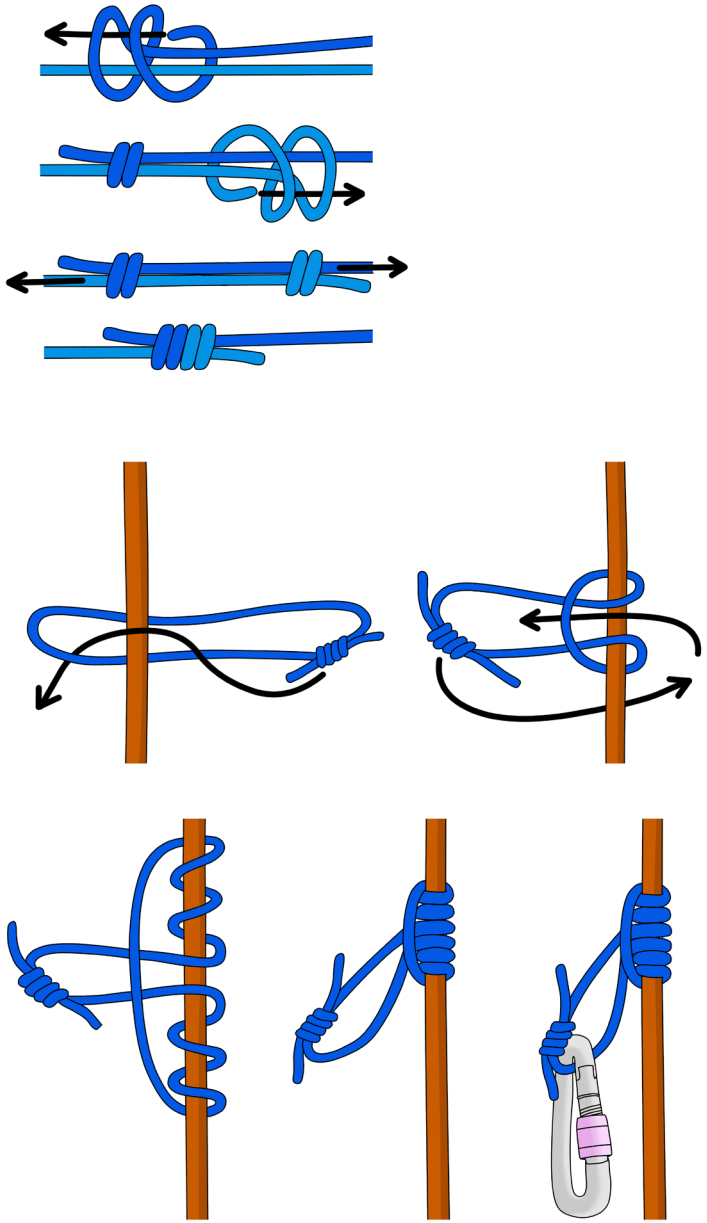


Figure 87 – Tying classic prusik

Each person should also carry two prusik loops to enable self-rescue in the event of losing or forgetting a jumar(s). A classic-style prusik is the most appropriate prusik knot for ascending a rope. A back-up clove hitch must also be used while ascending a rope using prusiks. **87/88/89**

13.7.5 **Jumaring – Passing a knot**

With ENSA knots present on the rope, passing a knot(s) will need to occur if ascending the rope to the surface. This is done in the following steps. The system described below will also work with prusik loops in place of the jumars. A backup should always be present throughout the process of ascending regardless of the techniques used. **90**

1. Ensure Clove hitch is snugged up and minimal slack remains.
2. Shunt top jumar up to around 1" from the ENSA knot. Ensure lower jumar is just underneath.
3. Stand in the footloop of the lower jumar. Once stood, remove the top jumar and place as high as possible on the rope above the ENSA knot.
4. Sit down into top jumar.
5. Depending on how much space there is between the top jumar and the ENSA knot may mean a small amount of upward movement is needed before the next step.
6. Whilst sitting in the top jumar, remove the lower jumar and place back on the rope above the ENSA knot.
7. Sit back down into jumars.
8. Untie ENSA knot and pull slack through the clove hitch and snug up to harness.
9. Repeat for further knots.

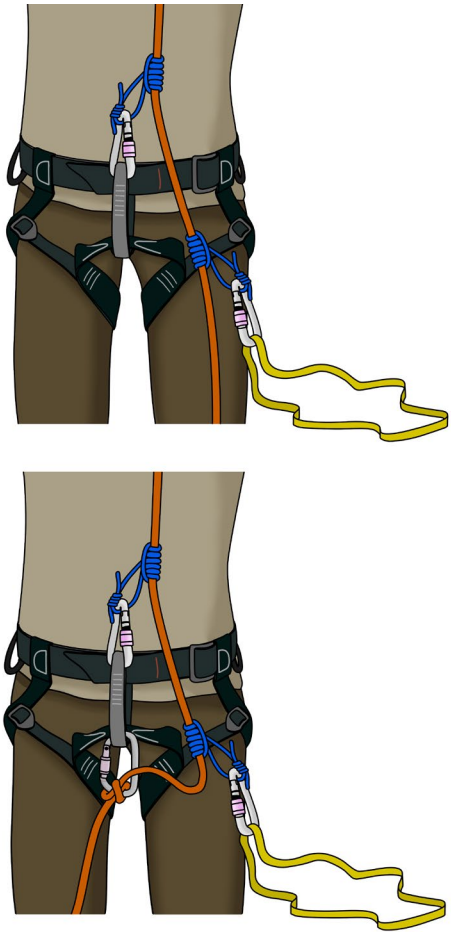


Figure 88 – Ascending rope using prusik

13.7.6 **Unassisted pulley system**

The BAS pulley system for crevasse rescue is unique in mountaineering terms. It has been designed to be as simple as possible for relative novices after some short but intensive training. The kit required for the system means that it is not the lightest weight but in the context of polar fieldwork weight is rarely an issue.

There are variations possible with this setup, such as a simplified 3:1 haul system for scenarios where a

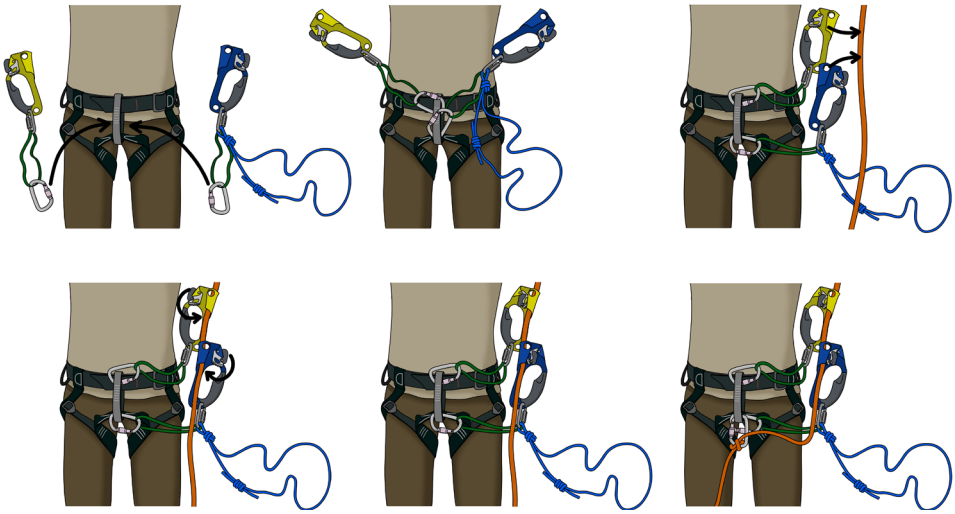


Figure 89 – Ascending rope using jumars

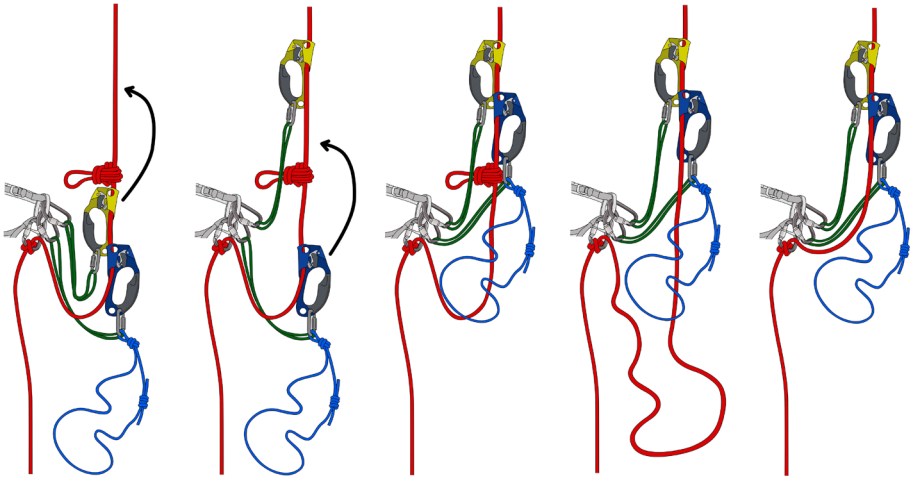


Figure 90 – Jumaring past a knot

smaller amount of mechanical advantage is required. This is not the standard for BAS, but it may be applicable in certain scenarios in the field. Field Guides should have the appropriate knowledge and experience to make this decision.

13.8 **BAS haul system**

Once the system has been escaped and backed up with a clove hitch, communications have been made with the casualty, and the rope over the edge has been protected from cutting into the lip, the following process is followed to set up the haul system. **91-1/2/3/4/5**

1. Lay out the rope creating five strands with pulleys at all the direction changes.
2. Place 2nd jumar onto the loaded strand of rope with the teeth pointing towards the anchor, ensuring the teeth properly engage.
3. Starting at the clove hitch, place pulleys onto the rope at all the direction changes. These being - the anchor, the front jumar, the front of the rear jumar, and the sling attached to the front jumar.
4. Once all the pulleys are connected a quick check should be made to ensure the system is correct.
5. Remove the clove hitch and begin to haul the casualty.
6. To reset the system – advance the front jumar down the rope as far as possible. Continue to haul.

13.8.1 **Hauling – Passing a knot**

Once the haul system is set up the knots in the system will need to be passed with the following process to continue to raise the casualty to the surface. **92**

1. Once the front jumar is advanced to near the ENSA knot (1" or so), 'crunch' the system down until the pulleys are almost touching (1" apart).
2. Tie an overhand on a bight as a backup knot around 2 meters from the first pulley (this equates to approximately an arm span width).
3. Advance the front jumar just past the ENSA knot.
4. Haul the system until it is crunched up again.
5. Attach the sling to the anchor and the front jumar.
6. Haul about 1" through the system to allow the clutch (Rear) jumar to be released.
7. Slowly pay slack into the system until the weight is on the front jumar and sling.
8. Pull a small amount of slack into the system to allow the ENSA knot to be untied.
9. Pull the slack created back through the system and re-engage the clutch jumar.
10. Haul enough to confirm clutch jumar is holding the weight then either remove the sling or leave in place if there is a second knot to pass.
11. Push front jumar towards next ENSA knot. The backup knot will likely foul in the pulley at this step - untie as needed.
12. Untie the backup knot (if not removed in previous step).
13. Repeat for more knots as needed.

Note: The backup knot must be tied in the tail with enough slack to ensure the entire process can be completed without it getting stuck in the system.

13.8.2 **Suspension trauma**

Death from suspension trauma can occur anywhere from 5-30 minutes into being suspended vertically and with no movement. Therefore being able to perform a fast and efficient crevasse rescue is critical.

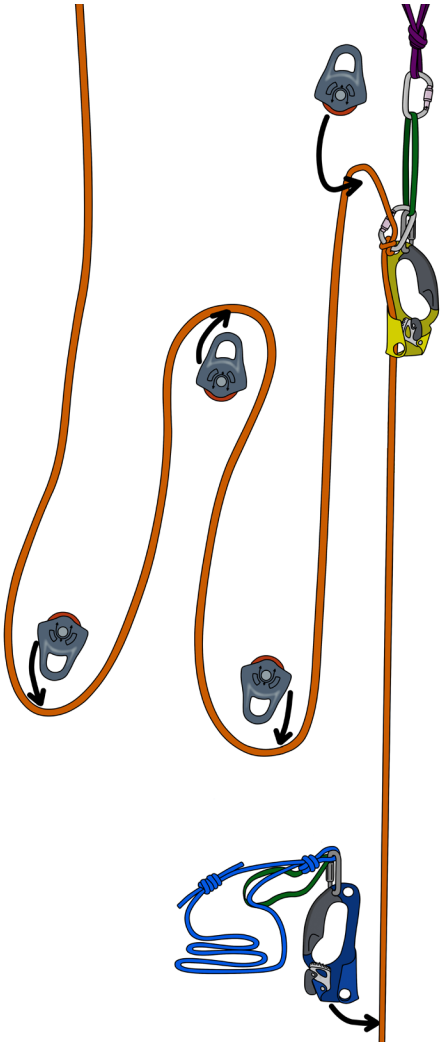


Figure 91-1 – Rope being laid out with five strands, jumar number two next to the rope at front

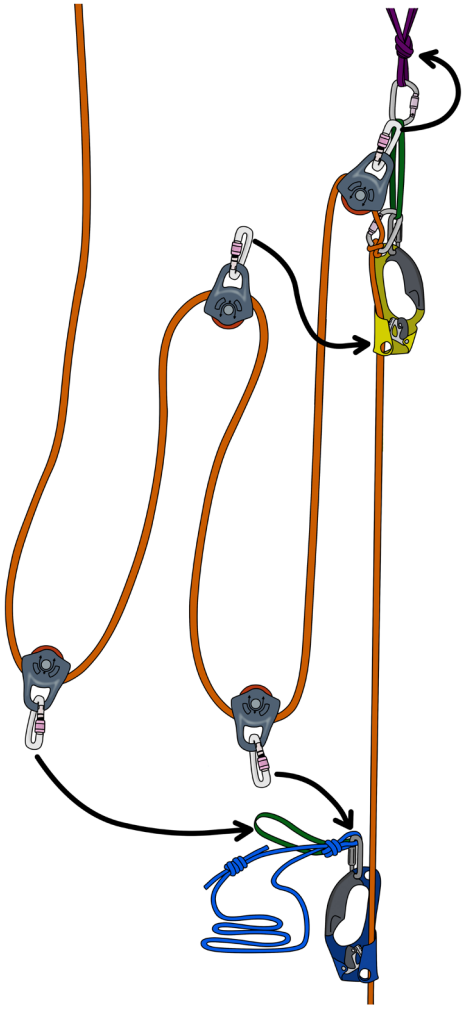


Figure 91-2 – Pulleys being placed at all points where rope changes direction

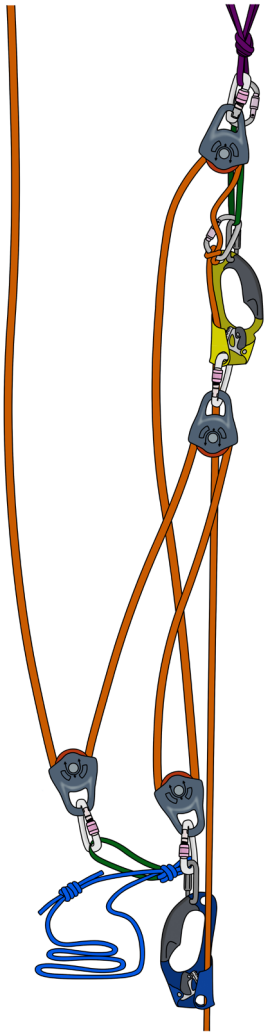


Figure 91-3 – Jumar connected, all pulleys connected

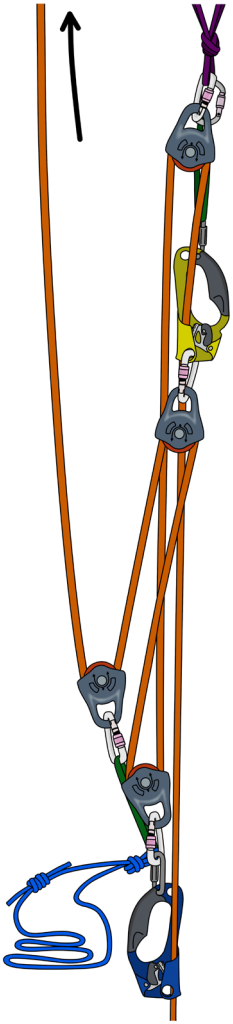


Figure 91-4 – Back-up clove hitch removed and hoisting begins

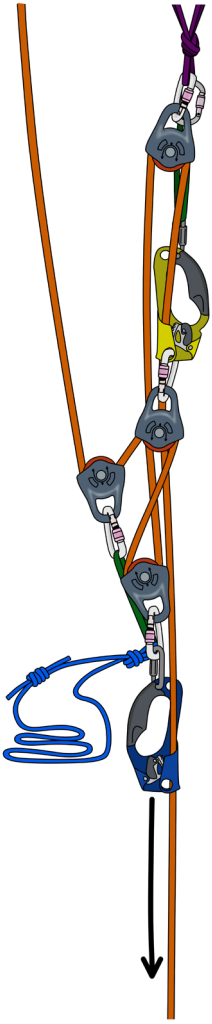


Figure 91-5 – Resetting the system for further hauling

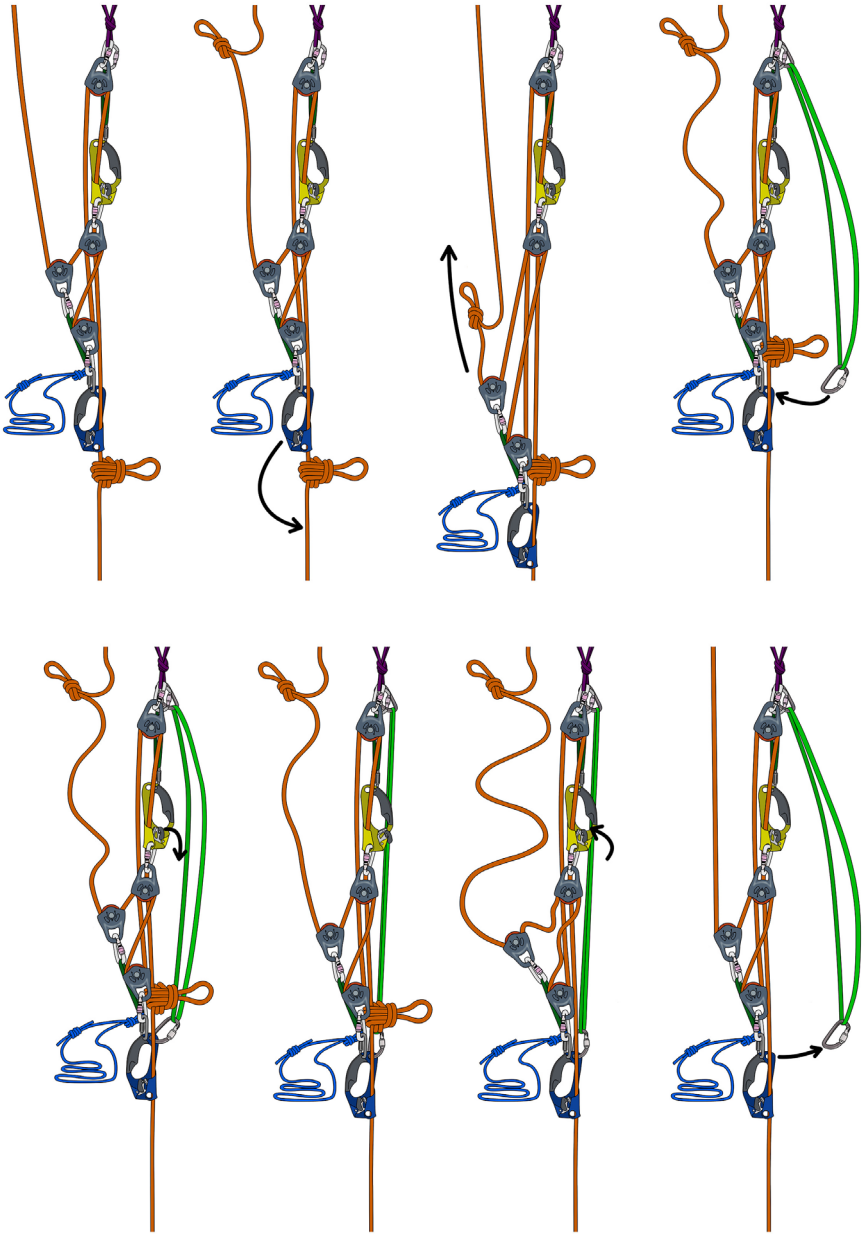


Figure 92 – Hauling past a knot

Chapter 14 – Field travel by snowmobile

14.1 **Introduction**

Field travel relies heavily on snowmobiles. The ability to deploy small teams into the field that can cover large distances using only a few Twin Otter flights for input is something that BAS prides itself on. Field travel by snowmobile is complex and calls on the majority of skills and techniques covered in this manual. Before travelling overland with snowmobiles it is essential that those involved are familiar with the relevant skills.

Many of the skills required are relatively unique to the Polar Regions and BAS. It is unlikely that many new staff will be suitably experienced prior to employment. Extensive training is provided and experienced Field Guides often mentor new starters in their first season.

All parties involved in field travel will be accompanied by a Field Guide. In rare cases a very experienced field scientist may act as a Field Guide.

14.2 **The BAS field unit**

The term 'Field Unit' refers to all of the component parts of a travelling set-up. Generally speaking this includes two Nansen sledges and two snowmobiles. One sledge contains all of the equipment required for routine life in the field and the other has spares and emergency supplies. Of course additional kit is often required in the way of scientific equipment and this is best carried on a separate sledge(s). Information on full and half unit sledges follows and snowmobiles are covered in the next section – 14.3 Snowmobiles.

14.2.1 **Half unit**

Half unit is the term given to the travelling set-up adopted for day travel when the intention is to return to station or a base camp in the evening. In this situation two ski-doos and one sledge will be taken. This sledge is the half-unit sledge and contains spares and emergency supplies to sustain an unplanned night out. The kit shown is for a standard half unit and depending on the tasks required and the other kit taken the setup may vary slightly. The image below is a good starting place for setting up a half unit for the first time, or after some time away from prepping field equipment. **93**

14.2.2 **Full unit**

The complete unit for field travel is taken when camp is being moved or on extended journeys where returning to station or a base camp is uncertain. The full-unit sledge contains all of the equipment required for planned nights out. As with the half unit, campsites and tasks all vary slightly and therefore the sledge may

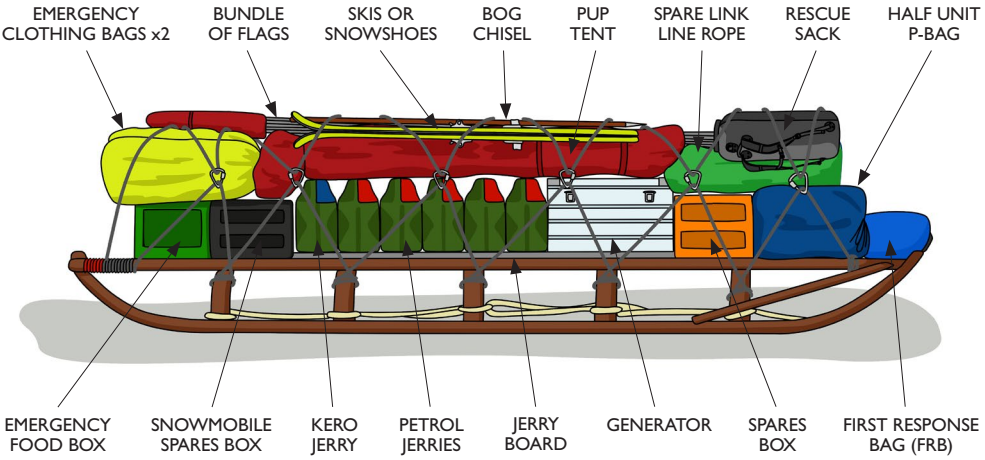


Figure 93 – Half unit sledge

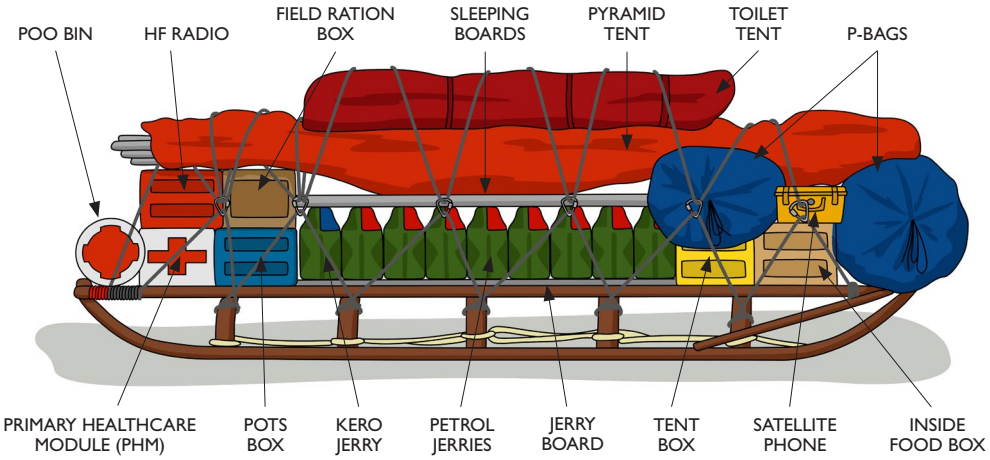


Figure 94 – Full unit sledge

be lashed with slight variations. However, this forms a good starting point to check that nothing major has been forgotten. **94**

14.3 **Snowmobiles**

Prior to operating a snowmobile all personnel must undertake basic training provided by the stations vehicles department. Field Guides receive additional training on advanced driving techniques, which they will then pass on to other field staff where appropriate. **95/96-1/2**

There are a variety of different models of snowmobile in use within BAS, but operating principles are similar – ensure you are familiar with the relevant model you will be using before field deployment. Snowmobiles for field travel have some subtle modifications – ensure snowmobiles used for field travel are equipped as such.

Caution: Correct PPE must be worn at all times when snowmobiling. This includes appropriate clothing and helmets.

Figure 95 – Snowmobile

14.3.1 **Field vs. station snowmobiles**

There are some important differences between station snowmobiles and field snowmobiles. Station snowmobiles should not be used in the field and field snowmobiles are not for general use around station.

Station snowmobiles tend to be older machines that are perhaps less reliable than they need to be for use in remote locations. Additionally station snowmobiles are not equipped for linked travel, i.e. they do not have a reinforced wire loop around the chassis and may not have items such as mounts for GPS.

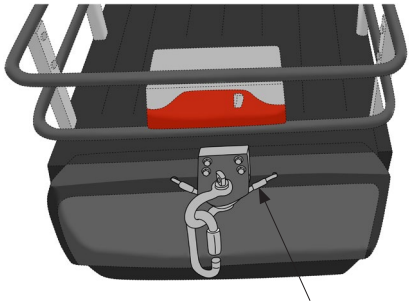


Figure 96-1 – Rear attachment point

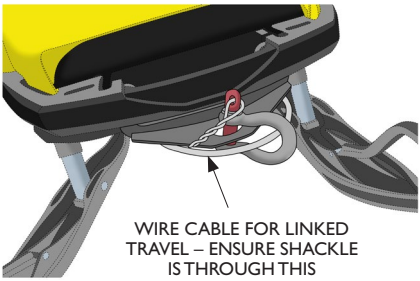


Figure 96-2 – Front attachment point

14.3.2 **Passengers**

When operating linked-up in the field there should only ever be one person to a snowmobile, if additional people require transport they should travel on a sledge.

If operating in an area that has been extensively checked and deemed free from the risk of crevasses, unlinked travel may be acceptable – this decision should be discussed with the FOM. In this situation travelling with two people on the same snowmobile is acceptable.

Caution: Two people on a snowmobile is the maximum permitted in any situation. More than this exceeds the snowmobiles weight capabilities and risks serious damage to the machine.

14.3.3 **Cargo on a snowmobile**

The storage area on the back of a snowmobile has a maximum weight capacity of 25kg. Although able to carry a passenger, when there is only the driver this weight limit remains the same. There is significant leverage on the back of the snowmobile and if overloaded serious damage can occur to the machine.

14.3.4 **Pre-start procedures**

Before using a snowmobile a set procedure must be followed to minimise the risk of damage to the machine.

1. Snowmobiles should be stored overnight with a tarp covering them to stop snow filling up the engine bay – this tarp must be removed!
2. If damaged or not put on correctly (or not put on at all!) snow may have found its way into the engine bay. All of this snow must be removed by lifting the bonnet/removing engine panels. It is particularly important that there is no snow around the drive pulleys/belt, air-intake and steering mechanism.
3. If snow/ice has built up on the underside of the snowmobile and in/around the track this must be chipped off to avoid lumps dislodging during travel and jamming the track system. Have a good look at the track system at this point, keeping a look out for any missing bolts or obvious damage/fluid leaks etc.
4. Overnight the track and the skis often freeze into the snow, lift each ski at the front to break the ice and lift or try to rock the track to free it (if lifting get someone else to assist).
5. If for any reason there is a fault showing, contact a vehicle mechanic immediately for advice.

14.3.5 **Warm-up procedure**

After following the pre-start procedures the snowmobile is ready to be turned on (see Section 14.3.6 – Operation for details on starting). Some models of ski-doo in severely cold temperatures will require the following:

Initial cold starting

Pre-Heat engine. Open the seat (V800) and locate 230V engine heater plug, use Honda EU10I/EU20I

generator supplied connected to this plug with extension lead provided and warm engine for minimum of 30 minutes.

- Note: If for any reason the battery is dead and the engine cannot be started, charge the battery with the generator
- Batteries can be charged by lifting the seat and locating the battery charging plug. Use generator and extension lead provided
- Warm engine starting
- Follow the procedure above without the need to pre-heat the engine

Once running, ski-doos should be left to idle to allow the engine to warm up – the engine should not be left to idle for more than 10 minutes. Some models have an automatic cut-off when the machine is getting too warm, to protect the engine.

Once ready to set off put the snowmobile into a forward gear (more info follows) and pull away slowly. If safe to do so, the snowmobile should be driven for a few hundred metres at a slow speed before coming back and attaching a sledge.

Once the warm up procedure has been completed the sledge(s) can be attached and you are ready to set-off. Be mindful of any unusual noises and stop to assess if you think something may be wrong with the snowmobile. A problem will only get worse if you ignore it and continue driving.

14.3.6 **Operation**

The basic operation of a snowmobile is relatively simple. The following sections outline how to correctly start and use a snowmobile. **97**

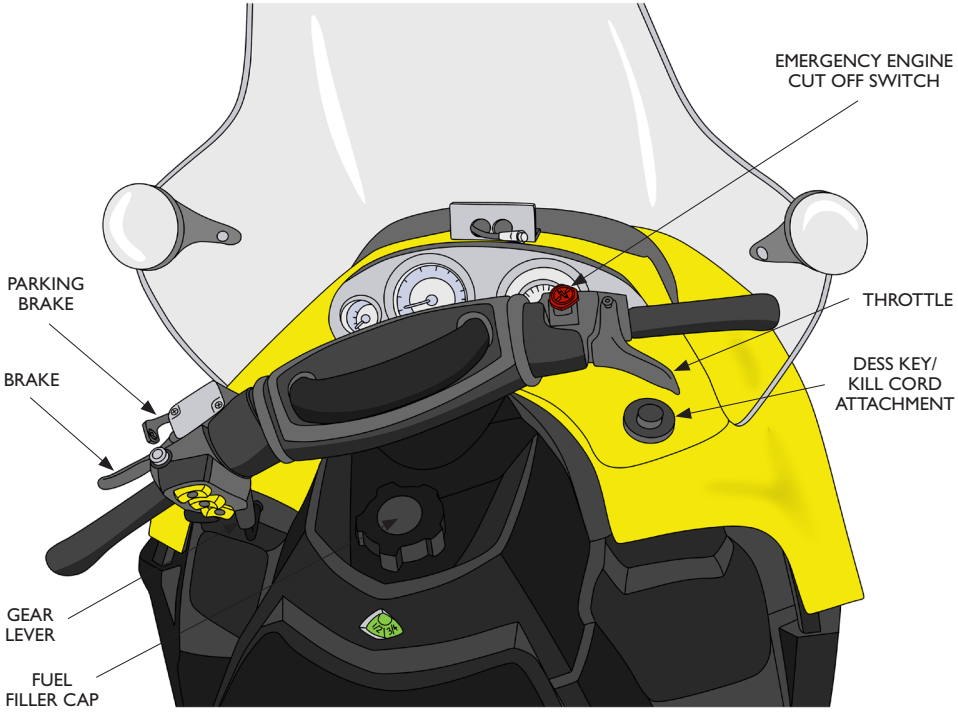


Figure 97 – Snowmobile controls

Starting

Four-stroke

To start the snowmobile you must ensure the kill cord is attached to the machine and to the operator and the gear lever is in the neutral position. Raise the red stop switch and push the start button. The start button should only be held in for a maximum of 10 seconds before resting the engine for 30 seconds and then trying again. This can be attempted three times. Release the button as soon as engine starts. If the snowmobile does not start after the third attempt then the generator must be connected to jump-start the machine. Four-stroke engines require a level of compression that cannot be easily achieved with a pull start, so they do not have one.

Two-stroke

The starting procedure for two-stroke snowmobiles is similar to above, although older models may have a key instead of a button to start the engine. In addition to this two-stroke models have a choke lever and a pull start. The choke should be switched to position three when starting from cold, as soon as the engine starts switch to position two for a maximum of 10 seconds and then to position one/the off position. Do not operate the throttle while the choke is on! **98**

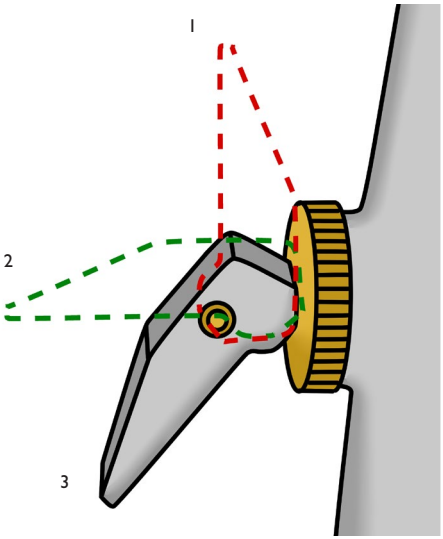


Figure 98 – Two-stroke choke lever

If the engine does not start after three attempts on the button/key then use the pull cord. If a model with a key, then this must be positioned to the on point before using pull start. Pull the cord out until resistance is felt and then pull vigorously all the way out, this may need repeated several times before the engine starts.

Accelerating

Snowmobiles have a thumb-operated throttle on the right hand side. Different models have varying levels of sensitivity on the throttle so practice is required. Speed should be kept below 40km/h. Average when towing a sledge is 25km/h but this will vary hugely depending on surface conditions, terrain and the cargo being towed.

Gears

The machine has two forward gears and a reverse. The gears cannot be changed while moving! Second gear is used most of the time. First gear can be used if pulling heavy loads or ascending steep slopes or in particularly soft snow.

> Caution: If you push the throttle in anticipation of moving and then realise you haven't put the machine into gear, you must wait for the engine revs to return to idle speed! If you try to put it into gear while the revs are up you will break the gearbox!

Brakes

There is a brake lever (two on some models). The left hand brake (often the only brake) has an additional lever that acts as the parking brake. This is only used if parking on a steep slope. It is not obvious if the parking brake is on, so before setting off always pull the brake lever as this disengages the parking brake if it has been left on. The brake is not often required when travelling on flat surfaces as releasing the throttle will allow the snowmobile to come to a gradual stop.

If using the brake on a steep slope in descent, avoid locking it on. Feather the brake to reduce the risk of a skid or uncontrolled slide.

Steering

Driving the snowmobile can be a physical task on certain terrain and in certain snow conditions. The machines are rider-responsive and can require a lot of movement from side to side in order to turn and keep level.

Switching the engine off

The engine should be switched off by pushing the red stop button down. The engine will also turn off if the kill cord is removed. Test both these methods of shutting down prior to using any snowmobile each day.

Fuel and refuelling

All snowmobiles in use run on neat petrol. For info on fuels and containers see Chapter 20 – Fuel.

All snowmobiles should be fuelled at the end of use. Refuelling in the field is usually carried out using 20 litre jerry cans. A funnel is kept with each snowmobile, usually under the seat along with a brush. The funnels are water-finding and also catch any debris that may have got into the jerry can. Refuelling is best done with two people. First clear any snow from around the fuel cap and the top of the jerry with the brush. One person can hold the funnel in the correct position while the other pours from the jerry can. Snowmobiles can be filled directly from 205 litre drums using a hand or electric pump system. It is worthwhile still using the funnels in this scenario. There will be a small amount of fuel left in the bottom of the water-finding funnels after re-fueling – pour this back into the jerry can once you are finished fueling.

> Caution: Refuelling should be undertaken with the utmost care to avoid spillages of fuel in the field.

Oil

The two-stroke machines require two-stroke oil to be put in a separate reservoir inside the engine bay. This must be checked and topped up on a daily basis.

Four-stroke models have a dipstick to check oil levels and this should also be checked regularly although shouldn't need topped up very often.

14.3.7 **Daily post operation checks**

> Caution: Engine must be shut down for at least 10 minutes and allowed to cool before daily inspections are carried out.
>
> Only remove guards and covers if necessary for repairs or detailed inspection.

Engine

1. Engine oil level.
2. Engine support.
3. Exhaust system including exhaust manifold bolts.
4. Coolant level (four-stroke models only).
5. Cooling system, hoses and clamps (four-stroke models only).
6. Check fan belt condition (two-stroke only).

Fuel system

1. Fuel line and connections.
2. Throttle cable.

Drive system

1. Drive belt condition.
2. Drive and driven pulley.
3. Brake hose, pads and disk.
4. Gearbox oil level – if low, check for leaks!
5. Track condition and tension.

Steering

1. Steering mechanism and front suspension.
2. Wear and condition of skis and runners.

Rear suspension

1. Front and rear springs for condition.
2. Wheels for condition.
3. 4 x main slide suspension unit securing bolts to chassis.

Electrical system

1. Inspect wiring harness and cables for rubbing/ chaffing.
2. Operation of lighting system, HI/LO beam, brake light and heated grips. If frequently blown it could

mean you have another problem that will need addressing – consult vehicle mechanic on the radio.

If for any reason there is a fault showing, contact a vehicle mechanic immediately for advice.

Only when all the above checks have been completed should the snowmobile be covered. Snowmobiles should be covered with tarps at night to stop snow getting into the engine bay and the track system. The tarps have snow valances on them, which should be weighed down by blocks of snow.

14.3.8 **Storing snowmobiles overnight**

The following process should be adhered to at the end of each day:

- Sledges should be disconnected and parked away from snowmobile park area
- Snowmobiles should be parked into the prevailing wind, paying attention that they are pointing away from any objects to the front and rear to aid in the start-up procedure
- Remove snow and ice build-up from rear suspension, track, front suspension and steering mechanism
- Fuel tank must be filled at this point to avoid any condensation build-up in the fuel tank
- Two-stroke models only – fill oil injection tank found under the bonnet with oil provided

14.3.9 **Troubleshooting**

The following information can be used to help work through a problem with a snowmobile. Always contact the vehicle department for advice prior to undertaking serious repairs in the field. If for any reason there is a fault showing while checking over the ski-doos as described above, contact a vehicle mechanic immediately for advice.

14.3.10 **Field repairs**

When travelling by snowmobile in the field a comprehensive spares box and tool kit is carried on the half-unit sledge. Modern snowmobiles require diagnostic equipment to identify and solve many engine-related problems, however most mechanical faults can be fixed by a competent person in the field. The vehicle department at the station you have been deployed from should be contacted prior to undertaking any major field repairs. This is so that they can give you some direction and advice but also so that the vehicle department and FOM are aware of a potential issue and can begin thinking of solutions should the problem require a replacement snowmobile or a mechanic.

Among the most common repairs in the field are the following. Ensure you know how to carry out each of these repairs on the model of snowmobile you will be using before deployment:

- Drive belt tensioning and replacement
- Replacing a blown fuse
- Fuel filter replacement
- Replacing shock absorbers
- Replacing track tension bars
- Replacing track wheels

14.4 **Sledges**

There are a variety of different types and styles of sledge used for transporting equipment behind a snowmobile. The following section gives information of the features on each as well as the associated pros and cons.

14.4.1 **Nansen sledge**

The Nansen sledge is a design that has been around since polar exploration began. It's a tried and tested piece of equipment that is just as appropriate now as it was 100 years ago. One of the main benefits of a Nansen sledge is its ability to bend and flex over the snow surface. This flexibility gives the sledge its strength and also protects fragile cargo by absorbing a lot of the impact from rough surfaces. The negatives of the Nansen sledge are its weight and its relatively narrow runners, which make travel in soft snow difficult. It also has the potential to be a bit top heavy, which can result in the sledge tipping over. Nansen sledges are easily maintained and fixed in the field – given good calm conditions, as it often requires gloves off for the lashings. **99**

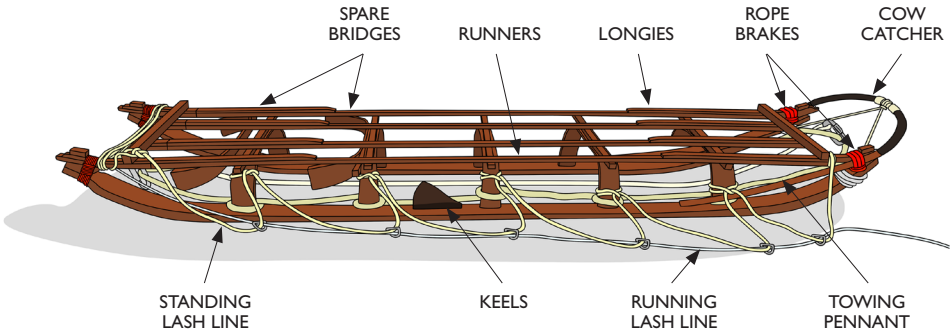


Figure 99 – Nansen sledge

14.4.2 **Plastic poly sledge**

The plastic poly sledge (brand name Siglin) is a versatile sledge ideally suited to carrying large amounts of cargo. The plastic poly sledge offers very little in the way of shock absorption for cargo so it is not great for transporting delicate cargo unless packed very well. Its wide surface area means that it doesn't sink deep into the snow even on a very soft surface and is still easy to pull. The construction is simple and relatively lightweight. It can be difficult to secure cargo properly as the sledge flexes, allowing items to move a little. It is worthwhile having a tarp over the top of all cargo or items stored within a larger bag to make lashing easier. The poly sledges come with a rigid towing pennant that should be clipped directly behind a snowmobile. If towing with a rope then this towing pennant must be removed. There isn't really much that can break on a poly sledge! Keels have been known to come off and occasionally one of the holes in the plastic for lash lines splits. **100**

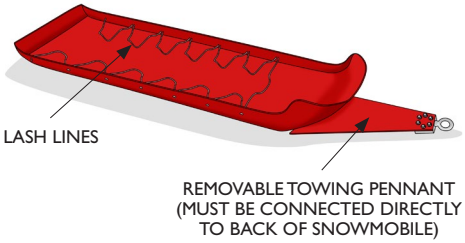


Figure 100 – Poly sledge

14.4.3 **Komatic sledge**

The komatic sledge is a traditional Greenlandic design. It is similar to the Nansen in construction but offers a wider load space. The komatic is a very heavy sledge but is capable of carrying a large amount of cargo and offering good shock absorption. Komatics are a bit fiddlier than Nansens to maintain in the field but it is possible. They are also a real pain to load in and out of a Twin Otter! **101**

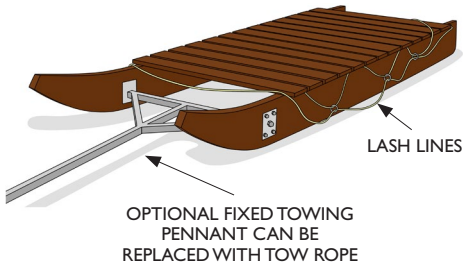


Figure 101 – Komatic sledge

14.5 Lashing a sledge

Sledges can be lashed traditionally with a rope or in some cases ratchet straps are a more appropriate option. This comes down to the sledge being used and the particulars of the cargo.

14.5.1 Traditional Nansen lashing 103

Step 1 – Load all cargo onto sledge.

Step 2 – Begin lashing from the rear of the sledge. The first loop of the running lash line should go to the second hook on the opposite side lashing, locked, and then the next loop goes to the first hook.

Step 3 – Continue the lashing going to each hook sequentially.

Step 4 – Once you reach the last hook, pull the lash line tight and lock off with a clove hitch. You will now need to work from the back of the sledge to the front pulling the rope tight, it is worth doing this two or three times before retying the clove hitch.

Step 5 – The lash line should now be run between the front and the rear hooks twice before creating a 3:1 pulley system to secure the load. **102**

Step 6 – Double check all cargo is secure before setting off.

Step 7 – Secure additional items using bungees over the top.

> Note: Fragile items such as the tent should not be included in the main lashing. Use the excess rope after completing the long lashing to secure the tent. To do this re-thread the rope through the rings on the standing lash line and pass the rope back and forth to the opposing hooks. The tent must be secure but not over tight.

14.5.2 Lashing with a ratchet

Certain loads are easier to secure with a ratchet strap than a traditional rope-lashing system. In particular when using poly sledges, the sledge flexes a significant amount and causes even the tightest of lashings to work loose. By using a ratchet strap you can easily tighten the load on the move without re-doing the whole thing.

If using a ratchet strap on a wooden sledge be careful not to over-tighten as you will snap the wood. **104-1/2**

14.6 Linked snowmobile travel

When travelling by snowmobile in glaciated terrain, the BAS-linked travel system must be used unless unlinked travel is specifically approved by the FOM. The system works on a similar principle to that of a roped team on foot.

The linked travel system's primary benefit is providing staff with some protection against crevasse falls when moving around the unit on foot. The snowmobiles' lower ground pressure and ability to bridge features provide a greater level of protection than a person on foot in glaciated terrain.

A person on foot has a higher ground pressure than most vehicles and is more likely to penetrate a snow bridge. There have been several incidents of drivers stepping off ski-doos and falling into crevasses.

The linked unit provides a mobile anchor while working on foot around the unit, remaining connected via the personal safety line or probe line provides a fall arrest system when initially assessing ground or until protected as an alpine pair.

The secondary benefit of the linked travel system is that it offers some protection in the event that a snowmobile and driver fall through a snow bridge while travelling on snowmobile. Although the system has worked effectively in the past it has severe limitations, and a snowmobile falling into a crevasse will almost certainly lead to serious injury or death.

The primary mitigation against this is correctly identifying crevasses and avoiding them if possible. When crossing features is deemed necessary and appropriate the route should be assessed on foot and features should be thoroughly inspected by probing and digging into them as necessary.

Only by understanding the size and shape of the crevasse along with the quality of any snow bridge present, can a considered judgement be made about the risk of crossing the feature on a snowmobile.

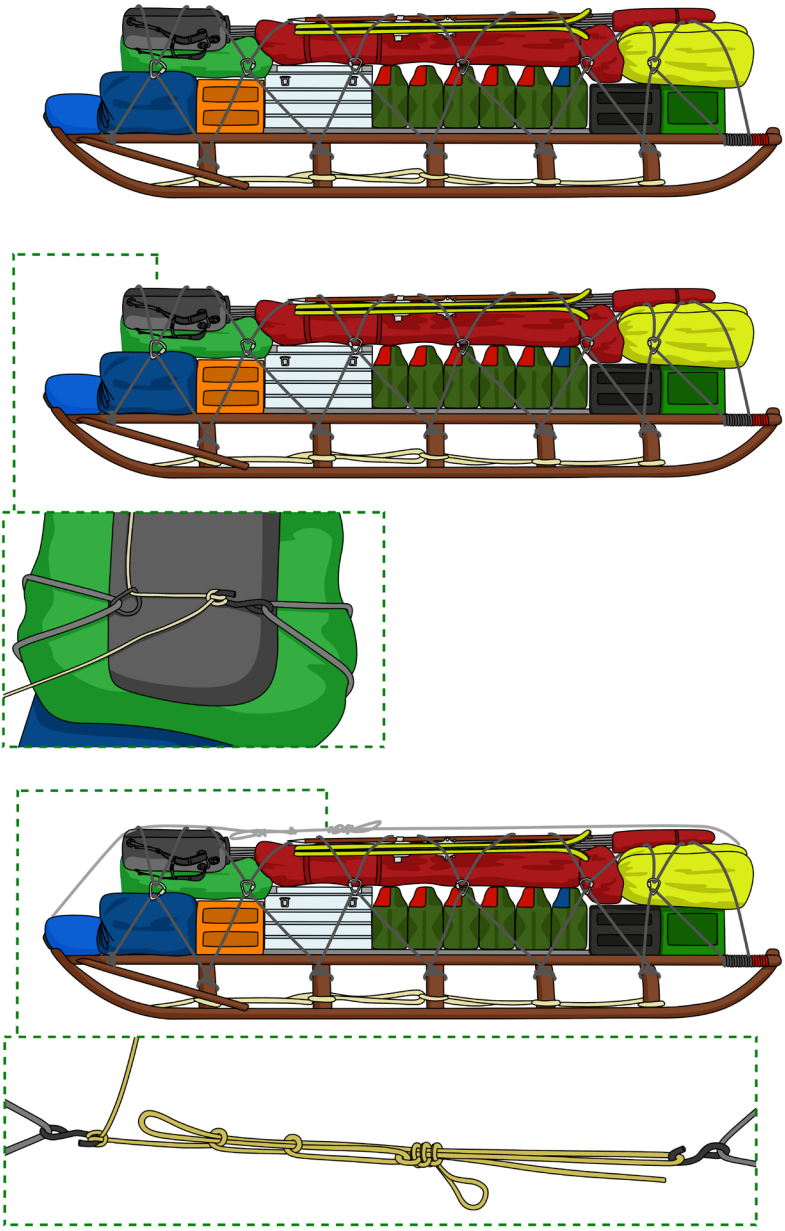


Figure 102 – Nansen lashing

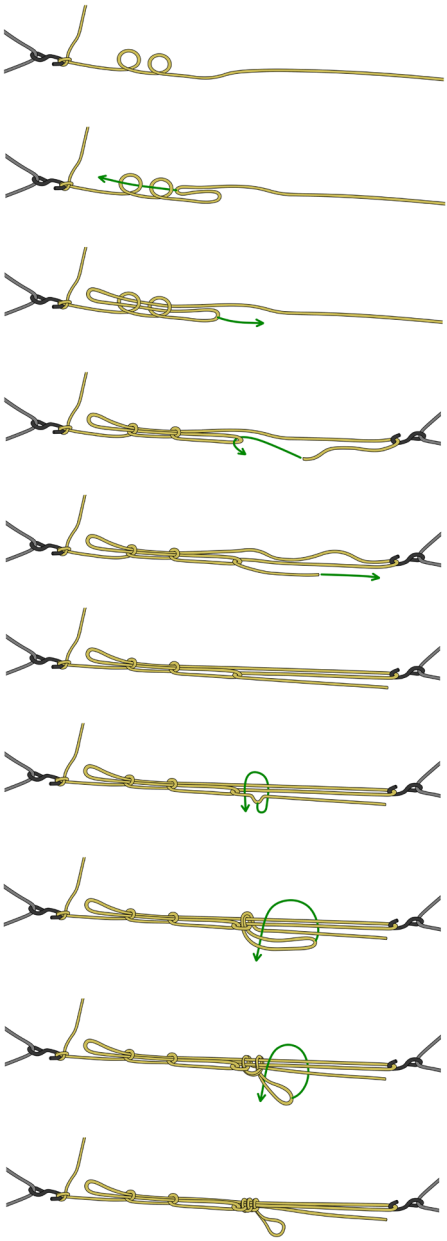


Figure 103 – Truckers hitch

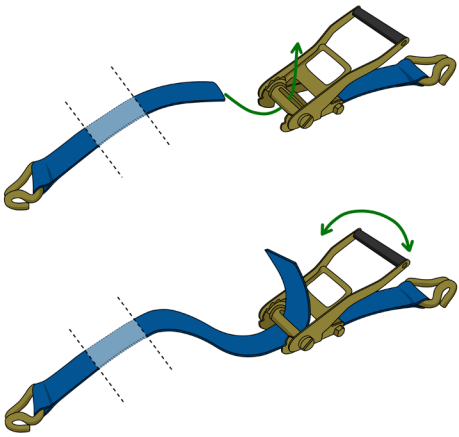


Figure 104-1 – Ratchet strap tighten

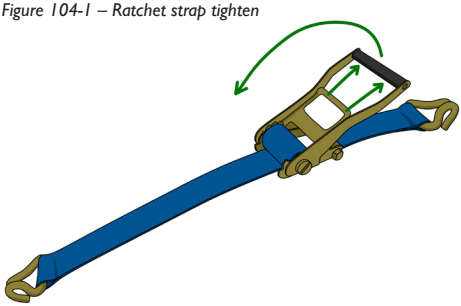


Figure 104-2 – Ratchet strap loosen

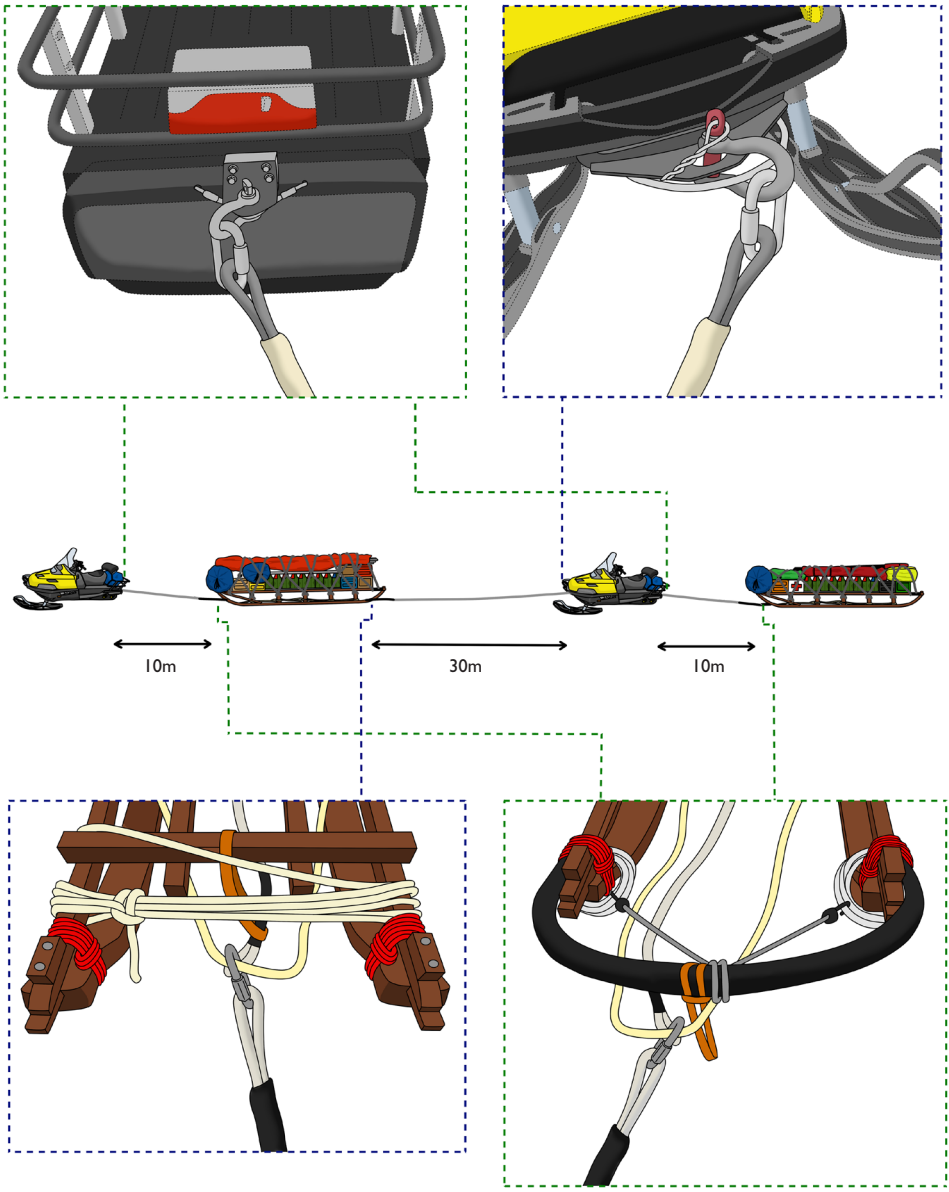


Figure 105 – Linked snowmobile travel set-up

Warning: Travelling on snowmobiles in glaciated terrain is complex, to do it safely requires experience and good judgment. The linked travel system provides some risk mitigation, but its limitations must be fully understood and considered in your decision-making.

14.6.1 **Set-up**

The snowmobiles and sledges are configured in the following manner: **105**

14.6.2 **Link lines and spares**

The towropes for sledges and link lines to connect ski-doos are made from 20mm three-strand rope. Eyes are spliced in both ends of each rope and rubber hosing is fixed over the splice to protect it from wear. These form the basis of the linked travel system; ski-doos should always have a minimum of a 30m link line between them. Usually this will be made longer as the half unit is also put between the two ski-doos. This makes up a system of: lead ski-doo – 10m tow line – half unit – 30m link line – rear ski-doo. If the full unit is also being carried this is placed behind the rear ski-doo on a second 10m tow line.

A spare 30m line, spliced with an eye in one end is carried and can be made into a link line or a tow rope if one becomes damaged.

14.6.3 **Centre lines**

These lines connect the ski-doos underneath the sledges. As these wooden sledges are not load bearing for a crevasse fall, the center lines run down the 'centre' of the sledges and are linked to the tow and link lines to create one continuous rope between the two ski-doos.

As the Sledges are all unique in length and size, this means all the center lines are unique in length to match the individual sledges. This means that the center lines are unique to the sledge they were made for and are labelled as such. For more information see Field work manual.

14.6.4 **Maillons**

Ropes are connected to sledges and snowmobiles using heavy-duty steel maillon rapides. Care needs to be taken when using the maillons. Never tow a sledge with a maillon undone or only partially screwed up. The threads can become stretched and will be very difficult to use in the future. Always carry an adjustable spanner to help with stuck maillons. It is also worth carrying a couple of spare maillons as they are easy to lose in deep snow.

Carabiners should never be used as they are not strong enough for the loads experienced and will break if used in this way!

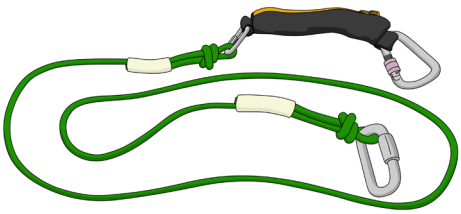


Figure 106 – Personal safety line

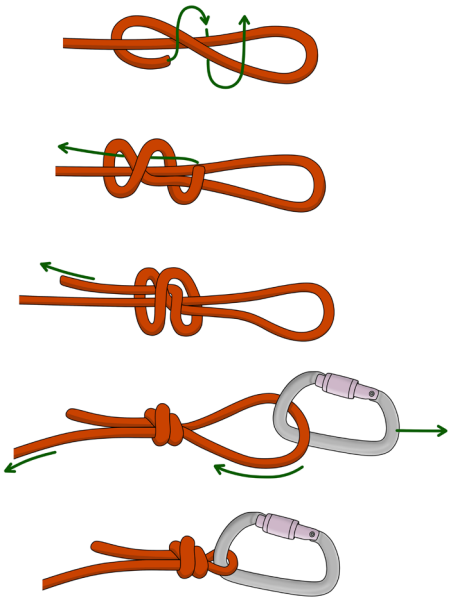


Figure 107 – How to tie a scaffold knot

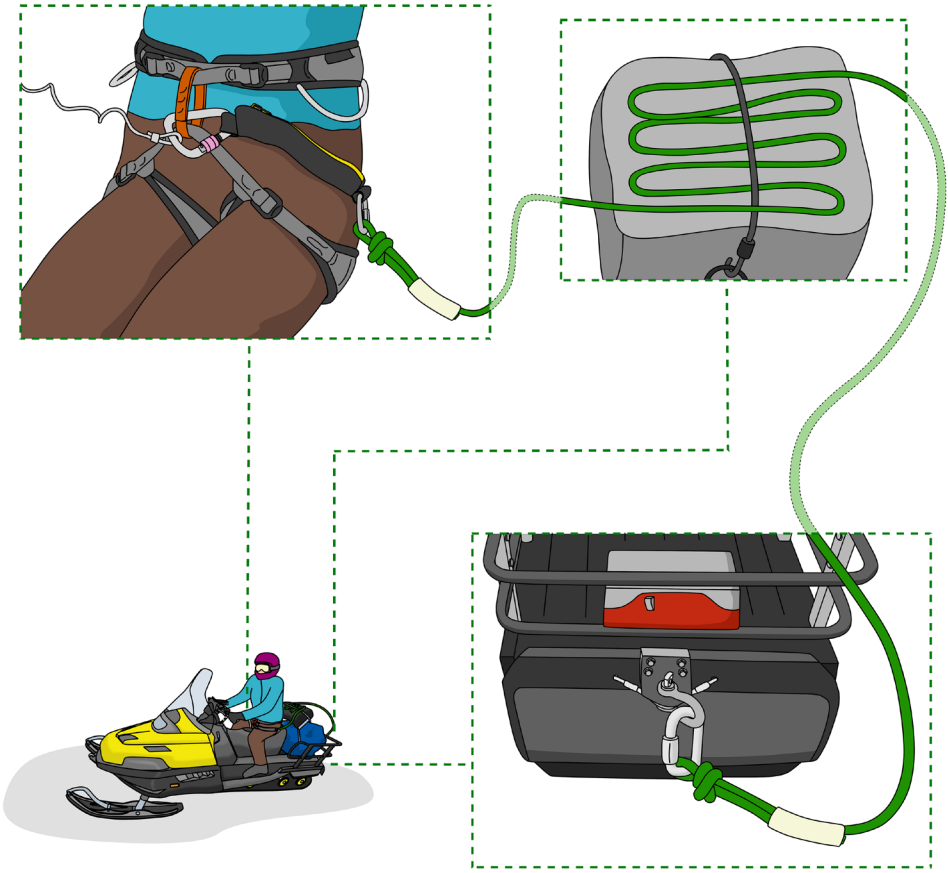


Figure 108 – Driver attachment to snowmobile

14.6.5 **Driver attachment**

Snowmobile drivers are linked into the system using what is known as a personal safety line. A climbing harness is worn while operating in a linked system and this is where the operator attaches the personal safety line. The personal safety line in made up from a length of dynamic climbing rope and a Petzl absorbica, shock-absorbing device. The personal safety line should be secured in a bungee around the back of the seat. It is easy to damage this line if it falls off the snowmobile and ends up in the track. Daisy chaining the rope-up to shorten its length works well but ensure it unravels easily when loaded. **106/107/108**

Warning: Never attach yourself to a snowmobile with a personal safety line unless linked up. Particular care needs to be taken if carrying out any traversing, as there is a risk of rolling the snowmobile. When linked try to go straight up or straight down a slope.

Note: Always use separate mallions for absorbica and tow line

14.6.6 **Ski-doo layout**

Loading ski-doos should be done in a thoughtful manner allowing access to equipment as needed.

There are certain items that should always be on the ski-doo when in the field. Ski-doos should always have a shovel with them, the location and way this is stored varies, but it should always be easily accessible. Ski-doos will generally also have the personal rucksack of the driver, and the tarp for the ski-doo inside the basket at the rear allowing access to food and water easily. It is important that the rear basket of the ski-doos is never overloaded as this can cause considerable damage to the machine. The weight limit for these baskets is 25kg.

Under the seat there is space for small items, there should be spares and refueling equipment in here while in the field, items such as spare maillons and bungees, along with a fuel funnel, adjustable spanner, and potentially some oil spill matting. There should also be the specific tools required for each ski-doo stored under the seat.

Finally, to complete the setup the driver will be wearing a BAS rack and harness, a helmet and the driver will be attached to the ski-doo via a kill-cord and Absorbica lanyard connected to the harness. A GPS is then found on the dashboard clearly visible by the driver and programmed with the information required. Ensure that the GPS is compatible with the mount on the ski-doo before leaving station.

Figure 109 – Snowmobile layout

14.6.7 **Cargo on a snowmobile**

It is recommended for a personal rucksack to be left in the rear basket to allow ease of access to items thought a day. This can include mountaineering equipment or small items of science cargo needed for the day. There are also some other items such as the ski-doo tarp, probe line, and harness (if not in use) that can be stored in the rear basket if needed. It is not standard practice for the Rescue sack to be stored on the rear of a ski-doo as this adds weight to the rear unnecessarily. The rescue sack should be lashed onto the half unit. However, this may be needed where access to the rescue sack is key, therefore variation exists, and it is still acceptable in some situations. E.g., returning for the second sledge while double heading. **109/110**

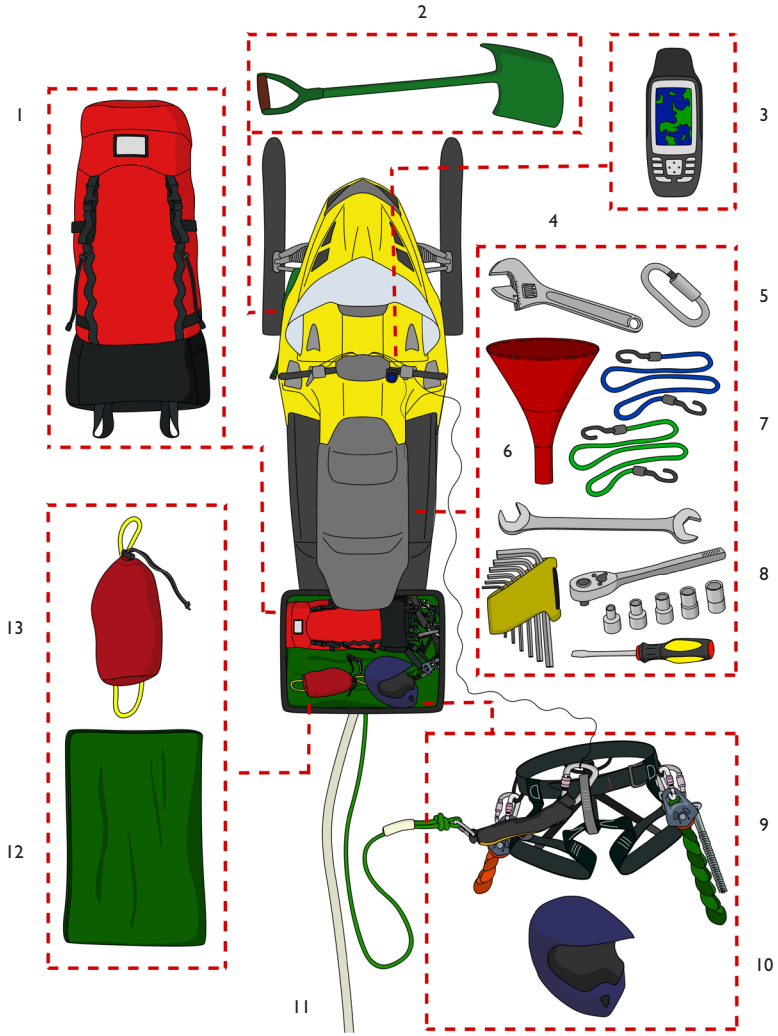


Figure 110 – Snowmobile items

#	Item of gear
1	Personal rucksack
2	Shovel
3	GPS unit
4	Adjustable spanner
5	Spare maillon

#	Item of gear
6	Fuel funnel
7	Spare bungee cords
8	Ski-doo tool roll
9	Climbing harness with BAS rack, absorbica and kill cord attached

#	Item of gear
10	Ski-doo helmet
11	Tow line
12	Ski-doo tarp
13	Probe line in a stuff sack

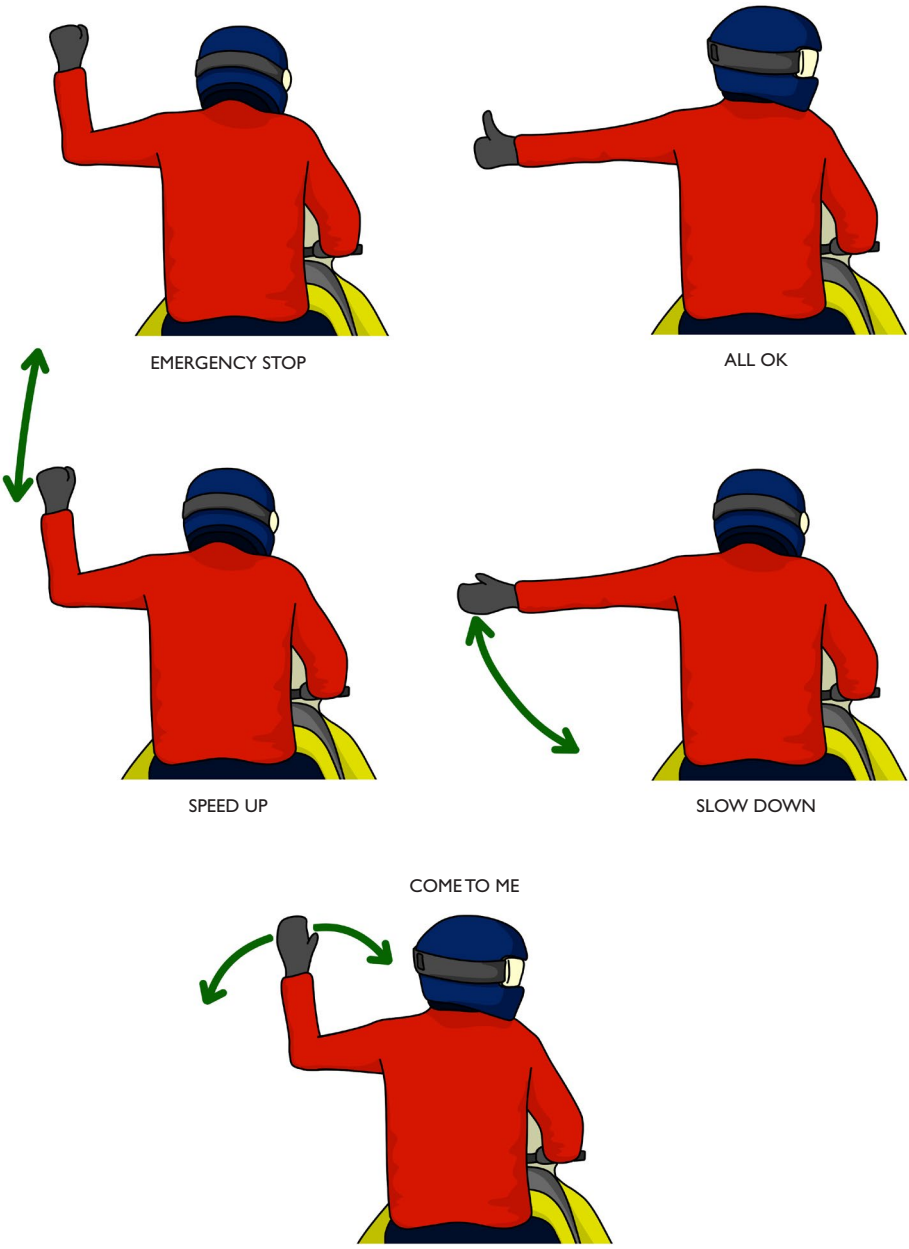


Figure 111 – Linked snowmobile travel hand signals

14.7 Driving as a unit

Driving as a linked unit can be challenging and requires good coordination between the two drivers. The lead driver is responsible for safe route choice and navigation. In addition to this the lead driver must attempt to keep a steady speed. The second driver has the hard task of maintaining the appropriate tension on the link line and not running over the rope! This can be challenging in certain conditions and requires a great deal of concentration. It is recommended that regular breaks be taken during linked travel. Driving for one hour and then stopping for a short break works well.

14.7.1 Hand signals

Effective communication between drivers is essential and a series of simple hand signals are used when travelling as a linked unit. Signals generally come from the lead driver; however if the rear driver needs to get the leaders attention gently applying the brakes will create a pull that will be felt at the front. **!!!**

> Note: It can be difficult to see signals if they are not performed correctly. The signal should be out to one side and not in front of the body.

14.7.2 Manoeuvering the unit

Actions must be carried out slowly and in a controlled manner when moving as a linked unit.

When stopping, ensure you slow down gradually to avoid the rear sledge running into the back of the snowmobile. In an emergency however this may not be an option!

Sharp turns need to be avoided if possible, although when in crevassed areas this may be necessary at times.

14.7.3 Moving between snowmobiles

When moving between sledges or snowmobiles clip onto the link line to protect yourself against crevasse falls when moving along the unit. A lanyard can be created using a sling or a short length of dynamic rope, clipped into your harness and then passed round the link line and clipped back to itself.

Once roped up as an alpine pair – as described in Chapter 13, Section 13.5 – the team can then travel away from the ski-doos.

14.7.4 Route choice

Identify likely routes before deploying to the field. Terrain, glaciology, surface conditions, and slope profiles can be used to identify likely routes and avoid steep slopes and crevassing.

Use as many resources as possible to thoroughly research your route before field deployment. Previous field reports and discussions with others who have worked in the area can be invaluable along with geographic information from MAGIC.

The nature of the terrain can be assessed as part of route selection before deployment. Areas of likely crevassing can be identified by considering slope and ice-flow speed and examining visual and radar data from satellites.

See Chapter 10 – Navigation for more information.

Proposed routes should be discussed with the FOM, and a terrain safety assessment may be carried out before deployment to identify areas of higher risk and ensure suitable mitigations are in place.

While driving and choosing routes always remain alert to the possibility of crevasses. If you suspect crevassing or other hazards stop and assess the route on foot.

Turning a linked unit requires a lot of space; turning around or reversing a route in crevassed ground is difficult and hazardous. Do not commit to driving a route unless you are confident you can reach safer ground that allows an opportunity to turn around.

If at any point you feel the route is not feasible, do not continue. It may mean that you are unable to reach an important work site but that is the nature of polar fieldwork. Safety is always the first priority.

14.7.5 Terrain assessment

An initial sense of the terrain can be gained through research before deployment as discussed above.

It may also be possible to reconnoiter routes from the air during the input phase of a project or view them from higher ground before committing to

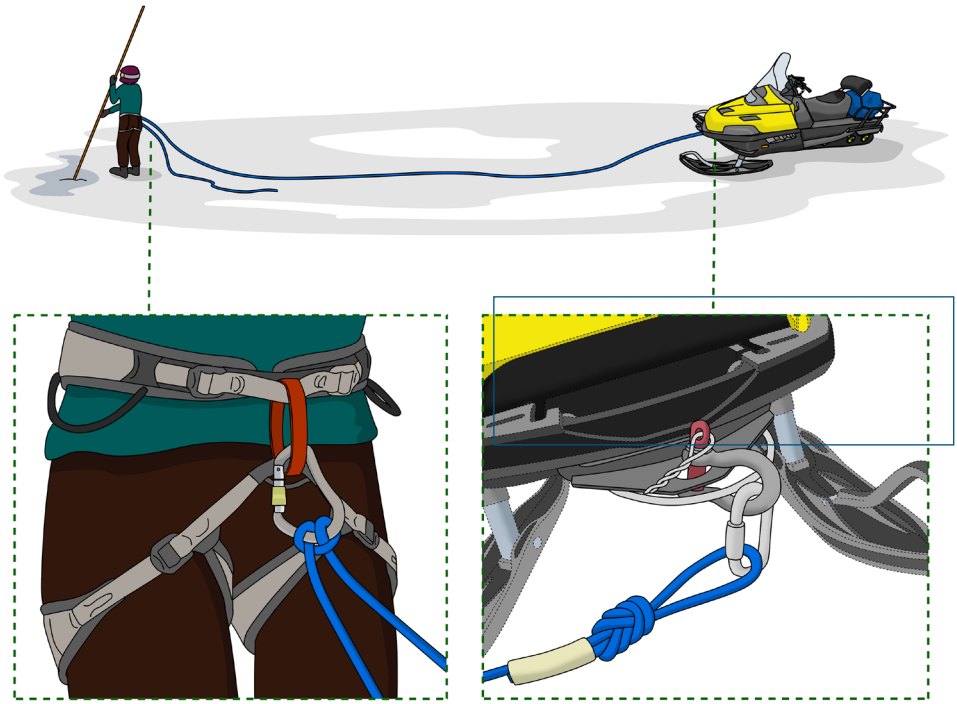


Figure 112 – Probing crevasse bridges

traveling them. Remotely piloted aircraft systems (RPAS) may also be used to provide an aerial view of complex terrain.

The following are all ways that BAS uses to assess terrain for travel once on the ground. These could be used as stand-alone techniques for benign terrain that needs confirming in some way or used in any combination to provide a route through more complex terrain.

Visual assessment

The FG should be constantly assessing the ground when traveling as a linked unit. Monitoring the terrain and changes in slope together with their understanding of glaciology allows them to identify areas of likely crevassing.

This should be combined with looking for any visual indication of crevassing, such as slumping, linear features in the snow or crevassing in the wider area. In suspect areas adopting a higher position up on one knee or standing on the snowmobile will increase the ability to spot crevassing.

Good contrast and visibility are essential for this to be effective

Probe lines

While travelling on ski-doos a probe line should be carried by the lead driver and can be used to check suspect features immediately in front of the ski-doos before committing to driving over it. A short 25m line is attached onto the front of the lead ski-doo to safeguard the driver, allowing them to check the ground in front. This saves the need to get a full climbing rope out of the rescue sack and is much more efficient for travel. An avalanche probe or bog chisel should also be carried with this line. **112**

On foot

If you are in any doubt about the safety of your route stop and check it as an alpine pair on foot before committing to driving the snowmobiles. It is far better to find a crevasse with your foot than a snowmobile!

Site Safety Assessment

In complex terrain, or if areas have never been visited, a recce with a small team of two may be required. This confirms conditions on the ground prior to any major project deployments. This could occur before a major science project, for the tractor traverse, or for a ship relief location.

Ground Penetrating Radar (GPR)

Ground penetrating radar provides information about subsurface features and allows for the identification of features that may not be apparent from the surface. It is used to assess routes for heavy vehicle traverse and to assist safety assessments of complex routes for linked snowmobile travel. In addition, it can be used to ensure an area is crevasse free to allow unlinked travel or to create a safe travel area around a camp.

The use and interpretation of GPR data for travel safety is covered elsewhere in the BAS field training programme and is beyond the scope of this manual. Science parties often use radar for research, but this is unlikely to be appropriate for travel safety purposes. Do not assume that because an area "has been radared" that it is safe to travel.

Flagging

If you need to cover the same ground more than once, then consider marking it with flags. This may enable you to visit a work site in poorer weather and visibility. It may be helpful to check and flag route from camp to several worksites early in a project.

Be aware that driving a route and flagging it does not guarantee safety. There may be hidden dangers that were not visible previously. See below and Chapter 4, section 4.2.1 – Heuristics for more information

14.7.6 **Crossing a feature**

Deciding whether to drive over a feature is one of the most serious decisions a Field Guide will have to make. Assessing the safety of driving across a crevasse can only be done by a suitably skilled and experienced person who assesses the feature immediately before crossing. Each situation will vary, but there are some general factors to consider.

Crevasse dimension and shape

A snowmobile can usually bridge a crevasse where the width is less than a quarter of the snowmobile's length. Provided the crevasse has parallel sides that will not collapse under the weight of the snowmobile it may be appropriate to cross. Bell-shaped crevasses with weak sides are unlikely to be safe to cross.

The possibility of catching a snowmobile ski, sledge runner, the balance point of the snowmobile or other circumstances that may cause the snowmobile to become stuck or throw the driver from the ski-doo should be carefully considered. As should any deterioration to the crevasse caused by the passage of the first snowmobile and sledges that could affect the crossing of the second snowmobile.

Snow bridge

When considering crossing a crevasse too wide to be safely bridged by the vehicle, the nature of the snow bridge is the primary factor that will allow a safe crossing.

Committing a vehicle entirely to a snow bridge is only done in exceptional circumstances where no other route is available. This is usually done on established routes on Adelaide Island that are regularly monitored to allow field training and running winter trips.

Snow bridges generally fail via three mechanisms;

Punching shear failure: Occurs when the bridge is not thick or strong enough to support the pressure of the person or vehicle, resulting in a hole and a fall through the bridge. This is common on foot, where people may put a leg through or fall up to their waist. Skis or other means of reducing ground pressure can counteract this.

End of bridge shear failure: Weak bonds between the snow bridge and the crevasse wall at either end fail under the additional load of a person or vehicle causing the whole bridge, and anything on it, to drop into the crevasse

Flexure failure: The additional load of a person or vehicle creates a bending moment or leverage in the snow bridge. If the snow bridge isn't strong enough,

it collapses, usually at the base of the bridge in the middle of the span and on the top at either end of the bridge. The mechanism is like snapping a pencil held at either end by pushing down on it in the middle

When assessing a snow bridge, the ratio of width to thickness and the strength of the snow that forms the bridge is key.

Probing or GPR can help understand the width and depth of a bridge. However, it may be difficult to fully understand the shape of the crevasse and bridge using a probe. The strength of the bridge can also be understood by the use of a probe or by digging a pit. Difficulty pushing a probe in by hand and the presence of ice layers or lenses are good indicators of a strong bridge. Soft, inconsistent snow or weak layers in the snowpack are a warning sign.

As a rule of thumb, any bridge with a width-to-thickness ratio less than 1:3 (e.g. 2m wide and 6m thick), or thick bridges of weak snow are unlikely to be appropriate to cross.

Before fully committing a vehicle to a snow bridge, you must be absolutely confident in the strength of the bridge, its dimensions, and the crevasse's shape. If a snow bridge collapses as a snowmobile and driver are crossing, the driver is likely to be injured in the fall or crushed between the vehicle and crevasse wall.

This is a situation where there is no ability to "fail safely" and there have been fatalities in the past. Beware of heuristic traps and seek an external point of view from the FOM.

As a rule of thumb, crossing a feature that can be comfortably bridged by a snowmobile is usually appropriate in the field, provided it is done correctly. However, fully committing a vehicle to a snow bridge is unlikely to be appropriate for a deep-field party and is usually limited to specific routes on Adelaide Island.

14.7.7 **Running over the link-line**

It is very common for the rear snowmobile to run over the link line. The line is protected by a thick section of rubber tubing so that it doesn't get damaged if this happens. Uneven surface conditions can mean that it is very difficult for the lead driver to maintain a constant speed, which can result in the rope being run over. It is very important that the rear driver indicates to the lead driver if the rope has been run over and has got caught around one of the skis. If this has happened it must be sorted before progressing any further as there is a risk of the rear snowmobile being pulled sideways and flipped over if the rope remains around the ski.

14.8 **Crevasse fall with snowmobiles**

In the event that a snowmobile ends up in a crevasse the other machine on the surface should hold the fall. It is most likely that the lead snowmobile ends up in a crevasse, although it is possible that it is the rear snowmobile. In practice the rear half of the unit is usually dragged forward until the first sledge reaches the lip of the crevasse and creates a sharp 90° angle. As soon as a snowmobile starts to fall the other driver must apply the brake to help stop the fall. **113**

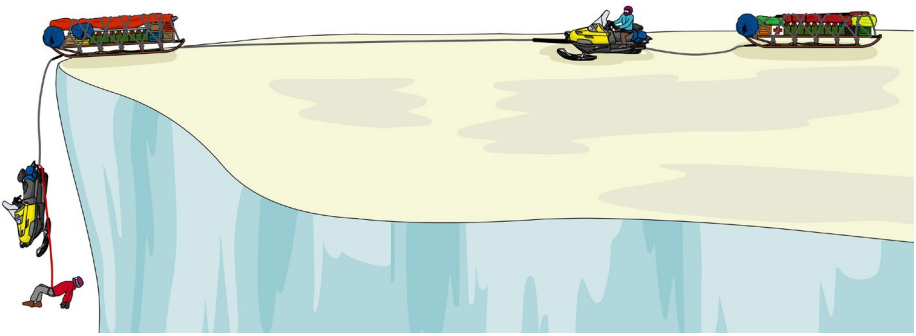


Figure 113 – Lead snowmobile in crevasse

Caution: Personal safety is paramount at all stages of the following scenarios. Look after your own safety first and don't risk becoming a second casualty.

14.8.1 **Rescue sack**

Each driver should have a rescue sack available either on the sledge they are towing or on the back of their skidoo.

The contents are as follows:

- Dynamic rope
- Static rope
- 10m of accessory cord
- BAS rack (see Chapter 13 for contents)
- Jockey winch
- Snow stakes x 2
- Climbing helmet
- Crampons
- Harness (will be worn during linked snowmobile travel)
- Ice axe and hammer
- Spare personal safety line

14.8.2 **Rescuing a driver**

In the event of a crevasse fall while driving in a linked snowmobile set-up the priority is safely extracting the driver. It is unlikely that a driver falling into a crevasse will not suffer some injuries so it is best to be prepared to have to perform an unassisted rescue. The rescue will be further complicated by the fact that the driver will be hanging underneath the snowmobile on their personal safety line, or in the worst-case scenario trapped between the wall of the crevasse and the snowmobile.

<u>In the event of a driver hanging underneath the snowmobile:</u>

1. Construct an anchor approximately half way along the 30m link line, and three-to-four metres to the side of it. Use horizontally buried snow stakes or a buried ski to create a solid anchor – it is vital that this anchor is up to the job and in certain snow conditions will require multiple anchors all linked together. Unlike normal crevasse rescue there will be no weight on you at this point so take the time to make sure your anchor is solid. Use the shovel to dig a slot for the skis or snow stakes. **114**
2. Set yourself up to abseil down to the driver and once at the edge of the crevasse assess the situation. If you are very lucky the driver may be relatively uninjured and able to jumar to the surface on the rope you have just anchored. Help them by preparing the edge of the crevasse so that the rope doesn't cut in to the snow.
3. If, however, you discover that the driver is unable to self-rescue you will need to abseil to them on a static rope and attach the end of the rope to their harness – two back-to-back screw gates on a double figure-of-eight is best. **115**
4. Ascend to the surface; pull up the slack rope and set up a hauling system.
5. Haul up enough rope to get the drivers full weight onto the hauling system and then tie-off the haul so that you can abseil back to the driver – you will need to use a separate rope in order to reach the casualty at this stage. **116**
6. Detach them from their personal safety line by undoing the karabiner on their harness or alternatively cut the personal safety line with a knife. **117**
7. Return to the surface and continue the haul until the driver is out of the crevasse. **118**

<u>In the event that the driver is trapped between the snowmobile and the ice:</u>

This will be a very serious situation that will be extremely difficult to solve. A jockey winch is carried in the rescue sack to enable the snowmobile to be shifted enough to release a trapped person. The first action will be to construct a solid anchor and abseil in to the driver. A driver in this scenario will be injured so immediate first aid is almost certainly going to be required. Assess the situation and decide on the most appropriate way to pull the snowmobile – up or to one side. **119**

Note: Ensure the satellite phone is with the rear ski-doo to aid in calling for assistance.

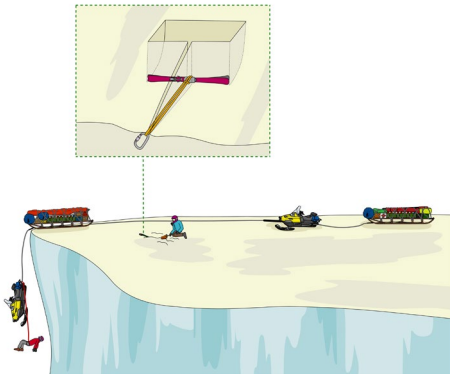


Figure 114 – Driver rescue 1

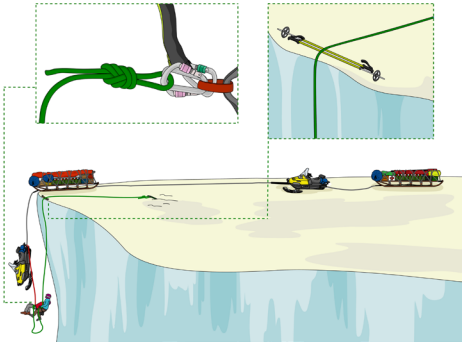


Figure 115 – Driver rescue 2

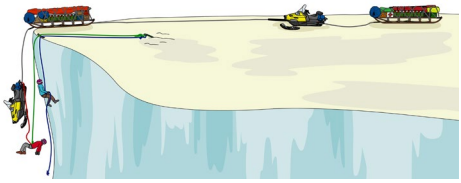


Figure 116 – Driver rescue 3

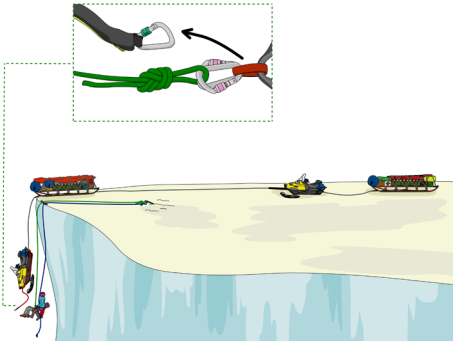


Figure 117 – Driver rescue 4

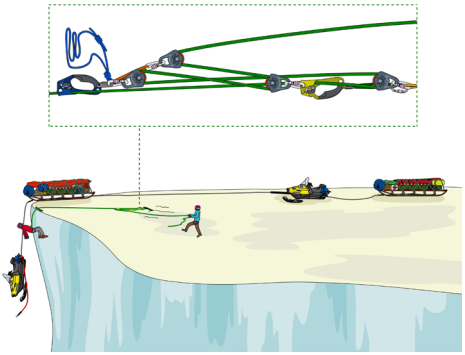


Figure 118 – Driver rescue 5

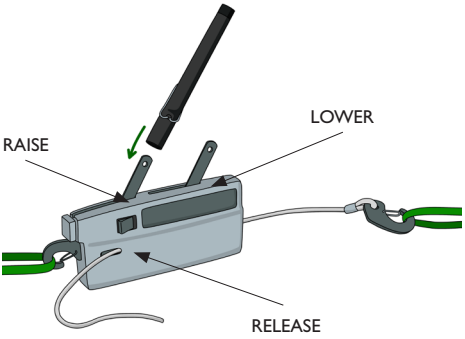


Figure 119 – Jockey winch operation

Warning: From all of the above it should be clear to see that this is a very bad situation to find yourself in. Putting a snowmobile in a crevasse must be avoided at all costs.

14.8.3 **Recovering a snowmobile**

Recovering a snowmobile from a crevasse is a major task that will involve equipment and expertise possibly not in the field with you. The priority is to extricate the driver, provide any necessary life-saving first aid, set up camp and wait for assistance.

14.9 **Difficult terrain**

The techniques described below can be used in a variety of combinations. The most appropriate method for the situation can only be learned through experience.

14.9.1 **Steep ground**

When moving as a unit it may be necessary to ascend and descend steep slopes.

Ascending

Steep slopes in ascent can pose problems in that the unit may struggle to get to the top without running out of momentum. This can result in snowmobiles becoming bogged down. To avoid this it is best to tackle ascents of steep slopes one sledge at a time. This technique is known as 'double-heading'. **120**

The down sides of the double-heading technique are that two journeys (or more if more sledges are in use) will be required. Also as you descend to collect the second sledge you will be separated from all of your equipment. For this reason, rescue sacks must be carried on the back of the snowmobiles and not the sledge. You must not travel further than it is possible to walk back to either one of the sledges.

Descending

Due to the sledge towlines being a non-rigid link, the sledges will run into the back of the snowmobiles when travelling downhill.

Nansen sledges have keels and rope brakes. Both are effective tools for breaking the sledge in descent. On moderate slopes the keels may provide enough resistance but if it is steeper then rope brakes will be needed.

Warning: Never use rope brakes on Nansen sledges without also having the keels deployed.

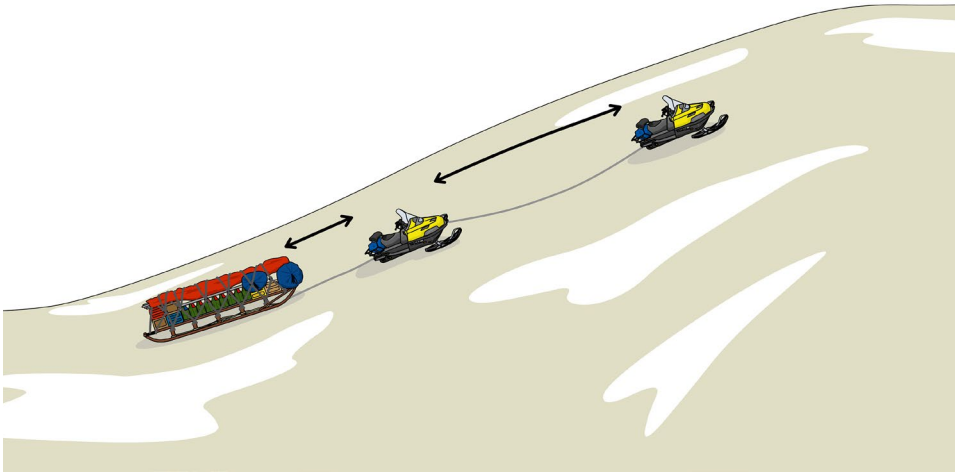


Figure 120 – Double heading

Other models of sledge can be fitted with a rope brake. A good technique is to daisy-chain a rope to increase its surface area and clip in on or near the front of the sledge. The rope will be dragged underneath and will slow the sledge.

The rear snowmobile can be utilised to slow a sledge by pulling back on the link line in descent. If necessary shuttle sledges down the slope one at a time in this manner.

> Warning: Allowing the unit to gather momentum and pick up speed is very dangerous. If one of the sledges was to flip or overtake the rear snowmobile it can result in the snowmobile overturning which is very likely to lead to injury of the driver.

14.9.2 **Soft snow**

Deep, soft snow can be very challenging to drive in even when pulling light loads. Heavy use of the throttle can cause the snowmobile to bog down, as will reversing in soft snow. Try to make movements as smooth as possible and avoid stopping and starting.

If the snowmobile does start to bog down, do not try and use power to get out! This will only lead to the snowmobile bogging in further. Dig away the snow the whole way around the snowmobile and gently try to drive forward. If this does not work you may need to detach the sledge, and get the snowmobile free before re-attaching to go downhill and attempting the ascent again. Ideally you should remain linked at all times if in glaciated terrain.

> Note: A steep slope with soft snow on it can be compacted by driving both snowmobiles up without sledges at first. This would require a set-up of snowmobile, 30m link rope, and snowmobile.

In very deep and soft snow conditions it may be necessary to double-head even on the flat. The lead snowmobile breaks trail and compacts the snow while the second pulls the sledge.

It may be wise to consider using multiple sledges with lighter loads on each to reduce how far the sledge sinks into the snow if operating in an area known to accumulate a significant amount of soft powder snow.

14.9.3 **Blue ice**

Blue ice is challenging to drive on, as it can be hard to maintain traction. Some snowmobiles can be equipped with ice studs on the track which assist with this problem. If travelling in an area known to have blue ice ensure your snowmobiles are equipped to deal with this before field deployment. It is recommended that you avoid having any sledges at the back of the system while travelling on blue ice as they can quickly get out of control.

Chapter 15 – Field travel by ski

15.1 **Introduction**

In certain areas it may not be feasible to safely travel with snowmobiles. This will most commonly be due to the quantity and severity of crevasses. It may therefore be necessary to travel on ski or with snowshoes. Skis are very good at spreading weight across a large area, and therefore minimising your risk of breaking through a crevasse bridge. When travelling by ski, equipment can be carried in pulk sledges. This chapter will look at the equipment required for such travel and explain techniques for glacier travel with pulks as well as additional knowledge on rescue systems specific to skiing/pulking.

Recreational skiing is permitted within BAS operations but is not covered in this manual. In the field skis are used as a means of transport rather than for enjoyment. The risk of injury from downhill skiing in the field is significant and should be avoided in most situations.

15.2 **Equipment**

15.2.1 **Skis**

There is a wide array of skis available for field travel. In general terms an alpine ski touring set-up is the most appropriate. The skis themselves tend not to vary that much, rather it is the bindings which have the biggest differences – All bindings described are a variation of touring bindings and are different to that of alpine style bindings found at a ski resort. Ensure all tools needed for adjustment and maintenance are carried, along with a selection of spares specific to the model used.

Silvretta bindings

Great for fieldwork as the bindings can be used with a rigid mountaineering boot. The safety release mechanism on these bindings is limited to heel release only. Skiing downhill with this set-up is strongly discouraged.

Fritschi bindings

These bindings require a dedicated ski touring boot. They are the best combination of safety and functionality, with the only penalty being the weight and being restricted to use with a ski boot.

Tech binding/pin binding

BAS does not have a stock of skis with this binding, but some people may have their own. They require compatible ski touring boots. Very functional and light.

Berwin bindings

The Berwin bindings are a very simple plastic basket that fit almost any boots. The advantages are that mukluks or other warm boots can be used with them. The bindings however are plastic and are prone to breaking in the cold. They are also only useful for skiing on completely flat ground. They are particularly useful for sea ice and associated testing.

> Warning: There is a training module that covers ski binding set-up. This module must be completed before skis can be set up. Until the module has been undertaken all skis should be set up prior to use by an experienced member of the field team.

15.2.2 **Skins**

All of the above styles of ski require a climbing skin. Skins should match the length and width of the ski, when fitted the metal edge of the ski should still be visible and able to make contact with the snow.

The glue on skins is sensitive to the cold and needs to be looked after. If intending to keep the skins on the whole time, applying them to warm skis before leaving station works well, but can leave a residue of glue on the base when removed. If taking the skins on and off throughout the day, store them inside your clothing system to keep them warm and prevent the glue from freezing.

Even warm skins will not stick well to a cold ski. It is sometimes necessary in particularly cold conditions to take skis inside the tent to try and warm them up before applying skins; otherwise the warm glue becomes frozen when it comes into contact with the cold base.

Skins need to be in good serviceable condition before field deployment. Extra glue should be taken for field repairs. Duct tape, cable ties and ski straps can also be useful for temporary fixes to get you back to a camp.

15.2.3 **Snowshoes**

Snowshoes are often a more appropriate choice for travel than skis. For those not competent in skiing, snowshoes are far easier to manage. Snowshoes also have the advantage of being small and can easily be strapped to a rucksack when not in use. Not all snowshoes have a crampon built in – if working on sloping terrain ensure the model you take is equipped with crampons. Remember to take a set of ski poles when snowshoeing!

15.2.4 **Pulks**

Pulks can be either plastic or fiberglass and can be fitted with rigid tracers or ropes for pulling. Dedicated pulking harnesses are best, but if on glaciated terrain, a mountaineering harness must also be worn. Pulks come in a variety of sizes, bigger is often better in order to keep the packed height low and minimise the chances of the sledge rolling. A selection of spare parts and items for field repairs must be carried when using pulks.

Pulks should be fitted with front and rear attachment points on the inside and the outside. These points are then connected on the inside with a length of climbing rope to act as a centre line. The centre line provides reinforcement of the pulk along with ensuring kit cannot be lost/dropped in the event of a crevasse fall. **121**

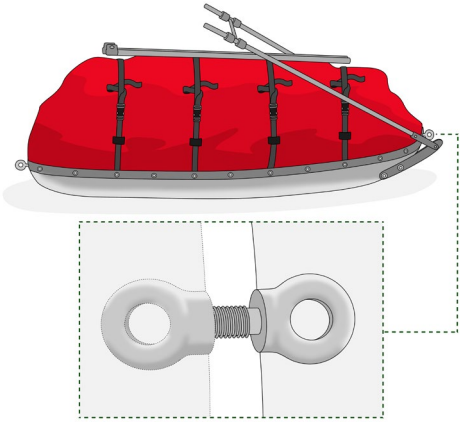


Figure 121 – Pulk

15.2.5 **Emergency equipment**

It is important to have the necessary rescue equipment close to hand in the event of a crevasse fall. The appropriate glacier travel equipment should be carried on the mountaineering harness. Rucksacks can be carried in conjunction with a pulking harness, although when using rigid traces this is rather cumbersome and not overly comfortable for long journeys. Snow stakes and ice axes should be secured using elastic to the rigid traces so that an anchor can be constructed in the event of your partner falling into a crevasse. With rope traces, a rucksack will need to be carried while in glaciated terrain to enable this equipment to be accessed.

In addition to the standard glacier travel equipment detailed in Chapter 11 – Glacier travel techniques (on foot), a spare dynamic rope should be carried in each pulk. This will make a rescue from a crevasse far easier.

15.3 **Roping-up for travel with pulks**

Roping up for glacier travel while using pulks is slightly different to when travelling as a team on foot. The pulks need to be attached to the main rope so that in the event of a crevasse fall the 'victim' can detach themselves from the pulk without losing it. This ensures no vital equipment is lost and that the person falling into the crevasse is not injured by the pulk coming in after them, both scenarios being equally serious when out in the field.

It is important to increase the distance between people while travelling roped up with pulks. A team of two should increase the rope out to have 20-25m between them; ENSA knots should be added on to the rope when travelling on skis with pulks, as arresting a fall on skis is much harder and the extra distance and knots assist with braking. A team of three or more should have 15m between each person and again include knots on the rope as described in Chapter 13 – Techniques for travelling in glaciated terrain. **122**

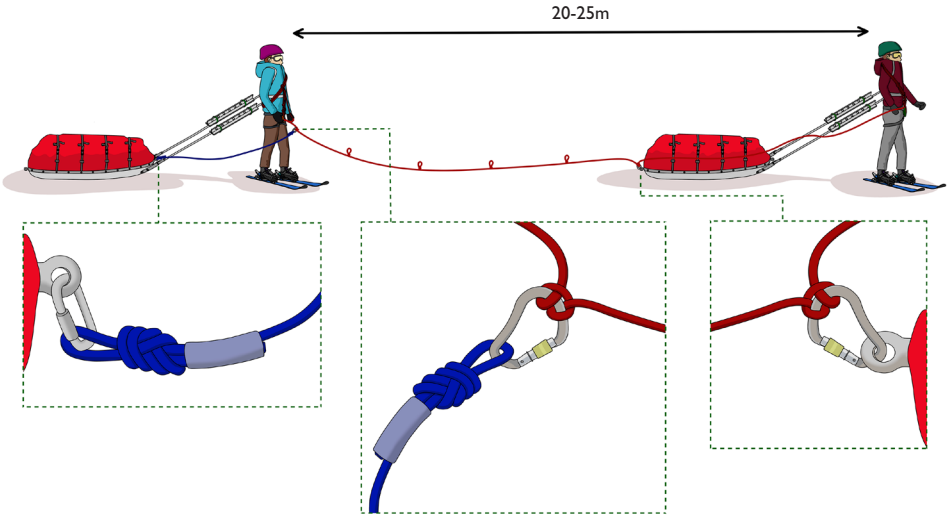


Figure 122 – Roping-up with pulks

15.3.1 **Roping-up on skis**

Ropes should be used when skiing on glaciated terrain but not for skiing downhill. The risks of accident by having the rope on in descent far outweigh the risk of falling into a crevasse. If it is essential to descend a steep crevassed area and you think roping up is wise then you should descend roped up on foot rather than try to descend on skis with the rope on.

15.4 **Sledge hauling**

Sledge hauling is very physically demanding and requires a good level of fitness. It is best to haul sledges on skis. However, it is also possible on snowshoes or on foot with crampons.

15.4.1 **Ascending**

Ascending a slope with a heavy pulk can be difficult. Try to pick the line of least resistance and zig-zag your way up. If stopping on the way up a slope for a break make sure you position the pulk across the fall line. It may be necessary to remove skis and use crampons for ascending steep icy slopes.

15.4.2 **Descending**

Descending with a pulk on rigid traces is much better than with ropes. The rigid traces hold the pulk back and stop it running into the back of you. Rope brakes can be created using a sling or length of rope, daisy chained and attached to the front of the sledge for friction. Rope brakes are essential for descending when using rope traces but can also be useful with heavy sledges on rigid traces.

The rear person can help to control the leaders sledge when roped together in descent by applying tension to the rope.

On very steep slopes it may be necessary to create an anchor in the snow and lower the sledges.

If crevassing makes descending a slope roped-up necessary, then skis must be removed and strapped to the top of the pulk – do not attempt to ski down while roped together! All members of the group should remain roped-up and travel down on foot if the terrain is glaciated. In some situations, it may be acceptable to unrope and ski down, this will depend on the terrain encountered and equipment carried. It will require a judgment call from the Field Guide on the ground. If using this approach one person should descend the slope at a time.

15.4.3 **Traversing slopes**

Traversing can be very awkward when pulling a pulk and is best avoided where possible. If necessary choose your line carefully and be aware that it will be more difficult for the rear person who will not have a rope running to the back of the pulk to help keep it from sliding down the hill.

15.5 **Crevasse rescue with pulks and skis**

See Chapter 13 – Techniques for travelling in glaciated terrain (on foot) for crevasse rescue information. The specifics that alter when towing a pulk with skis are detailed below.

15.5.1 **Self-arrest with skis on**

Position skis at 90° to the load to assist with braking. Ski poles can be used as a brake in place of an ice axe but it will be much less efficient. It is good practice to ski with hands out of the leashes on poles when travelling roped on glaciated terrain to enable hands to be positioned along the pole for arresting a fall. An ice axe should be stored on the rigid traces, or strapped to a rucksack if using rope traces, for easy access.

15.5.2 **Self-rescue**

For self-rescue 'the victim' will first need to wriggle out of their pulking shoulder harness, leaving the pulk suspended on the rope. Skis should be taken off and clove hitched with a sling to suspend from harness and prevent dropping or damaging other equipment. Jumars should be attached to the rope for ascending and a back-up clove hitch tied once sufficient slack has been generated through upward movement. The coils can then be dropped, and the 'victim' will need to untie from the rope. Ascending can be resumed using jumars and upon reaching where the pulk is attached to the rope, the jumars will need to be replaced above the pulk attachment point one at a time.

15.5.3 **Assisted/unassisted rescue**

As mentioned above in the equipment section each person in a two-person team should have a spare climbing rope stored in their pulk for crevasse rescues. An anchor should be constructed, using snow stakes, as in standard crevasse rescue and the system escaped. A separate anchor should now be constructed using a buried ski and the spare rope attached (if using snowshoes the original anchor used to escape the system will be used for both purposes). The rescuer can get the rope to the 'victim' and ask them to attach onto it using two back-to-back screw gate karabiners – if the 'victim' is unable to assist then the rescuer will need to abseil in and attach the end of the spare rope to the 'victim' themselves before jumaring back to the surface and setting up a hauling system. Haul the 'victim' until their weight is entirely on the new rope and either ask them to detach from the original rope if possible, or abseil back in and do this for them. Continue the haul until the 'victim' is on the surface.

The pulk can be recovered using the original rope as a second priority. **123/124/125**

> Warning: All personnel travelling using skis and/or pulks in the field must be familiar with advanced rescue techniques prior to field deployment.

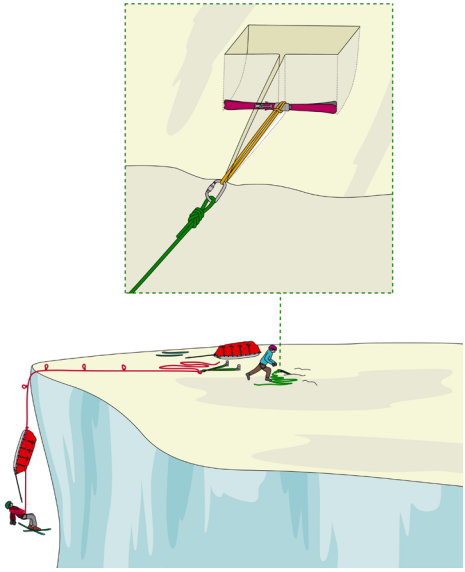


Figure 123 – Pulk crevasse rescue 1

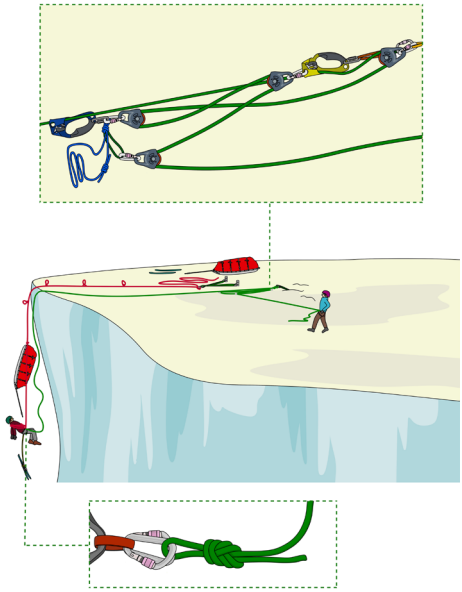


Figure 124 – Pulk crevasse rescue 2

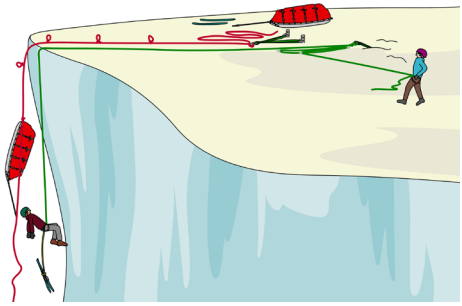


Figure 125 – Pulk crevasse rescue 3

Chapter 16 – Tractor traverse

16.1 **Introduction**

Tractor traverse refers to land trains, consisting primarily of PistenBully tracked vehicles pulling a series of Lehmann and plastic poly sledges. These types of traverses are often carried out with the intention of depoting large quantities of aviation fuel or cargo in deep-field locations to support future scientific campaigns. However, some traverses are undertaken with science as the primary focus.

Accommodation is often provided by the way of a shipping container/caboose on a sledge. On larger traverses a caboose may be used for living, eating etc. and mountain tents used for sleeping accommodation – This type of setup is outside the scope of this manual. For more information see the Traverse Operations Manual on the specifics of this area of field operations. This manual provides detailed information on vehicles, camp setups, living on a traverse, depot layouts, fuel, etc.

The tractor traverses are highly efficient at carrying out both logistic and scientific objectives. They are highly complex to organize and manage with multiple departments involved in planning, organisation and delivery. Speak with the FOM if tasked with a tractor traverse for more information. **126**

Note: If tasked with a tractor traverse project the Traverse Oil Spill Contingency Document must be referred to.

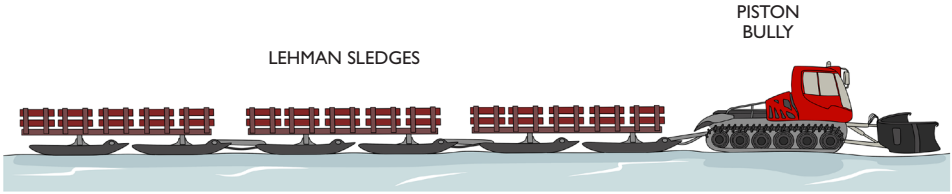


Figure 126 – Tractor traverse

Chapter 17 – Aircraft operations

17.1 **Introduction**

Fieldwork in the Polar Regions relies heavily on support from the BAS Air Unit. BAS operates four ski-equipped Twin Otter aircraft for field support and an airbridge to transport staff to and from the Gateway. The Twin Otters are the backbone of most deep fieldwork and facilitate 99% of deployments. The airbridge primarily transports passengers from South America to Antarctica during the austral summer season. Other stations may be served by external aircraft.

17.2 **Operating around aircraft**

All field staff will be involved at some stage with aircraft operations. As with any field operations, safety is paramount.

> Warning: Never approach an aircraft while the props are still turning; wait until the engines have been shut down and the red tail beacon stops flashing.
>
> Never stand directly in front of an aircraft on skis that has its engines running – no braking is available to the pilot, and the aircraft could move forward without warning.
>
> Always approach from the front of the aircraft and make eye contact with the pilot. Do not approach until the captain indicates it is safe to do so.
>
> When an aircraft is stationary hazards are still present. Propellors can move in the wind and cause serious injury.

17.2.1 **Co-pilot**

BAS Twin Otter aircraft are operated with a single pilot in the field, but there will always be two people in the front of the aircraft. One of these people will obviously be an experienced pilot and the other will be a nominal co-pilot. BAS staff may at some point have the opportunity to fly as a co-pilot.

The role of the co-pilot is to assist the pilot with both on-ground and in-air tasks. Before being eligible to fly as a co-pilot personnel must have undertaken Module 1 – Co-pilot training. This training covers safety around aircraft as well as emergency procedures. Module 2.5 – Aircraft camping provides training for an overnight stay based out of the aircraft.

If flying as a co-pilot it is your responsibility to ensure that you take a P-bag with you. For flights that intend to return to station the same day a communal emergency co-pilot P-bag may be used – check the situation with the pilot before leaving station.

17.2.2 **Ground support**

Ground support can be in a variety of differing forms but can include refuelling, weather observations and unloading cargo. The most important point to remember when operating around aircraft is safety. The pilot is in charge and will give you instructions.

For information on communicating with an aircraft see Chapter 11, Section 11.9 – Communication with aircraft.

Prior to an aircraft coming in to land at your location ensure any loose items around camp are secured and that there are no hazardous obstacles that could cause damage to the aircraft, i.e. glacio-poles sticking up that could damage an aircraft ski or propeller.

When meeting inbound aircraft, ensure the red tail beacon has stopped flashing and all engines are shut down before opening any doors and inserting the jury strut – known as the 'pogo stick.' The pogo stick is designed to protect the aircraft if it tips on its tail due to misloading.

When the aircraft flaps are not in the fully up position, it is possible for the rear cargo door to strike the flap. Always check flap position before opening this door.

> Caution: It is very important that any suspected damage to aircraft, however minor, is reported to the pilot.

Always be aware of propellors while operating around aircraft, even if engines are shut down, these may still move or spin in the wind and cause serious injury. If aircraft are on the ground for long periods, propeller ties are used to prevent this movement, the pilot is responsible for this but may ask for assistance.

Where possible, help with refuelling, a hot drink, and the chance to top up flasks with water will be greatly appreciated. Of course, the level of support that can be reasonably expected will differ from a busy two-person field party to a well-resourced tractor traverse.

Loading an aircraft in the field is a busy, physically demanding and at times stressful activity, and communication between FG and pilot is important. Once the aircraft is loaded and any passengers are briefed and onboard, the pilot will conduct a final walk-round check of the aircraft and its surroundings. It is critical that they are not disturbed or distracted during this check. The pogo-stick must only be removed by the pilot.

17.3 Aircraft marshalling

Aircraft marshalling is prohibited on snow or ice. In certain places aircraft will be marshalled to a particular spot but trained members of the Air Unit will carry out this task.

When an aircraft is coming into land at a field site, stand by the area you want the aircraft to stop. Standard procedure is to position two crossed flags at the point you want the aircraft's left wingtip to be over. However, any clear marker that will not cause issues or obstruct the aircraft is also acceptable. The aircraft will always come to a stop with the left wingtip over the marker. **127**

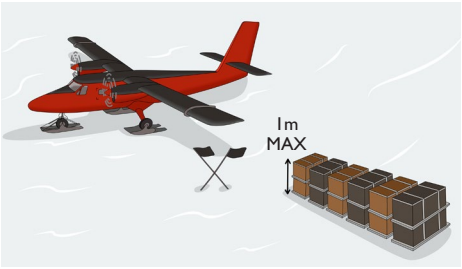


Figure 127 – Aircraft parking at field camp

Caution: Consider any obstructions when selecting a parking position. Remember that the Twin Otter prop is only 1.37m off the ground, and that loose items can be lifted by the propwash. As a general rule, there should be no objects within the footprint defined by the aircraft wingspan and nothing should be stacked higher than 1m.

Note: Aircraft will need to park facing into the wind. It is also acceptable to park facing other directions for a short period, if there is no other option or is chosen for a safer reason.

17.4 Aircraft overnighting in the field

At times aircraft will need to overnight at a location in the field; this could be due to a variety of reasons but commonly due to deteriorating weather or pilot duty hours.

All aircraft carry equipment onboard to allow for an overnight in the field. If the aircraft is empty, pilots often choose to sleep onboard but a mountain tent is far warmer and is carried in the rear of the aircraft for this purpose.

17.4.1 Securing an aircraft on the ground

Regardless of current weather conditions, aircraft overnighting in the field should be secured to the ground. Dead-man anchors are carried in the nose of the plane with pre-attached ropes. The pilot is responsible for the security of the aircraft, but Field Guides will often assist. **128**

17.4.2 Digging out aircraft

If an aircraft has spent a night on the deck in the field it may have become partially buried. The skis will often need to be dug out prior to departure. Great care must be taken when digging out the skis as they can be easily damaged with a shovel. The pilot must supervise and lead this activity.

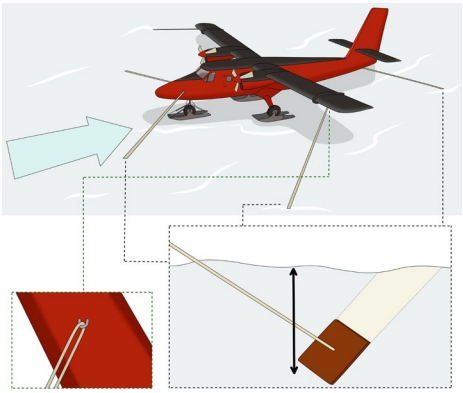


Figure 128 – Securing aircraft overnight

17.5 Aircraft loads

Aircraft are required to operate to strict weight and centre of gravity limits. It is the Field Guide's responsibility to plan aircraft loads for field deployment and uplift, pass this information to the pilot prior to loading. If departing from Rothera the FOM will help liaise with the air unit on your behalf. The weight limit for cargo on a flight will vary depending on the distance of flight, weather conditions and in-field refuelling options. The FOM will provide the payload figures prior to loads being planned.

Clearly mark all items with coloured tape with the weight clearly written in indelible marker. Weights should be as accurate as possible, rounded up to the nearest pound. Where weights are estimated, advise the pilot accordingly. All tape and markings from previous projects must be removed to avoid confusion.

In the field, outbound loads should be separated into aircraft loads, and laid out for inspection by the pilot. This will help the pilot plan their loading, and ultimately save time and effort.

Caution: Dangerous goods should be clearly marked and separated from the rest of the load to enable careful inspection by the pilot.

17.5.1 Load sheets

There is a spreadsheet available for creating load sheets. Standard weights of some items are included but non-standard items must be accurately weighed. See Appendix A3 for weights of standard field kit items.

Completed load sheets must be submitted to the FOM for checking a minimum of two days before planned deployment date. Field Guides should take a copy of completed load sheets into the field with them to help with load sheets for uplift.

All loads for aircraft are measured in pounds (lbs). If estimating weights a good tip is to use an unopened field ration box as a comparison.

Note: It is important to consider the bulk of a load as much as the total weight. Knowing what can fit into a Twin Otter comes down to experience so if in doubt discuss with pilots and experienced field staff.

17.5.2 Loading an aircraft

The pilot of the aircraft is in overall charge of all aircraft loading. Decisions on what to put where and commands for moving heavy objects should come directly from the pilot unless delegated to someone else – usually the Field Guide or Field Coordinator. If at any point anyone has any safety concerns for people or the aircraft they should shout 'STOP'. A clear briefing of how loading should take place must be carried out prior to any loading.

There is a serious risk of damage to people and the aircraft if loading is not carried out in a controlled and pre-planned manner. Never rush this task and always be mindful of trapped fingers or the potential to drop an item.

Hand signals

Hand signals are occasionally used to aid the use of machinery or heavy equipment with loading large objects into aircraft, the pilot usually takes charge of this operation. Seek advice if hand signals are required.

Note: Personnel involved in loading should be briefed and agree on communication prior to loading commencing to ensure a safe operation.

Loading/unloading heavy items at a station

When deploying from station a telehandler may be used to load heavy items. The vehicle must only be operated by qualified and experienced personnel to minimise the risk of damage to people and the aircraft.

Loading/unloading heavy items in the field

Metal ramps are used for loading and unloading heavy items in the field. Snowmobiles can be driven up the ramps and then maneuvered by hand into the aircraft. Ramps can be supplemented with wooden boards to aid with loading and unloading if required.

This procedure can be hazardous. The person driving the snowmobile up the ramps must be familiar with the correct procedures. Ensure that no-one is stood directly next to or behind the ramps, as snowmobiles

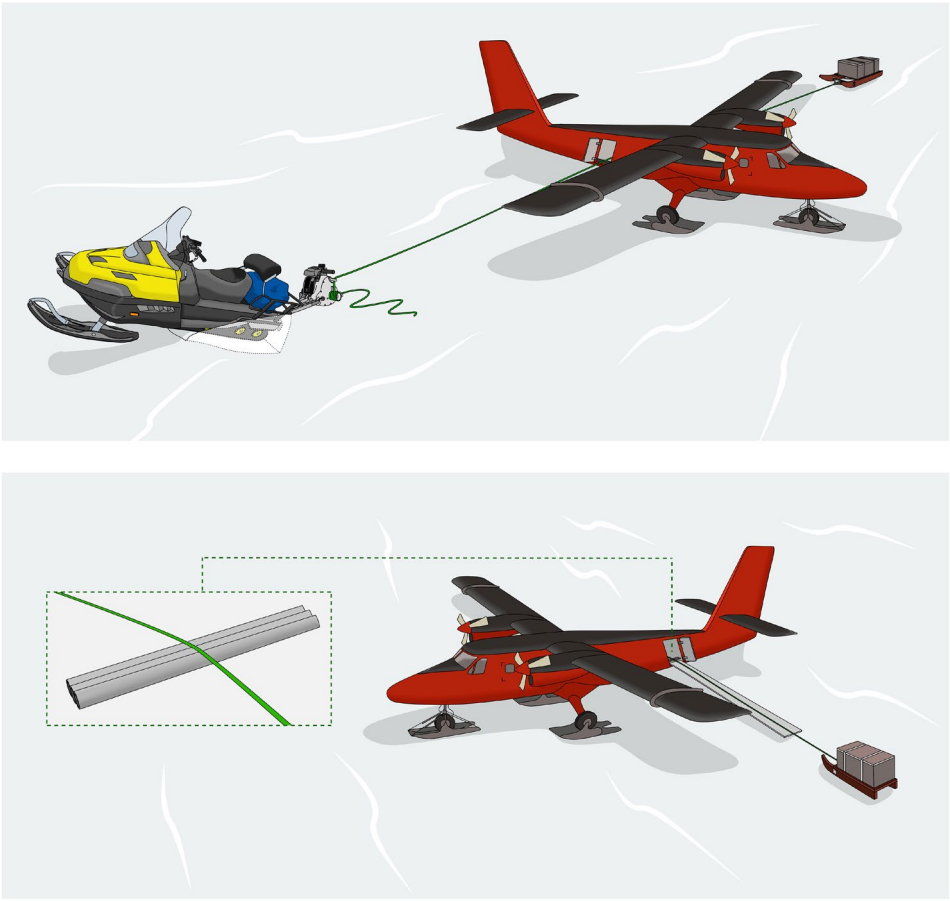


Figure 129 – Loading heavy items into aircraft using capstan winch

are being loaded/unloaded. Ramps need to be secured with a strop under the aircraft linked to the central bar and the lower ends should be dug into the snow for extra stability.

A capstan winch can be very useful if a project requires many heavy items to be loaded onto aircraft. **129/130**

Caution: The system overleaf should only be used after consultation with the FOM and Chief Pilot. Specific training must have been carried out to prevent damage to aircraft.

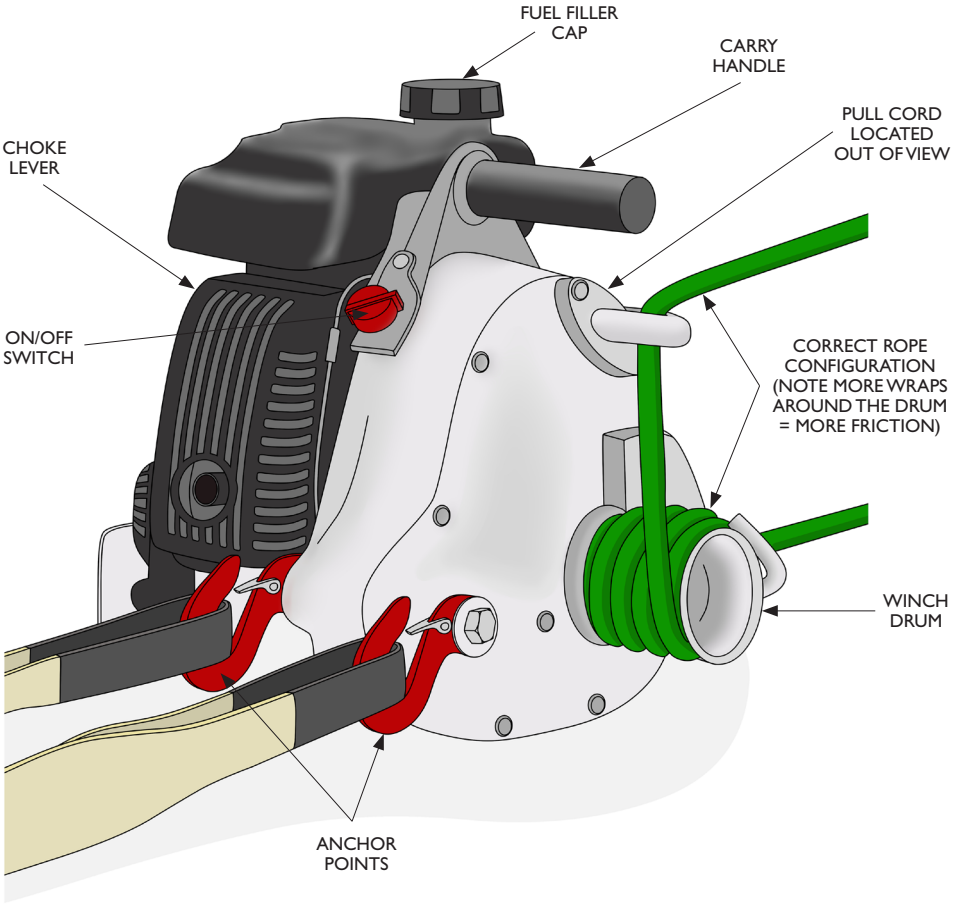


Figure 130 – Capstan winch

Snowmobiles on aircraft

Snowmobiles must have a maximum of one-quarter tank of fuel for transporting by aircraft. The left footplate, right powder ski and the windscreen must be removed prior to loading. In normal operations only one snowmobile will go on per aircraft load – aircraft deployed SAR operations are the only time that two machines may be loaded onto one aircraft. See specific aircraft SAR loading instructions for more information on this. Loading snowmobiles onto aircraft is a hazardous operation to both the aircraft and staff. This process requires training by both Pilots and dield staff, and it is a priority for both the Field Department and Air Unit to ensure this happens.

17.5.3 **First load**

The first load into the field must contain all the necessary equipment to live comfortably and safely in the field. Although multiple loads may be planned for the same day, many factors, such as weather and technical issues, may result in this not happening.

The following kit must be on the first input load to a site:

- Pyramid tent (and pegs!)
- Pots box
- Tent box
- Food box x 1
- 21-day emergency food box
- Fuel x 1 20 litre jerry of Kerosene
- HF radio
- Satellite phone
- P-bag for each person staying on the ground
- Personal kit bags
- Half-unit P-bag
- Primary healthcare module
- FRB cold bag
- Pup tent
- Spares box
- Shovels
- Rescue sack
- Satellite phone and GPS
- Bog chisel
- 10 x flags

If the payload allows, a snowmobile and sledge are useful for moving cargo from the aircraft to the camp. It can also be useful to have a snowmobile on the first input to make it easier to set up a ski-way. Be careful however not to drive around an unknown glaciated area without two snowmobiles being linked up.

The equipment detailed above should also be the last load out of a site. Even for short flights no-one should ever be left alone on the ground.

17.5.4 **Hazardous cargo**

Any hazardous cargo being transported by aircraft must be clearly labeled and transported in the appropriate container. The following list indicates hazardous goods; please note that this list is not exhaustive:

- Fuels
- Batteries
- Explosives
- Compressed gases
- Hazardous chemicals, e.g. mercury, acids etc.

Field staff should remind the pilot before the loading of any hazardous cargo that needs to be transported. When creating aircraft loads, set dangerous goods to one side so that they are obvious and can't be loaded accidentally without the pilot knowing about it.

17.6 **Setting up a ski-way**

At locations where aircraft will be making several trips a ski-way will need to be marked out. A standard field ski-way for a Twin Otter aircraft should be as follows:

- 500m long and 30m wide
- Orientated in line with the prevailing wind
- Straight
- Marked with black flags on one side at 50m intervals (total of 11 flags required). The left side is preferred, but this can vary with topography, camp position, prevailing wind etc.
- Contrast bags should be placed at the base of every other flag and at all four corners if these are marked with radar flags
- Large sastrugi will need to be flattened – either by towing a heavy sledge behind a snowmobile or with a shovel

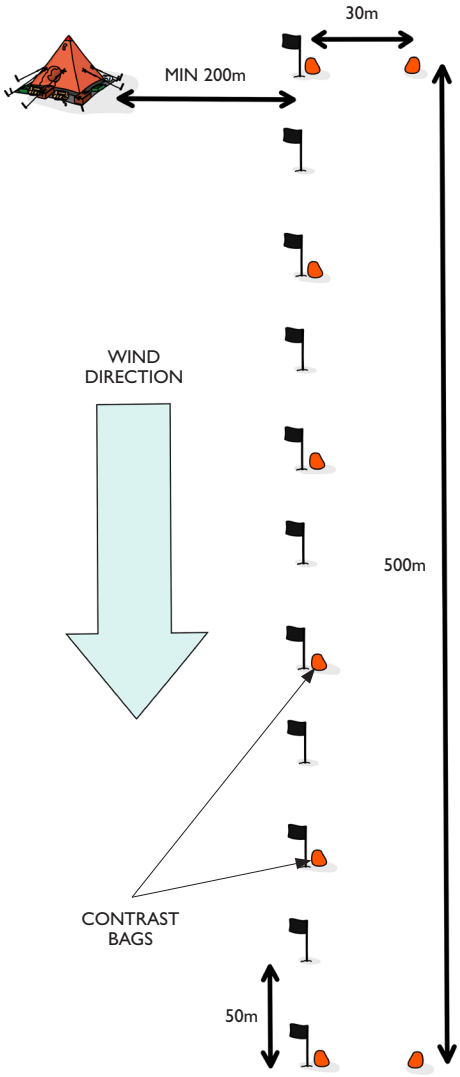


Figure 131 – Setting up a ski-way

- Ensure both thresholds are clear of any obstructions – camp should be positioned off to one side of the ski-way, a minimum of 200m away **131**

At times non-BAS aircraft may be used for deployment and uplift in the field. Check how the pilots of other aircraft wish the ski-way to be set out prior to deployment.

Twin Otter aircraft land at approximately 80mph. A few small flags can be hard to spot so driving up and down the ski-way with a snowmobile can help to increase the contrast from the air. Additionally, bags can be placed along the flag line to increase contrast from the air, if no designated contrast bags are available, other items may be used. A ski-doo placed at the first and last flag along with larger rucksacks or rescue sacks along the flag line can act as substitute contrast bags – ensure any items placed along the skyway flag line are secure and won't be blown away.

17.6.1 **Passing ski-way information**

The location of the ski-way flag line should be passed to the comms team using the following format:

- Centre coordinate position: S 00°00.000 W 00°00.000
- GPS elevation of centre coordinate in feet
- Orientation: 000° Magnetic
- Length, in metres
- How it is marked (as described above)
- Camp located to the N,E,S or W of ski-way flag line, aircraft advised to land on NES or W of flag line
- Surface conditions are smooth, firm, soft, sastrugi height
- Relevant hazards include… crevassing etc.

Any hazards present in the immediate vicinity must be clearly marked with crossed red flags. The area should be probed for crevasses and carefully monitored.

17.7 **Fuelling aircraft in the field**

All field staff will be required to assist with the refuelling of aircraft at some point while in the field. The following points must be observed:

Warning: When refuelling in the field the aircraft pump requires the right-hand engine to be running. The right hand side of the aircraft is therefore out of bounds during field refuelling!

- No smoking near aircraft
- The pilot will indicate how much fuel they want and in which tanks, comms may have relayed this information prior to the aircraft landing but always confirm with the pilot
- Take great care not to spill any fuel. Fuel spill equipment should be close to hand during refuelling
- Each drum should be carefully inspected for damage, if a drum appears to have lost fuel it could also have taken in some snow – a drum in this state must not be used
- Each drum should have a sealed cap, remove this just before using – do not open in advance of aircraft arriving
- Water-finding paste should be used to check each drum has not been contaminated. The check must be carried out before the drum is disturbed. Add a small amount of paste to a bamboo cane and insert to the bottom of the drum – paste should come out the same colour as it went in! If the paste has changed colour there is water in the drum – do not use the drum!
- Remove pump from rear of aircraft and attach hose and nozzle
- If a bonding strop (earthing pin) is attached to the nozzle, attach to the aircraft before placing the nozzle into the tank
- Refuelling requires two people, one to fuel and the other to swap the pump to the next drum and switch the pump on/off. Do not switch the pump off when moving between drums, as fuel will spill
- At the end of refuelling take care to empty the fuel from the hose into the aircraft. Disassemble the hose and place back in the rear of the aircraft

Caution: Water contamination of fuel is a major hazard to aircraft. Take great care to brush any snow from drums, and to keep exposed fuel hose couplings and the fuel nozzle out of the snow.

Take great care not to contaminate field clothing with aviation fuel.

Always refuel the forward tank first to avoid the aircraft sitting back on its tail.

17.7.1 **Emergency equipment**

All BAS aircraft operating in the field carry emergency equipment. Twin Otters carry the following kit permanently in the tail of the aircraft for unplanned overnight stays in the field:

- Aircraft pots box (set up for 6 persons on board)
- 2 mountain tents
- 5L jerry of Kero (this can be changed for larger jerries if needed for planned overnights)
- Combined emergency food and medical box (this should only get opened in an emergency)

17.7.2 **Planned overnight equipment**

If the aircraft is planning to overnight in the field, then additional equipment should be carried. This will be at the discretion of the FOM/Pilot/Field Guide:

- Air unit field food box - this is for use in addition to the emergency kit described above
- Additional Kero appropriate for the duration of the trip and number of PAX

17.7.3 **PRIST**

All BAS-purchased aviation fuel in sealed drums comes pre-mixed with FSII (Fuel System Icing Inhibitor), commonly referred to by its brand name PRIST. There may be times when the aviation fuel available in the field has come from other sources, e.g. bulk fuel from ships transferred into 205 litre drums or fuel bought from other Antarctic operators.

The pilot should always check whether fuel contains FSII or not and add their own to the drum if necessary. Depot logs should clearly state the origin of aviation fuel.

17.8 **RPAS operations**

Remotely Piloted Aircraft Systems, sometimes known as UAVs, can provide a useful tool for operations and research; there are a large range of platforms with an equally wide range of capabilities. RPAS are frequently used by BAS field operations for terrain assessment, route finding, monitoring and to support SAR capabilities.

BAS-supported staff may only use RPAS for scientific or operational purposes, there is no recreational RPAS use in Antarctica. RPAS operations can create flight safety and environmental hazards, so they must be carefully managed.

All RPAS flying must be done in accordance with the BAS RPAS operations regulations and will require advanced notice, evidence of pilot and platform suitability and adherence to the planning process. Contact the FOM or Tower Supervisor for further guidance on RPAS use as early as possible.

Chapter 18 – Boat operations

18.1 **Introduction**

Some field projects are deployed by boat. Many of the principles of field deployment by aircraft apply, but this chapter will provide specific information to help with planning the logistics for a boat-based deployment.

18.2 **Small boat deployment**

BAS has small boats at many of its research stations. They are sometimes the only way to gain access to certain coastal sites. Each station operating small boats will have a dedicated boating officer. Consult with them well in advance of field deployment if the intention is to go in by boat.

The RIBs that BAS uses do not have cabins and therefore all equipment will be exposed to the elements and spray from the sea. Ensure everything is well packed inside waterproof containers.

Boat deployments are likely to be on the Sub Antarctic islands or Peninsula islands with little to no snow cover, this will mean adapting campsites to fit the environment, Field guides should have appropriate knowledge and experience to make these judgements. All water should be taken ashore with you as there will likely be no clean snow to melt, water filters or spare water should also be taken for emergency use where appropriate, speak with the FOM for further information – a good rule to thumb is six litres/per person/per day but this figure should be confirmed using previous reports of the area if possible.

There are jet boats at some BAS stations. These boats do have cabins, however it is best to still pack all equipment in waterproof containers in case something is dropped in the sea during loading/unloading.

The same basic equipment required for aircraft deployment must be taken on first input when going by boat; this goes for day trips as well as longer deployments. See Chapter 17, Section 17.5.3 for detail of what must be taken – areas close to station with serviceable huts and depots of food and fuel are slightly different. See the FOM for clarification before deployment.

All personnel on BAS-operated small boats are required to wear immersion dry suits and life jackets. Factor in the time to get all field personnel kitted up on the day of deployment.

18.3 **Deployment by ship**

Some projects may be deployed by ship. In most cases actual deployment will be by a smaller boat from the ship but sometimes a ship will moor alongside an ice-shelf for example.

If being deployed by ship all cargo must be clearly labeled and a Bill of Lading (BoL) must be filled in for each item. See the Winter Station Leader for advice on filling out BoLs.

BAS currently operates one ship – the RRS *Sir David Attenborough*. In addition to BAS operated ships, work is frequently carried out with assistance from HMS Protector. Occasionally BAS will work in partnership with other Antarctic operators of ships for logistical purposes. The captain of the ship is always in overall charge, however if the Field Guide assigned to a ship-deployed project has any concerns over safety regarding the deployment they must make these concerns known to the captain.

18.3.1 **Helicopter operations**

Although arguably better-placed in the Chapter 'Field deployment by aircraft', helicopter operations are most likely to coincide with work from a ship.

Even if the intention is only to be out for a day trip, ensure you take the basic survival equipment of shelter, food, fuel, stove and communications equipment.

Liaise directly with helicopter pilots prior to deployment using helicopters for further specific information.

Chapter 19 – Sea ice

19.1 **Introduction**

Sea ice can be a fickle and risky medium on which to travel. The risks can be reduced by good decision-making and understanding of local sea-ice conditions.

It is important not to get complacent over sea-ice conditions – always keep alert and continually assess the weather and the state of the ice.

In the context of BAS field operations, sea-ice travel is necessary at times for scientific purposes as well as logistics. Relief at Halley is often carried out onto sea ice and at times fuel and other cargo have been offloaded onto the sea ice in the deep field. The ability to assess and make use of sea ice can have a significant impact on successful logistics.

This chapter gives an overview of sea-ice operations and techniques. For further information consult the relevant station sea-ice regulations and discuss with station management.

> Note: Sea ice in the Antarctic and the Arctic has noticeably different characteristics. Multi-year sea ice is less common in the Antarctic compared with the Arctic.

19.2 **Sea-ice formation**

Seawater will freeze when it reaches a temperature of approximately -1.8°C. Once this water temperature becomes stable under the influence of cold air temperatures, ice spicules or small plates start to form in the water surface layer. These coagulate to form grease ice.

This new ice may take on different forms according to influences such as sea state, wind strength and air temperature.

In calm conditions fast ice forms in five stages:

- *Grease ice* – an oily appearance in the water
- *Porridge ice* – a slushy layer
- *Pancake ice* – circular plates of newly formed ice which usually have raised edges caused by the movement and contact between adjacent plates
- *Young ice* – where the pancakes have consolidated into a continuous sheet but only a few centimetres thick

Figure 132 – Sea-ice formation

- *Fast ice* – the ice matures and snow may cover the surface. By definition fast ice is connected to the land, although often with a tide crack **132**

Caution: This process can be shorter and pack ice can form by the consolidation of old sea ice, brash and bergy bits. These freeze into an irregular continuous surface of blocks and pressure ridges. Travel over such sea ice can be strenuous and time-consuming unless snow cover has levelled the irregularities. Ice that has formed in this manner is often weaker than when formed through the above five-stage process.

Newly-formed sea ice has resilience akin to soft rubber and this provides comparatively better support than freshwater ice.

Before travel can take place on sea ice it will need to reach a suitable thickness (see below) and travel should not be undertaken on young sea ice until it has been tested by a significant storm (winds in excess of 40 knots for a long period). This is especially important if there is no safe alternative return route should the ice break out.

Under stable conditions, first-year sea ice can form to a thickness in excess of 1.2m. Multi-year sea ice can be in excess of 3m thick.

Mode of travel	Theoretical minimum thickness	BAS policy
Person on ski	10cm	20cm
Person on foot	13cm	25cm
Loaded Nansen sledge	15cm	30cm
Snowmobile, one person	15cm	30cm
Twin Otter	51cm	N/A
C-130 Hercules	157cm	N/A

These thicknesses are for ice only – exclude any layers of surface snow.

The bearing capacity of rotten ice is at best only half that of good ice.

19.3 Records

For areas around stations, detailed records of sea-ice formation and weather conditions should be recorded throughout a winter. This enables a picture to be built up and passed to those involved with decision-making back in Cambridge. This is usually done using a form that can be passed easily between both parties.

The following information is useful to record:

- Thickness measurements and positioning (see testing sea ice below)
- Daily weather observations – wind direction and strength and max temperature
- Presence of any large leads or areas of open water
- Position of large icebergs
- General weather history in relation to wind speed, direction and temperature
- Photographs of ice formation and change
- Sea temperature if available from science team

19.4 Training

Before travelling or working on sea ice all personnel must have undergone the Sea Ice Module training. This module covers procedures for safe travel on sea ice, identification of hazards and emergency procedures.

19.5 Weather conditions for sea-ice travel

The stability of sea ice is massively affected by weather conditions. Strong winds and warm temperatures can destroy stable fast ice in a matter of hours.

Sea-ice travel should not be undertaken if the air temperature is above -5°C. Wind must also be below 10 knots for extensive travel. In specific locations such as sheltered coves, a stronger wind, so long as it's on-shore, may be acceptable.

Refer to station sea-ice regulations and consult with station management for more information.

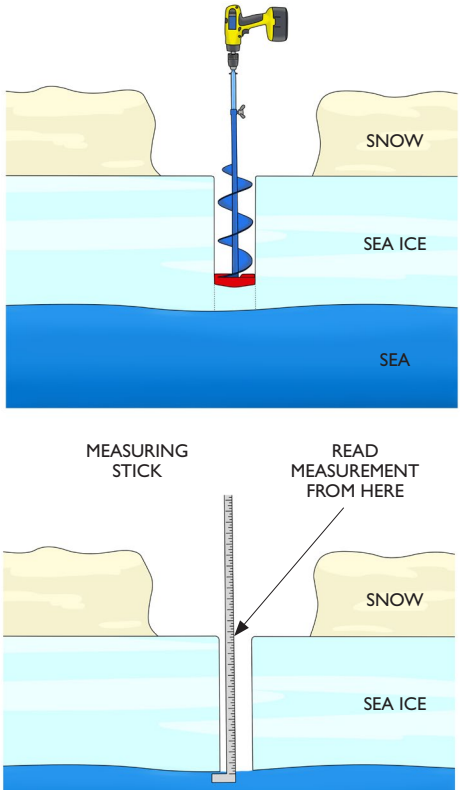


Figure 133 – Sea-ice drilling process

19.6 **Testing sea ice**

At some stage during sea-ice formation the decision needs to be made to venture out for the first time to gain further information on ice quality and thickness. The decision to venture out for the first time should not be made until after a period of significant cold and calm conditions. All sea-ice testing must be carried out with an experienced Field Guide in the party.

The most reliable method of testing sea ice is to drill through it and measure its thickness. To do this the surface snow must first be dug away to ensure the measurement takes into account the ice only.

An ice drill attachment can be used with a cordless power drill but be aware of the battery limitations. Take spares and keep them warm. A hand auger must also be taken as a back up.

Once the hole has been drilled to the sea, a measuring stick can be inserted. Custom-made units are available on BAS stations that include a right angle that catches on the underside of the ice to ensure an accurate measurement. **133**

> Warning: If at any point during testing it is discovered that the ice is below the minimum thickness as stated above in relation to BAS policy, the testing team must return to land via the route they came from.

Once an area has been drilled and deemed safe it may not need re-drilling for some time. It should be re-drilled if a significant period of time has elapsed or the conditions have changed.

19.7 **Operations on sea ice**

The following section details information on specific times when sea-ice travel may be necessary.

> Warning: Never camp on sea ice.

19.7.1 **Sea-ice relief**

Relief can be carried out at certain BAS stations and deep field locations via sea ice. Prior to a decision on relief site being made by station management/field operations department, an assessment of the sea ice must be made. This will require a visit and if suitable measurements of ice thickness should be obtained.

During a sea-ice relief, numbers on the ice should be limited to those required for operations only. All those operating on the sea ice should wear appropriate PPE such as personal flotation devices, immersion suits and hard hats. Self-inflating life jackets may be worn in certain scenarios e.g. working close to the ice edge.

Note: Self-inflating life jackets should not be worn inside vehicles at any time. Personal flotation devices are available for this.

Large vehicles may be travelling on and off the sea ice collecting cargo so particular care must be taken in relation to changes in the ice.

All hazards must be clearly marked with red flags and all those operating on the ice clearly briefed regarding procedures. One person on the ice should be assigned to monitor the state of the ice, particularly the edge and ramps leading to the ice shelf. Any concerns should be communicated immediately.

For more information on sea-ice relief and specific relief sites speak to the Head of Field Operations.

19.7.2 **Snowmobile travel**

Ski-doo travel on sea ice can be hazardous due to the speed at which travel can be carried out. If driving too quickly you can very quickly find yourself on dodgy ice without noticing the gradual change.

The following points should be observed when driving snowmobiles on sea ice:

- Keep the speed down, 15km/h max, although in certain situations it may be possible to go quicker. Remember that if you go too quickly you may find yourself on poor ice – don't get complacent as to the quality of the ice
- Keep at least 50m between each snowmobile
- Look out for signals from the lead driver, be particularly aware of the emergency stop signal
- Never link up on sea ice and never attach yourself to the snowmobile by anything other than the kill cord
- Only one person on each snowmobile
- Stop regularly to properly assess the state of the ice – as a guide every 100m when close to land and every 1km when further away, although this will vary depending on conditions. Be alert to any changes in the ice such as colour and if in doubt stop and drill
- Keep a close watch on the current weather and signs of it changing. A shift in wind direction could be significant
- Always play it safe when travelling on sea ice, if in any doubt over ice quality or the weather return to station

Snowmobiles may be used on sea ice for work close to station. If venturing outside the local area, full field travel equipment will be required. For more information, equipment lists, and travel limits see the sea ice regulations on station.

19.7.3 **Diving**

Where diving operations are to be carried out on sea ice refer to the BAS Diving Management System.

19.7.4 **Recreation**

Permission for recreational sea-ice travel may be granted. This decision will be made by station management in conjunction with the Head of Field Operations

19.8 **Hazards**

There are many hazards unique to travel on sea ice that must be understood prior to carrying out a journey or work related operations. **134**

19.8.1 **Tide cracks**

Sea ice is often weak where it joins the shoreline. Tide cracks are caused by a hinge effect during tidal movements and can be wide enough to lose a ski-doo in. As their cross-section is often in the form of an inverted 'V' with rotten edges, their true width is disguised.

Tide cracks can make access on and off the ice difficult, particularly after warm periods and during periods of large tidal range.

They should be crossed at 90° and only after thorough investigation.

19.8.2 **Icebergs**

Icebergs pose a significant hazard to sea-ice travel. The ice immediately around icebergs is always suspect and usually weaker than the rest of the sea ice.

If floating in the sea and frozen in place as the water freezes the berg will continue to move slightly and

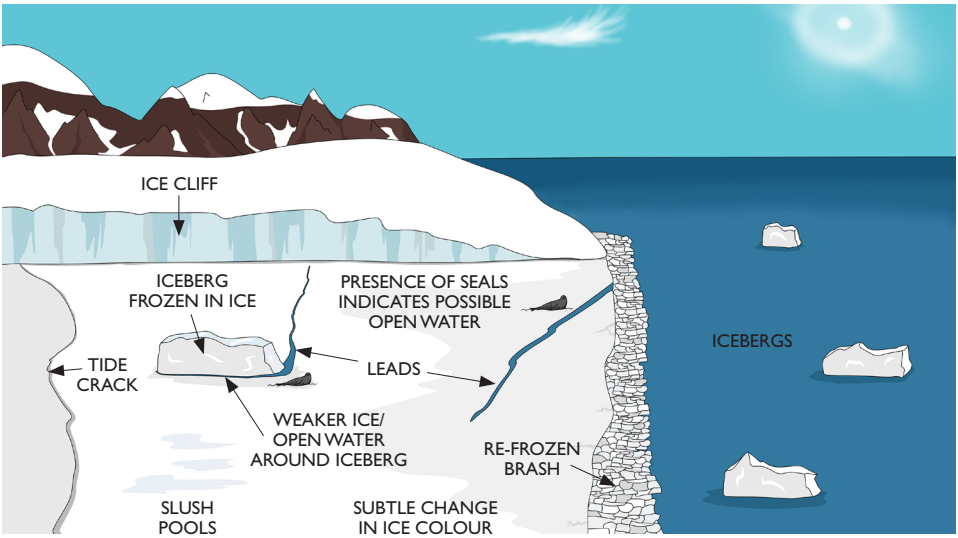


Figure 134 – Sea-ice hazards

can be affected by strong winds. This causes the ice around the berg to continually break up and refreeze so it is usually significantly thinner and therefore weaker than the other ice around it.

If the berg has grounded on a feature beneath the sea then the tide will move up and down the berg and create the same affect as a tide crack. This ice may refreeze but will again always be weaker than other areas of ice.

In addition to the above risks, chunks of ice can break off large icebergs creating danger if you are travelling too close. Give icebergs a wide berth or if possible avoid completely.

19.8.3 **Ice edge**

The ice edge is obviously hazardous as you become exposed to the open sea. In addition there is nothing holding the ice in to the land here so it will be the first area to break-out if conditions change.

Predators such as orcas, leopard seals and polar bears, if in the Arctic, often patrol the ice edge, as this is where they are most likely to find food. It may seem unlikely but this is a risk not to ignore.

19.8.4 **Coastal features**

Be particularly aware of narrow channels, reefs and areas close to land as these features can result in less predictable ice formation.

Ice cliffs and glacier terminations by the sea present a risk of falling ice from above. Do not travel too close to these features.

19.8.5 **Surface melt/slush**

Warm temperatures can result in ice decay on both the surface and the base of the ice. Surface water can form which is particularly hazardous to vehicles, which can get bogged down in the slush. A fresh layer of snow often masks this hazard.

19.8.6 **Ice quality**

There are many hard-to-see factors that can affect the thickness/quality of sea ice in localised areas. Currents and topography under the sea can cause irregularities that result in these suspect areas. Look out for any changes to the colour or texture of the ice surface and be particularly cautious around these spots. It may be that this change is not significant enough to

make travel unsafe but it is important to identify and investigate this before blindly travelling over it.

Measuring the thickness of the ice when assessing its suitability for travel only works if the ice itself is sound. Having sufficient thickness will not count for much if the ice is rotten and can't support your weight.

Danger areas/signs are:

- Darker ice usually indicates newer and therefore thinner areas
- Dullish grey colour variations in the snow cover can indicate wet areas
- Dirt in or on the ice surface may be a result of wind-blown dust. This will cause an increase in the absorption of solar radiation and therefore the rate of melting
- Large masses of snow can cause flooding and boggy areas, especially near cracks in the ice
- Melt pools formed by ablation. If there is a need to cross melt pools on sea ice, drill the ice to ensure it is strong enough
- Flooded ice. Sea ice can be heavily loaded by water and wet snow. This meltwater can also come from snow melt on land that has flowed out onto the sea ice (and under the sea ice)
- Thaw holes. These are vertical holes in the sea ice formed when the surface pools melt through to the underlying seawater
- Rotten ice. Sea ice that has become honeycombed and is in an advanced state of disintegration
- Water sky – dark linear areas of sky close to the horizon line can be reflections of open water. This is known as water sky and can alert you to possible open water from a distance

You should learn to recognise these types of ice. Remember that snow cover makes assessment difficult as it can mask danger areas.

19.8.7 **Leads**

Leads in the ice are essentially fractures of open water through the frozen sea ice. These leads can be caused by a variety of factors but predominantly through stresses on the ice created by either wind or ocean currents. Leads can form anywhere and if the air temperature is cold enough they may freeze over entirely, but they will be much thinner than the surrounding sea ice.

19.8.8 **Polynyas**

Polynyas are areas of permanently unfrozen water. These areas are often kept ice-free by ocean currents and warm upwellings. Polynyas tend to form in the same areas year on year and local knowledge will prove useful.

19.9 **Equipment for sea-ice travel**

The following equipment must be considered when operating on sea ice:

- *Immersion suits* – to be worn when drilling sea ice or operating close to the ice edge. After initial testing of an area it is acceptable for personnel to travel in normal field clothing
- *Personal flotation devices (PFD)* – to be always worn by all personnel while on the ice. Some exceptions exit. See documentation for more information
- *Life jackets* – to be worn by personnel working close to the ice edge, i.e. ship operations. Be aware of potential hazard of self-inflating life jackets in certain situations
- *Skis* – reduce the ground pressure and minimum theoretical thickness for safe travel on sea ice. Should be used when on newly formed sea ice during testing
- *Throw lines* – at least two per party, ideally one per person
- *Sea-ice belt* – waist harness to be worn by each person
- *Ice daggers* – two per person, used to gain purchase on the ice to haul oneself out in the event of falling through the ice
- *Emergency clothing* – two sets to be carried in waterproof dry bags. Clothing should be large enough to fit everyone in the group and easy to put on quickly
- *Communication equipment* – minimum 2 x VHF radios and satellite phone
- *Group shelter* – large enough for all party members to fit in or multiple shelters if a larger group
- *Navigation equipment* – map, compass and GPS with exit points loaded plus spare batteries
- *Bog chisel* – for probing suspect areas of ice
- *Drilling equipment* – drill, measuring stick, and shovels

Figure 135 – Equipment for sea ice

- *First aid* – minimum 1 x IAP per group
- *Food and drink* – a flask of warm liquid is recommended

Parties venturing away from areas local to station must take full field travel equipment. See the sea-ice travel regs on station for more information. **135**

19.10 **Sea-ice emergency procedures**

Things can go wrong very quickly on sea ice. Prevention is always going to be better than cure, but if you get caught out, knowing what to do and staying calm could save you.

19.10.1 **Sea-ice break-out**

Sea-ice break-out can occur quickly and with very little warning. When planning a journey over the sea ice always make a note of suitable escape points onto land. A break-out will not always start at the ice edge and may begin with the ice breaking away from the shore. Carefully assess the situation before crossing over cracks or leads in the ice.

If you find yourself on the ice during a break-up it is important that you remain calm and consider all the possible options. If retreat the way you came from is not an option, then make your way to the nearest area of land. Do not take any unnecessary risks and avoid getting into the water at all costs.

If reaching land is not possible then all is not lost – the wind may cause the floe you are on to drift towards land. Aim to get onto the largest floe possible and better still a grounded iceberg. Contact your station as soon as it is safe to do so and report your location and the situation. Even if there are boats nearby the brash ice may prevent them from getting to your position. If you are caught in a break-out and manage to get to safety you could be trapped here for days, weeks or months! Ensure that you do not get separated from your emergency equipment.

> Warning: The above scenario of being caught in a break-out is seriously unpredictable and unpleasant. Do not allow yourself to get into this situation and carefully consider the ice and weather conditions prior to a journey on sea ice.

19.10.2 **Falling through the ice**

In the event of falling through an area of weak ice you must act quickly! Cold-water immersion can lead to death in a matter of minutes.

Upon falling through the ice get rid of anything that might obstruct getting out, skis, rucksacks etc. Aim to climb back out the way you fell in – if on weak ice it is likely to continue to be weak if you move forward. Ice daggers should be carried as standard by each person travelling on sea ice, get these into your hands, gain purchase on the ice and haul yourself out. Look out for a member of the party throwing a line to you.

If someone in the party falls through the ice and you are on the surface, ensure that you stay far enough away as to not end up in the water yourself! Get out a throw line, call out to the casualty and throw the rope towards them. Some improvisation may be required; for example if the casualty is unable to grip the rope due to cold hands a loop in the end of the rope may be necessary so that they can get the rope under their arms.

Once out of the water get the casualty into some form of shelter – normally a bothy bag. Remove all wet clothes and replace with dry ones from the emergency clothing bag. If casualty is showing signs of hypothermia remain inside the bothy bag and use body heat from the rest of the group to warm them and prevent further heat loss. If they are able to have a hot drink this will help. Report the incident to station via satellite phone or VHF immediately and prepare for a return to station or casualty evacuation.

Chapter 20 – Fuel

20.1 **Introduction**

Within BAS field operations several different fuels are used for specific purposes. A system of colour coding fuel types is in place to ensure there is no chance for the wrong fuel to be used for the wrong application. Using the incorrect fuel can lead to serious accidents and/or equipment damage. The colour coding system must be adhered to.

Note: There may be drums in the field existing in the system from external operators that do not fit this colour coding system. Ensure care is taken to document and record these anomalies to avoid accidents and/or equipment damage in the field.

20.2 **Uses and colour codes**

Fuel	Colour	Container(s)	Uses
Petrol	Red	205 Drums (black drums with red tops) 20 litre jerries	Snowmobiles Generators Snow blowers Capstan winch Multi-fuel stoves
50:1 Petrol mix	Red/Yellow	2 litre jerries	Chainsaws Older models of two-stroke snowmobile
Paraffin/Kerosene	Blue	205 Drums (black drums with blue top) 20 litre jerries 1 litre Sigg bottles	Vapalux lanterns Primus stoves Multi-fuel stoves Refleks stoves
AVTUR/Jet A1	White	205 Drums (black drums with white tops) 20 litre jerries	Aircraft Refleks stoves in some huts/ cabooses
Meths	Silver	5 litre plastic containers 1 litre Sigg bottles, Meths dispensers	Priming lanterns and stoves

20.3 **Emergency stove fuel**

Within the spares box of a field unit there is a multi-fuel stove. This stove should be primarily used with paraffin/kerosene fuel but in extreme situations where there is no other option it can safely run on petrol. Petrol is significantly more volatile than paraffin/kerosene and great care must be taken when cooking inside a tent using petrol. The multi-fuel stove can also be run on AVTUR/Jet A1 – see below for considerations.

> Note: Some models of multi-fuel stove require the fuel jet to be changed depending on what fuel you are burning. Ensure you are using the correct jet for optimum performance.

The main Primus stove should only be used with paraffin/kerosene and never be run on petrol, but in extreme situations aviation fuel (AVTUR/Jet A1) can be used. AVTUR/Jet A1 is the same fuel as paraffin/kerosene with additives to prevent icing within an aircraft's engine. These additives may give off harmful gases when burnt in a stove, which is why AVTUR is not used in stoves routinely. If using AVTUR in an emergency situation ensure there is very good ventilation in the tent and avoid running the stove for longer than necessary.

20.4 **Fuel consumption**

The following gives guidance on fuel consumption for planning purposes. In very cold conditions figures will be higher; e.g. during the winter. Always ensure you have extra fuel to allow for unforeseen circumstances.

20.4.1 **Petrol**

Snowmobiles

Snowmobile fuel consumption varies a huge amount depending on snow conditions, terrain and cargo on sledges. Figures also vary depending on the model of snowmobile being used.

The following is a guide but be conservative with estimates and continually reassess during a field season in order to pre-empt running out of fuel and inform the FOM early to allow a resupply to be carried out opportunistically if possible.

Snow-mobile model	Tank size (litres)	Km per litre (1 snow-mobile)	Km per tank
V800	42	3.9	163
Ace 600	45	4.6	207
Ace 900 (untested manufacturers figures)	45	9.2	414
Alpine 3 (will also require approx. 1 litre of two-stroke oil per tank of petrol)	40	2.6	104

Remember that the above figures are for one snowmobile, multiply the estimated distance by the number of snowmobiles being used for the journey and then multiply by the relevant kilometre-per-litre figure for the model of snowmobile being used.

Fuel calculations should be checked and re-checked multiple times before field deployment. It is a real skill to calculate fuel for travelling projects, especially where pre-placed fuel caches are to be used. It is always worth asking someone else to confirm your fuel calculations prior to deployment.

During the season, fuel usage should be continually monitored to ensure that you have enough for the remainder of the season. If it looks like you might fall short inform the FOM as soon as possible to discuss resupply.

Generators

If petrol generators are being used for powering equipment, additional fuel will need to be factored into the calculations. Depending on the equipment plugged into the generator the fuel usage may vary slightly, factor this into any calculations to ensure there is enough fuel available!

Generator	Tank size (litres)	Run time	Power output
Honda EU10i	2.1	3 hours 30 mins	900w
Honda EU20i	3.6	3 hours 50 mins	1,600w

20.4.2 **Paraffin/Kerosene**

For deep-field projects and winter use, work on the basis of using one litre per day in a two-person tent (or half a litre per person, per day). In warmer regions, such as Northern Peninsula and sub-Antarctic islands 0.6 litres per team of two is sufficient.

Caution: Always ensure that a minimum of one extra 20-litre jerry of paraffin/kerosene is taken per tent team of two people, for use in conjunction with the 21 days emergency food rations.

20.4.3 **Meths**

This will increase considerably during cold weather and lie-up periods. During lie up the stove tends to go on and off more as you 'brew up' throughout the day. Using flasks will help to reduce this although 'brewing up' can be a bit of a lie-up ritual.

A rough guide to meths use, based on 2 people, is:

- 1 to 1.5 litres per month (summer and winter)
- Approximately 1 litre per 20 litre jerry of paraffin

Stoves can be primed using paraffin/kerosene if for some reason meths is not available – be aware however that this will cause lots of horrible fumes and black smoke so if doing this in emergency situations ensure adequate ventilation. Another good tip for priming stoves if no meths is available is to use alcohol hand gel, this burns cleanly.

20.5 **Transporting fuel**

Fuel is most commonly transported in 205 litre drums, 20 litre jerry cans or flexible fuel bladders. When transporting fuel the most important consideration is that the container is up to the task and will not leak. A fuel spill is a big problem both environmentally and logistically. For more info on dealing with a fuel spill see Section 18.6.

20.5.1 **205 litre drums**

205 litre drums are useful for storing and transporting fuel. The major downside to them is their weight and resulting difficulties in moving them while full. 205 litre drums should always be moved by two people or by one person using a drum lifter tool. Many injuries have resulted from people trying to move these drums on their own or through trapping fingers when positioning drums next to each other – take great care when moving drums. Steel toecap boots must be worn while working with 205 litre drums.

For information on moving drums in a field depot see Chapter 23 – Field depots.

Transporting 205 litre drums can be a challenge. A plastic poly sledge is the best option available as drums can be rolled on and off relatively easily. Ensure care is taken when manoeuvring drums on plastic sledges as these are extremely slick. Ensure any bolts on the sledge are either removed or well-padded to avoid puncturing the drum. If part used make sure both caps are tight, and the seals are in good order.

Transferring fuel from a 205-litre drum to a machine or a smaller container can be done in a variety of ways. The most common methods are by using a pump with the drum in a vertical position or a drum tap with the drum in the horizontal position with a small 'V' dug to stabilise the drum and a pit dug for the container being filled. Geared pumps are extremely efficient for direct filling to a snowmobile or for decanting fuel into jerry cans. Drum taps are useful as they are small, lightweight, and reliable. For either method of decanting fuel a drum key will be required, there should always be a drum key and a drum tap in the spares box of a field unit. **136/137**

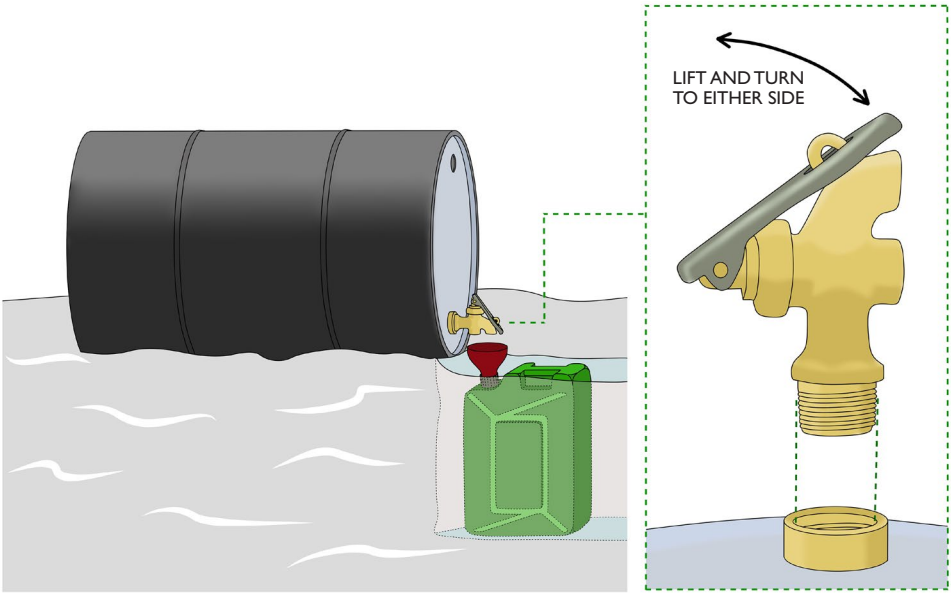


Figure 136 – Drum tap

20.5.2 **Jerry cans**

20 litre jerry cans are the standard way to transport fuel in the field. Jerry cans are reliable and user-friendly. Snowmobiles and other machinery can easily be filled by using a jerry can along with a funnel. Jerry cans must be serviced before field use to ensure the cap does not leak. Replacement seals can be fitted and these should be carried in the field.

Metal jerry cans sometimes end up with debris peeling off on the inside. Always use a filter funnel when filling machinery to avoid this debris ending up in the engine.

A siphon tube or pump is useful for filling smaller bottles from the jerry cans and is found in the field unit pots box.

20.5.3 **Fuel bladders**

Flexible fuel bladders enable a large quantity of fuel to be transported without the weight of numerous drums. This system is intended to be used on long snowmobile traverses and allows a small team to carry a much larger quantity of fuel than would be possible using drums and jerry cans.

Fuel bladders are surprisingly tough, however great care needs to be taken to ensure a shovel is not put through the bladder after snowfall or a storm, shovels should be checked for sharp edges and filed prior to use if necessary. Wide bladed plastic snow shovels are available, If a bladder is to be used it may be advisable to take this type for use with the bladder.

20.6 **Fuel spills**

A fuel spill in the field has many consequences in terms of logistics, but the other major concern is that of the environmental impact. When operating on snow a small spill of fuel will disappear through the snow-pack very quickly and there is very little that you can do. If however the spill is large – a leaking 205 litre drum for example – then you must act quickly to minimise the impact.

On projects with large-scale operations involving fuel, a dedicated fuel spill plan will be created – ensure

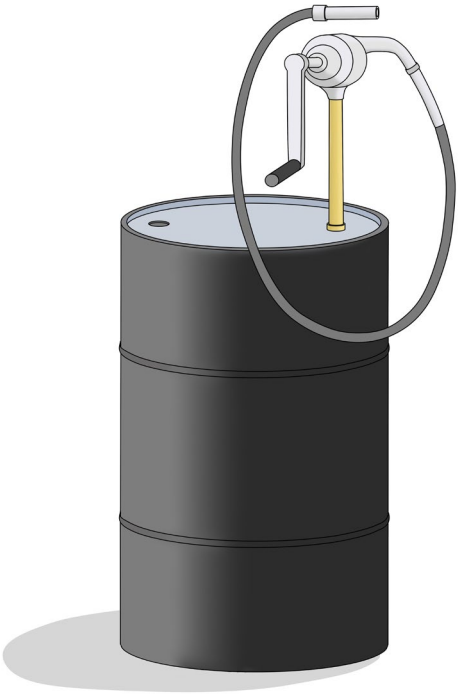


Figure 137 – Fuel pump

anyone involved with handling fuel is aware of these procedures and knows what to do if a spill is detected.

Field staff should undergo dedicated fuel spill response training prior to involvement on large-scale projects involving significant quantities of fuel, e.g. drilling projects or tractor traverses.

If the fuel spill kit has been used during a spill the transportation of materials soaked in fuel must be transported back in an appropriate container – discuss this with the FOM in the event of a fuel spill. The pilot must also be notified prior to transport by aircraft.

The bottom line with fuel in the field is to do everything possible to avoid a spill. In addition to this, detailed plans must be in place to deal with a spill should it occur. These plans will vary and will be specific to each project so must be thought about prior to field deployment. As a minimum, the following controls/mitigations should be in place.

- Inspect all fuel containers to ensure they are in good condition
- Take care when shovelling near fuel containers to prevent accidental damage
- Refuelling activities should make use of funnels
- Absorbents should be to hand to help mop up any small drips/spills
- Note: BAS policy is not to recover petrol with absorbents (petrol-soaked absorbents are a fire risk and cannot be flown). Spilt petrol should be allowed to evaporate

Note: Any fuel spill, large or small, should be recorded on the MAXIMO database or reported to the FOM if unable to access this system.

Chapter 21 – Emergency procedures

21.1 Introduction

An emergency in the field, even something relatively minor, is a major logistical operation. A more significant incident is therefore very serious. Despite the infrastructure available to BAS in the forms of expertise and equipment, the remoteness of field operations in the Polar Regions should not be underestimated. Every measure must be taken to operate with safety as the number one concern, however it is the nature of remote fieldwork that accidents can, and do happen. This chapter outlines the procedures for dealing with an emergency in the field.

21.2 What is an emergency?

For the purposes of this chapter any incident that cannot be dealt with by those in the field party and which has an element of time pressure attached is considered an emergency. This could be an injured party member or it could be a severely damaged camp due to sustained bad weather. It could also be something along the lines of a shortage of food or a missing person.

If in doubt as to whether an incident is an emergency, treat it as such. When working in remote locations, outside help may take hours or even days to reach you. Informing the controlling station of an incident early on allows steps to be put in place to speed up a response should it be needed.

21.3 Effective response to an emergency

Responding to an emergency in an effective manner is vital to successfully resolving the situation. As with any emergency a structured response is required. Strong leadership is vital and in most cases this should come from the Field Guide in the party – it may be the Field Guide that is injured though so all party members should be familiar with the information in this chapter.

Division of tasks is important if there are the numbers within the group. Anyone given a specific task must report back to the person in charge so that someone has an overall view of developments.

21.3.1 Priorities in a field emergency

The following list is intended as a guide to tasks that need to be carried out in a field emergency. The list is not exhaustive and in some cases not all tasks will be necessary. Many of the tasks below can be carried out simultaneously if numbers allow but ensure one person coordinates proceedings, rather than everyone self allocating a task and getting stuck in.

- Ensure no-one else becomes a casualty, the safety of rescuers is paramount during an incident
- Stabilise the situation and prevent it from becoming any worse
- Provide first-aid
- Erect shelter
- Communicate nature of incident to controlling station

21.4 Emergency communication protocol

In the event of an emergency in the field you must make contact with the controlling station (that is the station or ship you were deployed from and communicate with at your daily sched).

The most efficient means of communication in the event of an emergency is to use the Iridium satellite phone. Emergency numbers must be checked prior to field deployment to ensure they are up-to-date.

If after trying the controlling station there is no response try calling another station. Control will be returned to the controlling station as soon as possible. Ensure all team members have the knowledge and ability to contact the controlling station at all times of day should the need arise in an emergency.

21.5 Contact outside BAS

It is important that in the event of an emergency information is not passed to 'the outside world' until it has been communicated to the controlling station and has then been authorised by the Head of Field Operations or the FOM. With the increase of technology in the field it is important the correct lines of communication are adhered to. This is partly due to legal issues but also to consider the knock-on effect of undue stress with concerned next-of-kins or the media contacting BAS while an emergency response

is underway. Lines of communication can become blocked resulting in complications and delays.

21.6 **Legal implications**

In the case of serious injury or death there will be legal implications. It is vital that the reporting and recording of events, witness statements and any failed equipment are kept for BAS internal reports. Photographic or video evidence is important.

Chapter 22 – Search and rescue

22.1 **Introduction**

This chapter looks at the processes and techniques used for search and rescue operations. As with most remote field operations every situation is different, and an element of improvisation is usually required. The information in this chapter is in addition to the SAR manual which provides a far more comprehensive look at SAR capabilities and procedures within BAS. Those involved in SAR operations require extensive knowledge, experience and ongoing training. For more information speak to the FOM.

The environment in which BAS operates is extremely harsh and remote – SAR capabilities are limited when compared to other areas in the world and response times are increased significantly. Always bear this in mind and do everything possible to avoid unnecessary risks in the field.

> Note: During winter SAR capabilities are limited even further with the absence of aircraft and limited staff on station

22.2 **Procedure**

In the event of a SAR incident the following procedures should be followed. A useful acronym throughout is LAST – Locate, Access, Stabilise, and Transport. Of course there are varying degrees of SAR incident, ranging from simple solutions where injury is avoided to more complex scenarios where someone is missing and injured. The exact procedure will vary depending on the specific nature and location of the incident.

Specific SAR response procedures exist at each station, these should be read for those involved with SAR operations.

22.2.1 **Reporting an incident**

If you are involved directly in an incident while in the field you must first act based on the information in Chapter 21 – Emergency procedures. The incident should be reported to the controlling station as soon as possible, while not conflicting with 'the priorities in a field emergency'. With the increase in communications while deployed it is important the correct lines of communications are followed and kept in mind during an incident.

If you discover a potential emergency/SAR incident remotely, i.e. noticing that a party has not signed back into station at the end of a local field trip or you receive a call from someone in a party then you must inform the station management immediately.

22.2.2 **Fast response team**

With most field SAR incidents a fast response team must get to the incident as soon as possible. Their job is to control the situation as best they can and report back to station on the necessary equipment, personnel and expertise to fully resolve the situation. During the period between arriving on scene and waiting for the main response team to arrive, the fast response team should attempt to stabilise the situation – in the case of an injured person this will include basic life-saving first aid and protecting the casualty from the environment. The fast response team should always ensure they take a large group shelter and some additional warm clothing to protect the casualty.

A member of the fast response team will become the site controller for the duration of the rescue. Their job will often involve standing back once the main response arrives and co-ordinating the search/rescue.

A fast response team will often consist of two or three personnel. The skill set of the fast response team will depend on what is known with regards to the nature of the incident. The fast respond team should always include at least one Field Guide. A doctor would be the other logical member of a fast response team. It is therefore important that all station doctors receive comprehensive field and SAR training early on in their deployment to a station.

With the distances involved in a deep field SAR scenario it may be that the fast response team is also the main response, read on for details of the main response.

Two suitably-trained people will be nominated on SAR duty at all times on a station. These people must be contactable 24/7 and be ready to deploy as a fast response team should an incident occur.

22.2.3 **Main response**

The main response team's role is to come to the scene with the specific equipment and resources

as identified by the fast response team. The main response team will have an appointed leader who will first liaise with the incident controller from the fast response team to discuss a plan. This plan will then be communicated to all involved and tasks delegated out.

Within the main response the following roles are required:

- *Team Leader* – liaise with incident controller and coordinate main response team, while ultimately taking direction from the incident coordinator
- *Communications* – report back to base with status updates and provide them with the necessary information to plan ahead for arrival of casualties etc.
- *Event recording* – if numbers allow it is a good idea to delegate someone the task of noting down key events during the SAR operation. In a small group the person responsible for comms may also be able to do this
- *Runners* – to collect equipment as required and bring it to the site
- *Medical* – to provide first aid and prepare casualties for evacuation (if a doctor is on site they will lead this group)

22.3 **SAR team**

The SAR team will be made up of Field Guides plus suitably trained SAR assistants. On stations with no Field Guides, SAR will be the responsibility of the Station Leader who will appoint specific personnel to certain roles.

> Warning: The safety of the rescuers is the number one priority during a SAR incident. No-one should put themselves in a position where they are at risk of also becoming a casualty.

In reality a SAR operation in the field, even if locally to a station, is a major undertaking and one that will require lots of people to get involved. Tasks such as transporting a casualty on a stretcher, are strenuous and require five people, plus at least another five to swap round as necessary.

Doctors usually play a prominent role in a SAR situation, as often an incident will involve one or more injured persons. The nature of the incident and the number of doctors available will determine whether a doctor goes to the scene or remains at the station to prepare for a casualty arriving.

22.4 **Search techniques**

The following section covers search techniques used in the case of a rescue party trying to locate a missing person(s). For information on personal relocation techniques please see Chapter 5.

22.4.1 **Reconnaissance**

This type of search covers a large area and attempts to reduce the likely location on the missing person(s) to a manageable area. This would involve covering the intended travel route of the missing party and likely alternatives. This phase of a search may be conducted from the air or the ground.

22.4.2 **General search**

This search will consist of multiple small search teams of one or two people investigating the main features in the area identified from the reconnaissance search as being the likely location of the missing person(s).

22.4.3 **Sweep search**

This technique will only be used in a relatively small area that has been identified as highly likely to contain the missing person(s). A formation line of people is formed with each person maintaining visual contact with the searcher next to them. This method is slow and should only be used when there is a reasonable chance of success.

22.4.4 **Rope search**

The rope search is an incredibly useful method of searching a small area in the immediate vicinity of a tent, hut or building. It is a very safe technique for the rescuers, as providing the rope has been anchored securely, it is always possible to return to safety.

The technique itself is fairly self-explanatory – see diagram below. Ropes should always be available in the field. A rescue sack should be kept on the tent valance when at camp. **138**

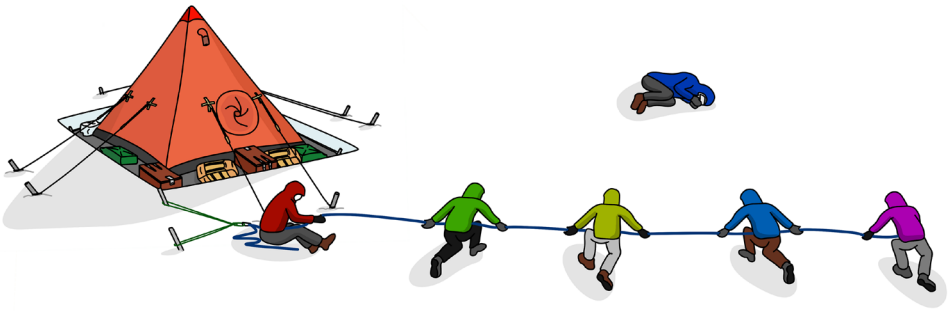


Figure 138 – Rope search

22.5 **Casualty packaging**

When extricating an injured and immobile person it is important that you wrap the casualty up correctly. An injured person will lose heat rapidly, especially once secured to a stretcher and unable to move. Casualty blankets should be used whenever moving a casualty even on a calm and sunny day. Hypothermia is much more likely to set in if someone is suffering from shock. Heat packs for warming casualties are available in fast response bags if needed.

It is also very important that a casualty is as comfortable as possible when secured to a stretcher. Straps securing the casualty must be snug but not so tight that breathing becomes challenging – always ask a casualty to take a deep breath in before tightening straps.

Once packaged up, one person must be assigned to monitoring a casualty. This is easy if the casualty is conscious as they can maintain dialogue. If the casualty is unconscious this person must keep a much closer watch and monitor any changes. If a doctor is on scene they are the best person for this role.

22.6 **Stretcher rescues**

As previously mentioned the specifics of a SAR operation can vary hugely. Almost all SAR callouts involving an injured person will require the use of a stretcher. A variety of different models of stretcher are available and each have different pros and cons. Ensure the most appropriate stretcher is used for the situation.

Caution: When extricating a casualty from a scene using a stretcher there must always be a minimum of two safeguards in place; i.e. if a stretcher is being carried/dragged up or down a steep slope by a team of people this is one safeguard, a rope fixed to a belay must also be used as a back up. If raising or lowering a stretcher using a rope as the primary safeguard then an additional rope must be secured to the stretcher as a back up.

22.7 **Loading an aircraft for a SAR operation**

An incident in the deep field may require a SAR team to be flown to the location with the necessary equipment to survive in the field themselves and the kit needed to resolve the incident. A system has been devised that allows a modified field unit to be loaded into one Twin Otter aircraft. The system requires a set procedure for loading to be followed otherwise the kit will not all fit in! This process should be practiced in a controlled situation as part of annual training for new Field Guides and Air Unit personnel.

22.8 **SAR equipment**

The exact equipment available for search and rescue operations varies from station to station. SAR equipment must be routinely checked throughout a season and after every use. SAR equipment should not be used for anything other than a SAR situation or training. Ensure that you are familiar with the technical and medical equipment available at your station.

Chapter 23 – Field depots

23.1 **Introduction**

Equipment and fuel are often left in the deep field if another party is planning on visiting the same area in a subsequent season. The cost of flying equipment back and forward is huge, so where possible and beneficial, equipment will be depoted. Fuel-only depots for aircraft are also strategically placed throughout BAS's operational area allowing aircraft to access fuel more efficiently on the continent. The challenges come from snow accumulation, high winds and active glacial areas where over the course of a year the geographical position of the depot will alter. These challenges vary from site to site and therefore exits within the system. Depots are ideally in a safe area that can be easily accessed by air or snowmobile depending on the purpose of the depot. Additionally, choose a location that will have minimal snow accumulation and light winds if possible.

This chapter will provide advice on the basic layout of various depots and how to efficiently and successfully input, raise and record them. Larger depots do exist but are not described here as they are specialist and only used in certain scenarios. e.g. tractor traverse depots.

The most important rule when raising depots, handling fuel, or moving heavy objects is to look after the physical health of yourself and the team. Depot work is extremely physical, and staff are urged to work within their means and not rush the task at hand. Fingers, toes and backs are particularly vulnerable to injury when working with drums or heavy objects, ensure care is taken when handling.

When inputting or raising a depot, it is best to always work under the proviso that it will be yourself digging it back up. Therefore, be as logical as possible. The devil is in the details; one small oversight could mean the difference between digging up exactly what you need or digging up the entire depot to find it!

Only equipment confirmed on the environmental assessment should be left in the field. If equipment has been lost or is irretrievable, a GPS waypoint of the location should be made and a MAXIMO report submitted on return to station. The Environment Office must also be informed through the Head of Field Operations.

23.2 **Depot types**

23.2.1 **Fuel depots**

Layout

Aircraft or fuel depots are the main type visited by staff in the field. They are built up of anywhere between 3 – 100+ drums of fuel. Laid out in a triangle if there are only three drums, or in a rectangular grid pattern if there a more. Drums should be laid out with minimal gaps between them to reduce how much snow will get in between and should be positioned as per the diagram below. Snowmobiles at one end that can be driven out work well.

Depots are always orientated pointing into the wind and should be orientated to minimise drifting snow. The width depends on the situation - common layouts are 2x3, 3x5, 4x8, 5x6 etc. It is possible to have a depot wider than 5 drums depending on the scenario and whether it needs to be accessed by aircraft for fuelling or not, whatever the situation, the short edge of the depot should always be pointing into the wind. **139**

Drums are usually staggered in rows, and it is common practice to stand the drums upright – However in certain circumstances drums are laid on their side. Dunnage (old lengths of wood) is used under the drums to prevent them melting out and falling over. This should be laid down strategically so one length spans two rows of drums to maximize usage (See Figure 143).

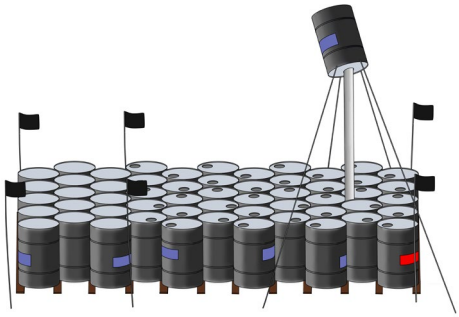


Figure 139 – Laying out fuel drums in a depot

Markers

From the air, depots can be very hard to spot once covered with snow. A large wooden post with an empty up-turned fuel drum on top makes a 'depot marker' that the aircraft radar can often detect. Markers such as this must be well secured with guy lines and snow anchors and are required for all depots left in the field. They should be placed at the downwind end of the depot, around one or two rows in. Spare dunnage and other small items should be tied to the top of the depot close to the depot marker as snow will naturally drift to the height of the highest object so having higher objects on the downwind end of a depot makes sense. This may be irrelevant though in areas with significant snowfall.

All additional items should be clearly marked on the depot plan to aid efficiency of future visits. Fuel should then be taken from the upwind end of the depot first meaning that it will 'shrink' backwards towards the marker as fuel is used.

Using fuel

Once drums have been used by an aircraft, they are either carried back to station or, if this is impractical, turned upside-down and left at the depot. A note should be made of how many drums were used and where in the depot the split of empties/full drums now lies. If empty drums are being left at a depot, they should be tied to neighbouring drums to ensure they remain in place.

23.2.2 **Field depots**

Field Kit may also be left in the field if a project intends on returning to the same site the following year.

First, only leave items that are in a usable condition. Tents and sledges that require significant maintenance should be returned to station. Ideally field kit that is being depoted should be left fully lashed up on a sledge with all the boxes etc included. Small items must be put into suitable boxes (empty food boxes are useful) and everything should be labelled with its contents. Light items or items likely to be blown away must be secured. Any larger items such as fuel, science cargo etc can be depoted individually in a separate line.

Some items such as P-Bags are needed on aircraft as safety kit so these will return to station with you, along with comms kit, CO Monitors etc, and any broken or damaged kit requiring an overwinter service.

Snowmobiles can then be depoted separately, care should be taken to ensure items are left in a line facing into the wind to reduce the chance they drift one another in. Food and fuel can be left but ensure the food will still be in date at the time of the next planned visit to the site and never store food underneath fuel in case of a leak! Discuss all items to be left at a depot with the FOM in advance.

Layout

There is lots of variation with field depots due to the varied nature of deep field projects and their kit requirements. However, there are two schools of thought and some basic ideas that will help make organising and recovering them considerably easier. Both layout options have their benefits and drawbacks. Field kit should either be laid out with multiple items in a line including ski-doos, sledges, drums etc, or organised with everything packed tightly together with minimal gaps between items in a way that minimises the drifting and snow accumulation. Whatever the layout decided they should always be neat, logical, and organised with flags in all four corners. The flags should be at the widest and longest points meaning digging can be more accurate (See Section 23.3.2 – Flagging later in this chapter). **140/141**

Recovery

Upon return to a field depot, it is useful to get any snowmobiles up and running first to aid with the recovery of the remaining kit, this however is not always possible. Once any snowmobiles have been dug out, sledges can also be dug around, cracked free of ice, and driven out. When the sledges have been driven around a small distance the remaining snow should shed, this option means items of field kit do not have to be dug out individually.

This means whatever is being left should be put on 'wheels' where possible if a snowmobile is available, along with being orientated to be easily driven out. This will greatly reduce the time and effort required to raise the depot on the next visit. It is also beneficial to ensure items are tight together to reduce the amount of snow that needs to be moved. Alternatively ensure there is a shovels width of space between larger items to facilitate easier digging once items are buried.

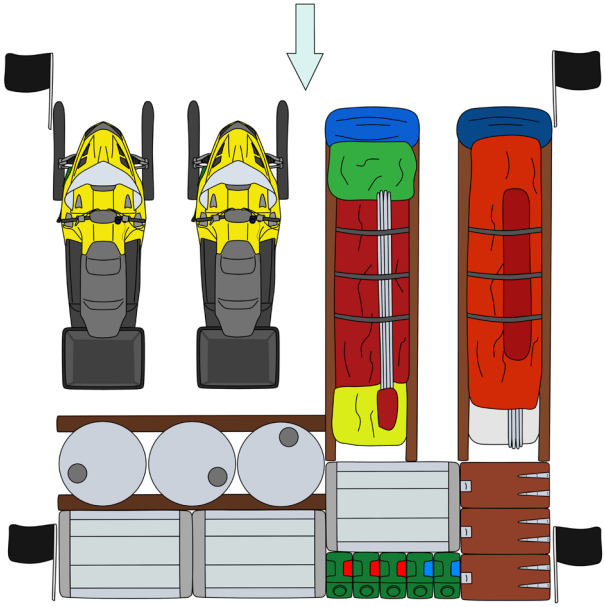


Figure 140 – Field depot line layout

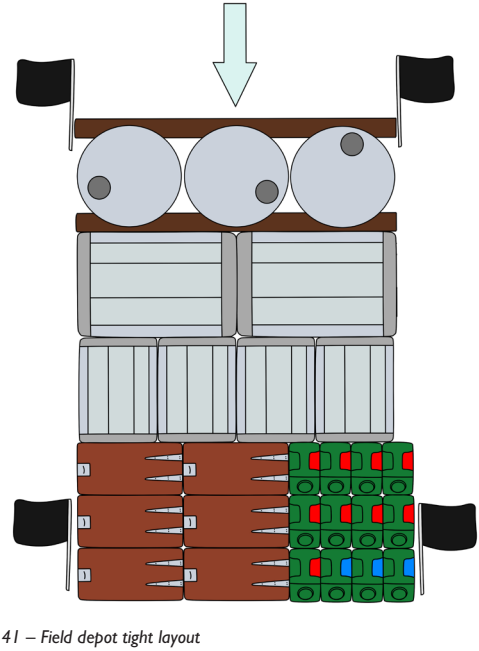


Figure 141 – Field depot tight layout

Note: For larger depots with kit on berms or sites which contain multiple depots, the orientation of items within the depot (e.g. ski-doos and sledges) should be recorded along with the orientation of the depot itself. Try to record as much fine detail about these sites as possible

23.3 **Raising a depot**

When it comes to raising a buried depot there are a few tips that can make the job easier. Try to avoid digging more snow than is necessary and ensure the correct tools are taken if tasked to raise a depot.

Raising drums

The most efficient way to raise a fuel depot is to use a ski-doo and drum chains with a shallow ramp at one side of the depot. Time spent digging a ramp is very rarely time wasted. Ensure the floor of the pit and the ramp are as flat as possible to make it as easy as possible for the drums to move, this is made even better if there is spare dunnage to create a firm surface to roll the drums on. Drag the drums one at a time up the ramp and over to the new depot. If possible, an efficient system can be created where the ski-doo does loops between the new and old depots picking up and dropping off drums. **142**

Caution: Although tempting, pulling drums out from inside a 'cave' to avoid excess digging should always be avoided due to the risk of the roof collapsing.

If a snowmobile is not available, then a capstan winch can be set up at the top of the ramp and used to haul the drums up (see Chapter 17, Section 17.5.2 for information on operating a capstan winch). Drum chains can be used in conjunction with the capstan winch or alternatively a strop around the middle of the drum will work. If no snowmobile or capstan

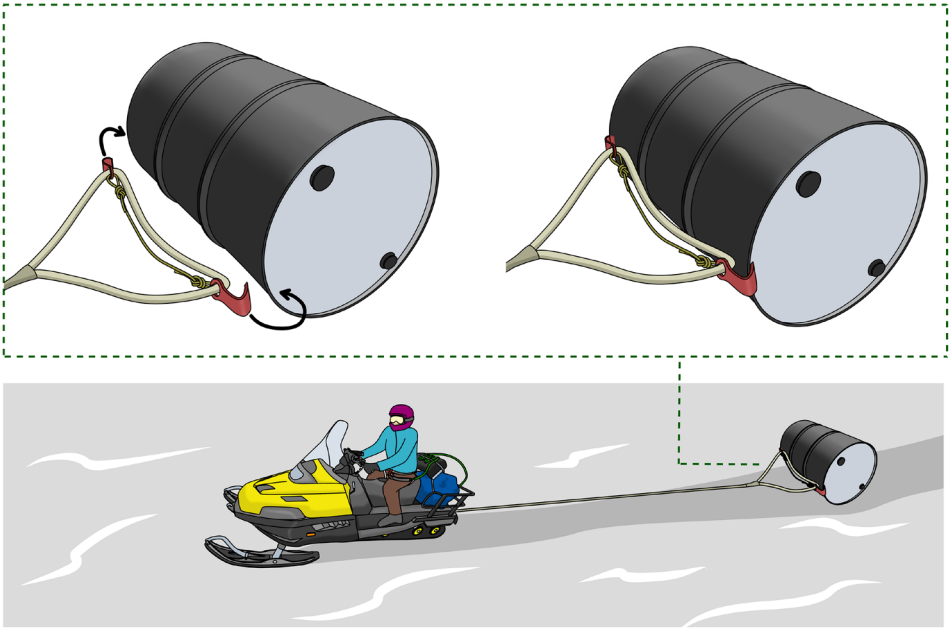


Figure 142 – How to use drum chains

winch is available, then a wide strop can be used to haul the drums up a shallow slope. Create a 2:1 system with the strop by fixing one end at the top of the ramp with a snow anchor, loop the strop around the middle of the drum and pull on the free end from the top of the slope. This technique is useful, but care needs to be taken, as it is strenuous!

> Caution: Handling 205 litre drums requires care; they are extremely heavy and have been the cause of numerous injuries to fingers and toes. Always wear appropriate footwear with toe protection and avoid lifting drums on your own.

Location

The new location of a depot needs careful consideration. They should never be placed downwind of the old depot to avoid localised drifting effects from the piles created during digging. Depots are usually moved upwind of the previous pit, meaning the new depot drifts in the old pit.

Thought as to who will be visiting the depot in the future is important. Will it be aircraft? Is there a possibility of a visit by the Tractor Traverse? In both scenarios a well flagged depot with plenty of space surrounding it is beneficial.

Depots are very rarely move sideways in relation to the wind, but if this is the only choice give plenty of room for aircraft. Fuelling will always happen from the left side of the aircraft with the nose facing into the wind as standard, so ensure there is space for this (See Chapter 17 – Aircraft Operations for more information). Pits that have been created after digging up a depot and/or re-siting it need to be clearly marked on the depot plan and with red flags on the ground to indicate the hazard. This is essential if aircraft are going to be operating in the vicinity.

When re-siting a depot of fuel drums ensure that you dig up the wooden planks (known as dunnage) from underneath the drums, if any lengths are unretrievable then a note should be made of the location and quantity to pass on to the Head of Field Operations and Environment Office. The drums should be placed back on the wood to stop them melting into the snow and tipping over. This is done in rows perpendicular to the wind. If done correctly, one length of dunnage can span two rows of drums. Dunnage can also help to stand drums upright and slide them around as this is much easier to do on a firm surface. **143**

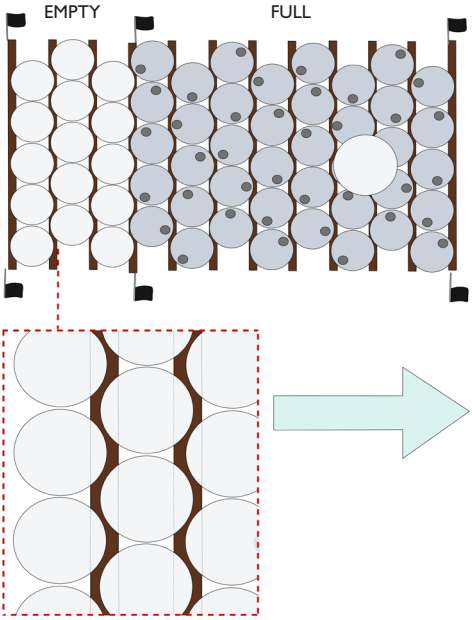


Figure 143 – Drums and dunnage layout in a depot

23.3.1 **Raising – Task list**

Below is step-by-step task list for a depot raise, this list is not exhaustive and should only be used as a sense check while on the ground or as a reference to those that are new to the task. If more information is required speak to an experienced member of the field team or the FOM.

1. Prioritise team safety on arrival – check for localised hazards such as crevassing.
2. Decide on a location for camp if this is the intention – ideally 200m away from the depot and perpendicular to the wind.
3. Input a skiway if needed – sometimes depots will be restocked by aircraft at the same time as being raised by a digging team.
4. Identify a location for the new depot – upwind of the old depot and positioned so that visiting

aircraft do not have to move around the old pit to refuel (remember – Twin Otters refuel on the left).

5. Pass skiway, camp and new depot GPS locations to Rothera – this helps inbound aircraft land safely.
6. Identify outside 'boundaries' of the buried depot – use avalanche probes/bog chisels and mark the layout in the snow using flags.
7. Identify the prevailing wind direction and consider digging the ramp on this side of the depot so it doesn't bury if there is a storm.
8. Dig the shallow ramp always being aware of the physical exertion required – stop regularly to rehydrate and eat.
9. Crack drums out from any ice – care should be taken to not puncture drums.
10. Use dunnage if possible, to create a firm surface on which to move the drums.
11. Use whatever tools you have to move the drums up the ramp – this could be a snowmobile with drum chains, a winch of some sort, or just by hand.
12. Avoid creating a 'cave' which could collapse on top of you – this requires more work but is much safer.
13. Stand the drums on dunnage, close together and in a rectangular formation as described earlier in this chapter – be mindful of trapping fingers between drums when stacking.
14. Place the drum marker at the 'leeward end' of the depot and secure well.
15. Depot any additional equipment such as sledge rations or Kero jerries at the leeward end of the depot.
16. Fill in the old pit as best you can – this is a tiring job but reduces the hazard to aircraft significantly.
17. Mark the old pit with red flags.
18. Mark the new depot with black flags.
19. Remove any other hazards that remain – Old bamboos, glacio poles etc.
20. Spend time recording the depot information – take lots of photos, draw diagrams. There is no such thing as too much detail!

Note: Should any drums be punctured, the spill should be quickly controlled. For more information refer to Chapter 20, Section 20.6 – Fuel spills.

23.3.2 **Flagging**

On first glance flagging is a simple task. However, the fine details are important to ensure the depot operates efficiently.

Flagging depots accurately is crucial in locating drums. Depot markers are useful for finding the depot from the air, but when it comes to digging individual drums the layout of flags is essential. All items left in the field should be flagged accurately, black flags for items and markers and red flags for hazards. Flags should be as tight as possible into the objects they are marking. However, if the object is not straight then it should be flagged to the width of the widest points. This ensures that should a machine need to dig up the contents there is a clean line that can be followed without doubt that anything will be hit by the blade or bucket.

Flags should be placed at one per corner to create a rectangle as described. Depending on the size more flags may be needed down the sides of the depot. These subsequent flags should be placed at key points, for example – the split between empty and full drums and/or the split between Avtur and Petrol drums. Flags in these key points with a detailed depot plan make the depot easy to navigate and efficient to use.

When recording, accuracy is important, if only one flag remains, the nearest drum is found. Using its type, contents etc along with the depot plan the orientation and location of the remaining drums can be determined.

Caution: Any remaining flags that are not necessary for marking items should be removed as these become hazardous to aircraft on return trips. If flags are frozen in place they should be cut flush with the surface to remove.

23.4 **Recording**

23.4.1 **Depot plans**

Depots of equipment and fuel left in the field must be clearly marked with a GPS position and flags. The start of a good depot is an organised layout on the ground. Depot plans then provide a way of recording and noting down all the information that is important. This information covers everything from the depot location to the depot's exact layout on the ground and includes all the minute details to ensure no information is forgotten. No matter what is left, lots of notes and photographs should be taken. Once a field depot has been created or an old depot raised the depot plan should be updated with the correct information. The following section will give a brief overview of some of the things to be mindful about.

A good way to approach gathering information for a depot plan is to think what information you would want to know if you had to visit the site in the future, taking notes should be an ongoing process and should start from the beginning of the season/visit – it is the key to a good depot!

23.4.2 **Fuel depots**

Avtur or Jet-A1 is the primary fuel stored at depots in the Antarctic and is commonly stored in Black drums. Petrol and Kerosene is also used for various tasks, and these are found in red (petrol) and blue (kero) drums. However, there are occasionally drums in the system that do not match this colour convention laid out by BAS (see Chapter 20 – Fuel for more information).

In the case of oddly coloured drums, these should be clearly marked on the depot plan with their contents, colour, and location within the depot. This will become especially important if there is a mix of fuels within the same depot. Other types of fuel such as petrol or kero should be placed at the downwind edge of the depot, close to the marker and these should also be marked clearly on the depot plan, ensuring there is a detailed record of location, type, age, and colour of all the drums. **144**

When preparing to create a fuel depot plan, all details should be recorded. This information will be used to create an up-to-date depot plan or PIM sheet once back on station. It is usually the pilot's responsibility for recording this information when using drums to refuel aircraft from depots. The Field Guide may also take the lead with this if tasked with raising a depot independently and no pilots are present. This information is kept for planning and logistic purposes, so it is important that it is correct and up-to-date. Some information can also be added once back on station such as when it was last visited, and the speed of movement (see example depot plan on next page).

Useful notes taken in the field should include:

- GPS location
- Location and distances to old pit
- Location of flags
- Depot marker
- Snow height on drums
- Quantity of full drums and empties
- Wind direction
- Colour and contents of drums
- Any extra kit
- Spare dunnage
- Any Present wind tails or other hazards
- Skiway location, surface, and snow conditions
- Any relevant photos that can be used as reference

23.4.3 **Field depots**

Field depots will be solely the responsibility of the Field Guide to record. As with all field kit, comprehensive and detailed lists of items are the key to being organised. Photos are a useful tool in allowing others to orientate themselves with kit before they are on the ground. Photos can be taken of the depot itself and of contents of boxes or bags laid out on the ground prior to being stored. It can be especially useful to photograph any damage as this will be useful when it comes to pack repair items the following season. Science cargo being depoted in the field should also be well documented, ideally in an Excel file or similar, as an itemised list with unique identifiers to each item such as BOL numbers or numbered Zarges.

Basic depot information should include GPS location, Wind direction, Distances, Speed of movement (this can be done retrospectively), skiway surface and any present hazards.

Castle

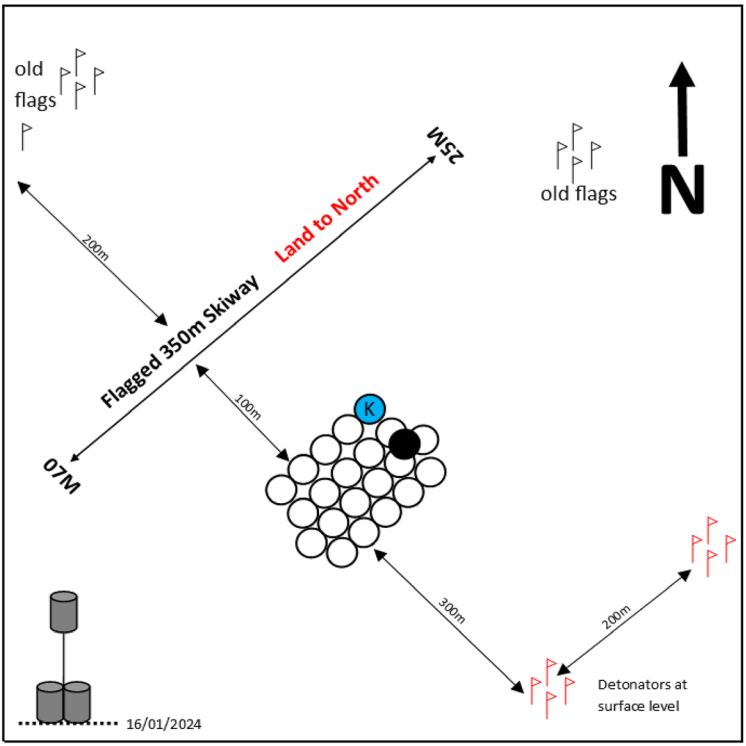
CASTL

Last Visit: 16/01/2024 DL

S76 54.998 **W088 03.286** **3781 ft**

Avtur Drums: 20 Petrol Drum: 0 **Last Raised:** 16/01/2024

Kero Drum: 1 **Empty Drums:** 0



Hazards: OLD Flags
Detonator depots
Old traverse berms now buried

Skiway: flagged skiway to the north, flagged, 250 mag /350m.
Land north of the flags, flags are half buried.

Notes: 2 depots; Avtur and Dentonators.
On top of Avtur Depot:
8 lengths og dunnage
4 Jerrys of Petrol
3 Jerry of Kero

Figure 144 – Sample field depot plan

Speak with the FOM to confirm what kit can stay at the depot and what should be returned to station, make sure this is done in plenty of time before an uplift. Depending on the kit being depoted the following may vary. Below are some potential considerations for a full unit and useful information that should be collected. It is advisable to look at old depot plans prior to deployment for further knowledge if you know kit is planned to be left at the end of the season. The following is by no means exhaustive but may prove a good starting point when in the field.

Ski-doos

- Ski-doo numbers
- What items were left under the seat?
- Was there a GPS mount left on it. What type?
- How much fuel was left in it? Photograph?
- Mileage
- Any issues?

Full/half unit

- Are the units serviceable?
- Is anything broken or missing?
- What needs to be flown it to ensure the unit is 'complete' create a list for the report?
- Are boxes with missing items labelled?
- How much fuel is in the jerries, are any empty and where are they located?
- Are there any small items in empty unit boxes, are these labelled?
- Are rescue sacks complete or missing items?
- Are the linklines complete? Do they need to be replaced?

Science cargo

- Are BOL numbers recorded?
- Are all items identifiable and labelled with unique labels?
- Are there any hazardous items?
- Is there a comprehensive list of what science cargo is being left?

Chapter 24 – Reports

24.1 Introduction

The Field Guide responsible for a project must write a field report at the end of the season. Field reports provide invaluable information that inform future field operations both generally and operations specific to an area.

All field reports must be submitted to the Head of Field Operations and the FOM once a project is completed. They are collated at the end of the season, recommendations extracted and then submitted to the BAS archive and Ops GIS system.

It is important to keep a brief diary or make notes each day during a field season to help with the report writing. This chapter will help by giving guidance as to the information and required structure for a field report.

24.2 The purpose of field reports

The purpose of a field report is to record information that could be useful for future projects. In addition it is a means by which suggestions for improvements can be made. The field report should cover areas relevant to the planning and logistics of a field project and in particular any information regarding safety and travel. The intended end reader of a field report is another Field Guide but the information is often used at higher strategic levels when planning future field seasons.

Note: Field reports may be the only source of information about a previously unvisited area and are used to make significant planning assumptions about future operations. It is important that as much useful information is available to help future field parties.

24.3 Summer and winter station reports

Reports are written for each station on behalf of the field department at the end of each Summer and Winter season as a roundup of all events taken place on station during the respective periods. A template exists for both reports for the lead Field guide to complete at the end of the season, they should however liaise with the wider Field team to include all opinions and suggestions.

Topics included in these reports could be special taskings, conditions report on technical areas, sea ice conditions, SAR events and trainings, any recreational trips, kit preparation and repair, procurement needs or issues and any feedback for the Field Management team.

These reports are useful to convey information that may otherwise get lost during a busy season or not included in field reports and is key to the smooth running of operations on station.

Note: Field reports may be the only source of information about a previously unvisited area and are used to make significant planning assumptions about future operations. It is important that as much useful information is available to help future field parties.

24.4 Other reports

Field sites such as Sky Blu and Fossil Bluff require an open up and close down report each season, this allows information to be passed on season to season. Winter trips also require reports to be written. Each trip requires its own report, and these should be written in a similar style to those described in the field reports section below.

24.5 What to include in a field report

The following section indicates information that is required in a field report. The field report should be factual, but some opinions and suggestions can be useful. Before writing a field report have a look at some past reports saved on the networked system, there is a wide and varied range of projects undertaken in the field by BAS all of which will have a report. The following are suggestions to include, not all will be relevant but are worth thinking about.

24.5.1 Introductory paragraph

A brief few sections at the start of the report to outline the project title, start and end dates, all locations used (Lat & Long) and names of Field guide/s and Science staff.

24.5.2 **Project aims**

This can potentially cover a wide and varying array of topics but serves as a brief introduction to the season's goals and objectives. Depending on the project type, this could be operational aims or include information on the planned scientific work being undertaken during the project.

24.5.3 **Input and uplift**

To include detailed information on all PAX and cargo. How many Twin Otter rotations required, and any issues encountered. It may be necessary to include individual input and uplift sections depending on project requirements and size.

24.5.4 **Diary of events**

A day-by-day chronology of events throughout the project from input to uplift. Include all lie up days, workdays and travel days. Include relevant information for each such as distance travelled, wind speeds etc.

24.5.5 **Statistics**

Statistics help to refine standard consumption rates and provide a useful tool for planning future projects in a similar area.

Summary and weather

1. Days in field, and PAX numbers.
2. Lie up days.
3. Days winds over 30 knots.

Travel

1. Ski-doo information:
   - Ski-doo numbers
   - Ski-doo models
   - Starting mileage
   - Any mechanical issues and spares fitted in the field
2. Total ski-doo mileage.
3. Total ski-doo fuel consumption – recorded as km per litre for one snowmobile.

Equipment

1. Sledge numbers and mileage.
2. Tent numbers, total days tent usage, number of days tent exposed to >30 knots.
3. Number of field ration boxes used.
4. Kero/LPG and meths used.
5. Human waste drums used.
6. Generator type, hours, fuel use.

24.5.6 **Weather and hazards**

Weather can contain any observations that may be useful for future operations along with any weather station data if they were deployed in the area.

- Local weather conditions and phenomena; i.e., persistent low cloud, fog at certain times of day, katabatic winds, etc.
- Instruments etc. including location
- Hazards, areas of crevassing, hazards to aircraft (glacio poles etc).
- Surface conditions

24.5.7 **Routes**

The travel section can be one of the most important parts of a field report and should include the following:

- Useful routes, passes etc.
- Include a map of the work area, either a scan of paper maps or a print from Mapsource, QGIS etc.
- GPS waypoints and routes should be tidied up and saved as a GPX file: this should include:
  - Camp locations
  - Ski-ways – Including magnetic orientation and centre lat/long positions
  - Depots left in the field
  - Tracks
  - Locations

Projects operating on snow-free ground should record GPS tracks of snow-free ground covered or indicate this on a map.

24.5.8 **Tactics and equipment**

This section can be used to record what equipment was used and how it performed. Include detailed information on snowmobiles, sledges, tents, clothing, cooking equipment, communications gear etc. Ensure all field repairs are noted. If you have nothing relevant to note regarding a particular piece of equipment, then there is no need to record it. It may be useful to report findings on HF frequencies used and any known drop out times for satellites phones/GPS.

24.5.9 **Learning points and problems**

Any problems encountered and descriptions of actions taken or particularly successful tactics (i.e. travel at night when surfaces were better) along with other recommendations and hints for future visits to the areas should be recorded.

24.5.10 **Equipment depoted in the field**

If any equipment is to be depoted in the field at the end of the project this must only be done with the agreement of the FOM. A detailed inventory of equipment left must be made, including equipment numbers and any deficiencies. The next time someone visits the depot it will likely have been completely buried by snow, photos are therefore useful to identify where to dig.

See Chapter 23 for more information on field depots.

24.5.11 **Summary of recommendations**

A brief conclusion of the project. Was it successful considering the aims and goals or does further work need doing? This is to include a summary of recommendations about equipment, techniques, clothing etc. mentioned throughout the report to better aid and steer future operations.

24.5.12 **Appendices**

Attach any extra files to the document or state locations if saved elsewhere. These could be photos of depots, comprehensive equipment lists, GPS screenshots etc.

24.6 **Archiving field reports**

The final draft of the report should be sent to the FOM, who will then allocate a report number. The report should then be saved as a .pdf file and sent to the FOM with the accompanying .gpx file containing waypoints etc.

Field reports should be completed within two weeks of a project finishing and must be submitted before returning to the UK.

24.7 **MAXIMO reporting**

Accidents and incidents, near misses and environmental issues in the field should be reported as soon as they occur. However, if for whatever reason that has not been done, then ensure it is done at the report-writing stage and recorded through MAXIMO. See the FOM if in doubt over what needs to be recorded or for help with the recording procedure.

Chapter 25 – Returning

25.1 **Introduction**

Upon returning to station after a spell in the field it is important that all equipment is dealt with appropriately. After a field season all kit will need to be properly checked and serviced. Some kit can be left and serviced over the winter months but other items will need dealt with immediately to prevent damage.

25.2 **Drying equipment**

Fabric items will need to be dried and aired after time in the field. Even if kit hasn't got wet it is likely to be slightly damp and leaving it in a bag will cause damage. Clothing (particularly down clothing), tents and P-bags are the main items that will require hanging up in the designated location (this will vary from base to base). Items should be left for long enough that they are completely dry and well aired before being put away. Ensure that you return to put items away within a few days so disruption to others is minimal.

25.3 **Returning equipment**

Equipment belonging to other departments, such as satellite phones, radios, generators, or science cargo, should be returned in a timely manner, as these will also need to be serviced by the relevant staff.

If any item has known issues these should be clearly marked when returned. It is especially important that this label is clear so staff are made aware of any issues. This will hopefully ensure that the item is repaired before any further field use.

25.4 **Servicing equipment**

At some stage all equipment that has been out in the field will require a full service before going back into the field. The Field work manual contains details on specific service requirements and techniques for repairing certain pieces of equipment.

If there is no time due to other work commitments to service equipment immediately following return to station then items must be clearly marked and/or stored somewhere that they will not be accidentally sent out for field use. Any known issues with a particular piece of equipment after a field season should be marked to make servicing easier, especially if it may end up being someone else who carries out the servicing.

Field unit boxes, sledges and tents are the major items requiring servicing following use in the field. Additionally technical mountaineering equipment requires an annual PPE inspection but this is usually done all together at the end of all field projects.

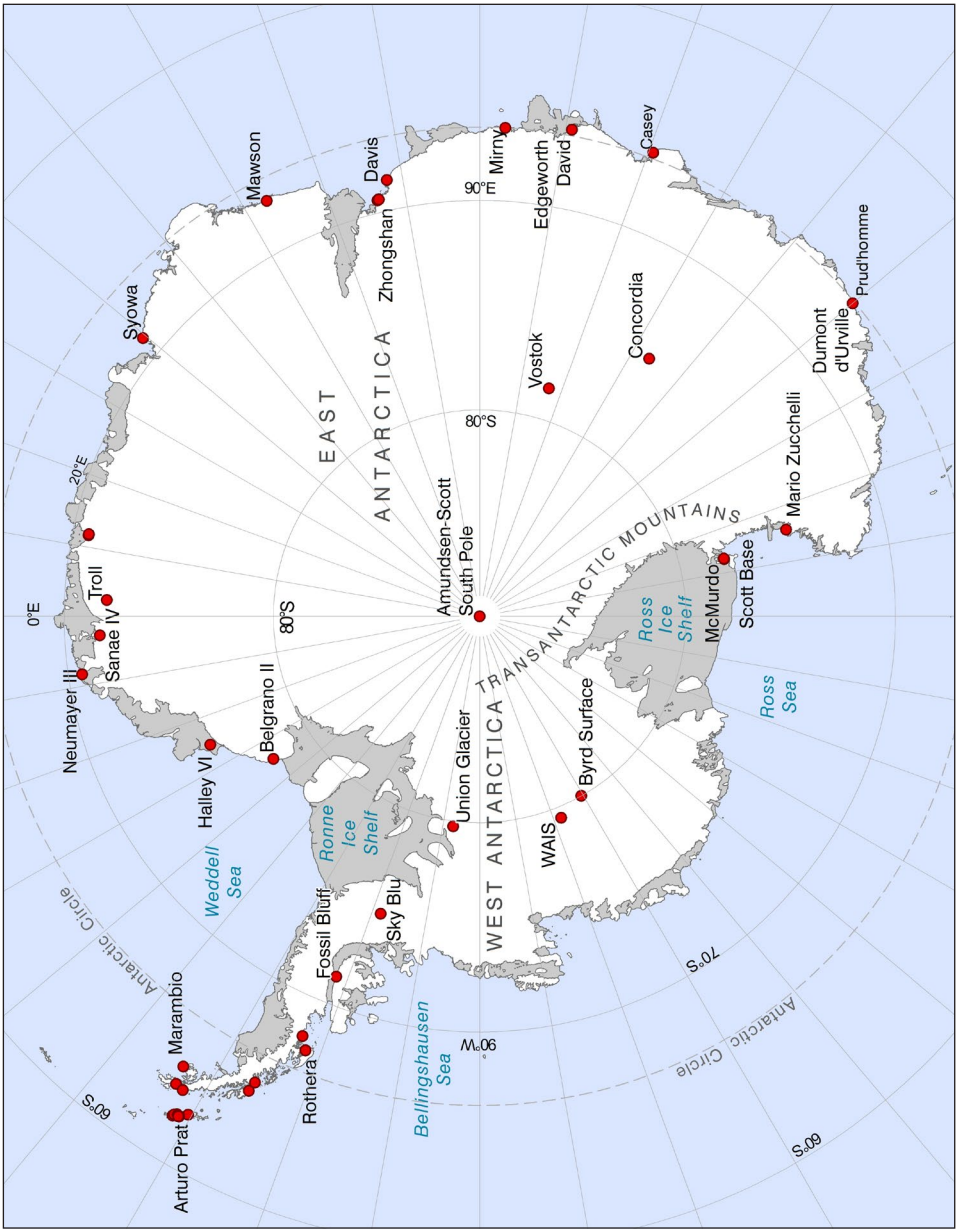
25.5 **Recording usage and condition**

Upon returning to station certain items of field kit require information to be noted in the designated online logs. Tents and sledges are the main items that require this sort of information to be noted down. Tents require number of days used along with number of days used over 30 knots. Sledges need milage used and surface conditions of those miles. With tents in particular it can be hard to assess their condition while servicing without knowing the history regarding exposure to UV and strong winds. Each tent and each sledge has its own page within the designated log and history can be recorded. If a full service isn't carried out after the project, then a clear note must be made in this log for it to be serviced over winter.

Appendices

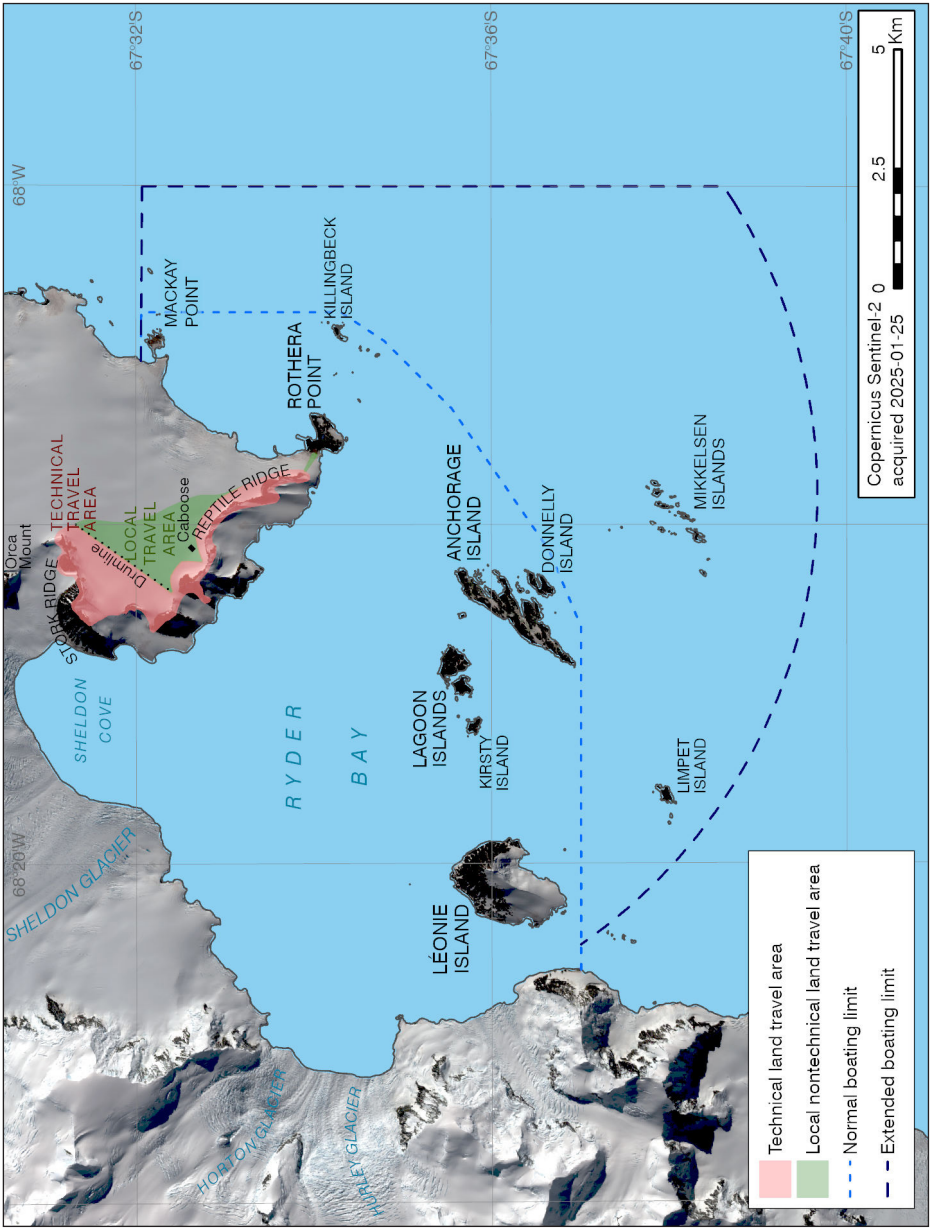
A1 – Useful maps

A1.1 – Antarctica with stations marked



A1.2 – Air network – Antarctica

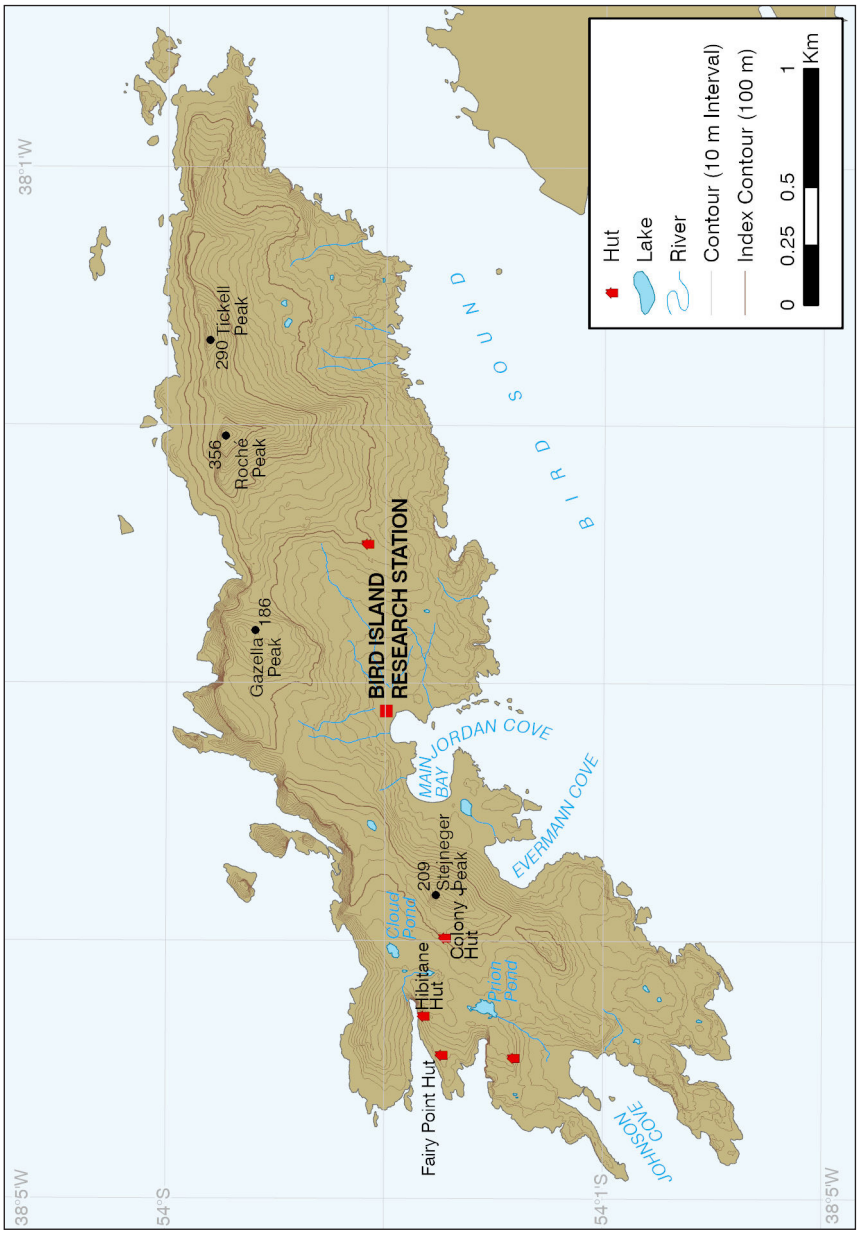
A1.3 – Rothera local area



A1.4 – KEP local area

A1.5 – Signy local area

A1.6 – Bird Island local area



A1.7 – Halley local area

A2 – Box contents lists

A2.1 – Tent box

Item	Quantity
Wooden spoon/spatula	1
Dessert spoons, knives, forks, tea spoons	2 each
Mugs	2
Bowls (and plates)	2
Pack of sealed matches (12 boxes)	1
Toilet rolls (as much as space allows: rest in P-bags) One roll per person per week. Need at least two rolls for static parties who may have fewer boxes to store toilet rolls in	2
Torch, spare batteries (4), spare bulb - check	1
Blanket pins	16
Alarm clock – check (and spare battery)	1
Toothpaste, soap, toothbrush, soap powder as required	
Stainless steel thermos 1 litre – (tested)	2
Plastic drinks bottle 1 litre (preferably wide neck)	2
Protractor, ruler, compass or divider	1 each
Spare compass, spare whistle	1 each
BAS Field Ops Manual Not currently enough copies for all field boxes, FGs should have their copies with them in a field party)	1
BAS Field Emergency Manual	1
Stationary including: felt tip markers (3), pencils (3), writing paper, envelopes	
Notebook	1
Copies of all maps carried	
Rubbish bags and small food bags as required	
Assorted personal items as space allows (paperbacks, personal stereo, etc.)	
CO monitor in plastic bag to reduce chance of contaminating sensor	1

Mending kit containing:

Item	Quantity
Domestic needles or house wife	1 packet
Sailmaker's palm	1
Sailmaker's needles	1 packet

A2 – Box contents lists *continued*

A2.1 – Tent box *continued*

Item	Quantity
Reel of terylene thread	1
Whipping twine: one thick, one thin	2
Canvas or cordura material patches	
Tent inner material	
Elastic for clothing, and 4mm and 8mm bungee cord	2m
Ventile 1 x 1m – for tent repairs	
Scissors	1 pair
Araldite (fast set)	1
Seam sealer	1 tube
Freesole	1 tube
Sail tape and part roll of duct tape	1 roll
Thermarest repair kit	1
Velcro	
Tent pole cord: 12H and 8H cord each	3m

A2 – Box contents lists *continued*

A2.2 – Pots box

Item	Quantity
Vapalux lamp with oven cloth/karrimat wrap	1
Primus stove with new style pot ring, legs and tank lid (Model 45K)	1
Set of pans with lids and handles (with small mug inside pan set) including Primus heat exchanger pot and grip handle	1
Syphon tube	1
Meths dispensers	2
Small filter funnel	1
0.6 litre bottle of meths (silver)	1
1 litre paraffin transfer bottle (blue)	2
Cleaning kit: scourers, 'J' cloths, tea towels etc.	2
Box matches in sealed tin.	12
Cooking board with routed groove for stove, 48cm long to fit with pots rods	1
Rods to stop pans spilling	1 pair
Fire blanket	1

Primus spares Model 45K containing:

Item	Quantity
Burner with connector tube	1
Nipples	3
Tank lid with air screw (ensure correct model)	1
Pump complete, with spare tank lid on handle (two different types-both fit)	1
Pump leathers or neoprene 'O' rings	3
Pump valve complete	2
Burner connector tube washers (lead)	3
Fibre burner washers	8
Spare legs	3
Jet prickers	4 packets
Nipple spanner	1
Pump valve spanner	1
Burner spanner	2

A2 – Box contents lists *continued*

A2.2 – Pots box *continued*

Vapalux lantern spares containing:

Item	Quantity
Burner complete	1
Mantle holder	1
Spirit cup plus wick	1
Vaporisers	2
Riser tube	1
Washer sets	2
Pump complete	1
Pump valve	1
Tank lid plus air screw	1
Mantles	10
Glass – check model	1
Small wire brush and pipe cleaner	1
Small bottle of oil	1

A2 – Box contents lists *continued*

A2.3 – Spares box

Item	Quantity
Spare D ring and hook (sledge lashing)	1 each
Jubilee clips	6
Cable ties, various lengths	10
125 ml bottle tautening dope (in heat-sealed bag)	1
Ball 4 oz balloon cord	1
Helvetian hide thonging plus threading wire	5m
Roll of adhesive tape	1
Length of ash for splinting	1
Lashing toggle	1
Junior hacksaw and blades (4)	1
Pad saw and blades (2)	1
Bradawl	1
Tin of nuts, screws and bolts for sledge repair	1
Fid	1
Optimus Nova or MSR XGK stove with fuel bottle and pump	1
0.6 litre meths bottles (silver)	2
0.6 litre paraffin bottle (blue)	1
Jerry seal	2
Small filter funnel	1
Meths dispenser tin	1
Tin of sealed matches (12 boxes)	1
Ski skins adhesive	1
Tube pig putty	1
Drum tap	1
Drum key	1
Toilet roll	4
Spare box liner and P-bag liner	1
Medium pan and lid, mugs (2), knife, fork, spoon (2)	1
Crampon spares for both sets of crampons – check model	
Ski binding spares for both sets of skis, spare ski basket – check model	
Stove spares for Nova and combi spanner (and screwdriver/socket spanner to replace fuel pump non-return valve)	
Petzl head torch + spare batteries	1

A2.4 – Emergency food box

Item	Quantity
Dehydrated main meal	21
Packet soup	5
Packets of Biscuit Brown/fruit	21
500g tin of butter	1
Jar of Marmite	1
Tin of Nido (powdered milk)	1
Bars of chocolate	10
Tea bags	80
Sachets of coffee	60
Sachets of Alpen	21
Packet of sugar	1

A3 – Useful equipment weights

Item	Weight lbs	Weight kg	Hazardous yes/no
24-hour rat packs	3	1	
Avtur drum 205l	410	186	Yes – Fuel
Avtur drum 60l	120	55	Yes – Fuel
Bog chisels	3	1	
Emergency clothing bag	15	7	
Emergency food box (20-day)	66	30	
Empty drum 205l	50	23	
Empty drum 60l	18	8	
Flags (10)	8	4	
Generator 1 kVA	30	14	Yes – Fuel
Generator 2 kVA	47	21	Yes – Fuel
Half Nansen sledge	70	32	
Half unit P-bag	25	11	
Honda snow blower	273	124	Yes – Fuel
Ice core boxes (empty)	20	9	
Inside/outside food box	55	25	
Iridium phone	22	10	Yes – Batteries
Jerry board	25	11	
Jerry (empty)	10	5	
Expedition pulk	5	2	
Komatic sledge	220	100	
Field Ration Box	66	30	
Medical Box	35	16	
Meths	5	2	Yes – Fuel
Nansen sledge 12'	140	64	
Paraffin drum 205l	400	182	Yes – Fuel
Paraffin jerry 20l	50	23	Yes – Fuel
Petrol drum 205l	395	180	Yes – Fuel
Petrol drum 60l	104	47	Yes – Fuel
Petrol jerry 20l	48	22	Yes – Fuel
Pots Box	45	20	Yes – Fuel
PRIST (anti-icing fuel additive)	6	3	Yes

A3 – Useful equipment weights *continued*

Item	Weight lbs	Weight kg	Hazardous yes/no
Propane large 47kg (empty)	90	41	Yes
Propane large 47kg (full)	187	85	Yes
Propane medium 19kg (empty)	24	11	Yes
Propane medium 19kg (full)	66	30	Yes
Pulk manhaul fiberglass	15	7	
Pup tents including Al pegs	37	17	
Pyramid tent (two-man) including Al pegs	82	37	
Pyramid tent (three-man) including Al pegs	90	41	
Radio Box	50	23	Yes – Batteries
Ramps	80	36	
Rescue sack (full)	50	23	
Rescue sack (static two-man)	50	23	
Shovels	6	3	
Plastic cargo sledge (Siglin)	60	27	
Ski-doo ACE 900 (with two-thirds full tank)	820	373	Yes – Fuel
Ski-doo ACE 600 (with two-thirds full tank)	790	359	Yes – Fuel
Ski-doo V800 (with 2/3 full tank)	820	373	Yes – Fuel
Ski-doo Alpine 3 (with two-thirds full tank)	700	318	Yes – Fuel
Ski-doo link lines	62	28	
Ski-doo oil	2	1	Yes
Ski-doo spares box	53	24	
Ski-doo tarps	24	11	
Ski-doo tools	13	6	
Skis	12	5	
Sleeping boards	8	4	
Spares Box	45	20	
Sunlyte battery	70	32	Yes – Batteries
Tent Box	40	18	
VE 25 tent	22	10	

A4 – Unit conversions

Speed			
1 km per hour	0.54 knots	0.62 mph	0.27 metres p/s
1 knot	1.85 km/h	1.15 mph	0.51 metres p/s
1 mile per hour	1.61 km/h	0.87 knots	0.45 metres p/s
1 metre per second	3.60 km/h	1.94 knots	2.24 mph

Temperature	
0 degree Celsius	32 degrees Fahrenheit
0 degree Fahrenheit	-17.77 degrees Celsius

Fuel mileage		
1 mpg	0.35 km/litre	2.83 litre/km

Length/Height/Distance		
1 km	0.62 miles	0.54 nautical miles
1 mile	1.61 km	0.87 nautical miles
1 nautical mile	1.15 miles	1.85 km
1 foot	0.30 metres	

Weight		
1 kg	2.20 lbs	0.16 stone
1 lb	0.45 kg	0.07 stone
1 stone	6.35 kg	14 lbs

A5 – Timezone adjustments

Location	
Rothera	UTC -3
Halley	UTC -3
South Georgia	UTC -2
Signy	UTC -3
Falkland Islands	UTC -3
Punta Arenas	UTC -3
Cape Town	UTC +2
South Pole	UTC +13
UK	UTC +0
UK – British Summer Time*	UTC +1
Zulu time	UTC

* BST begins on the last Sunday of March and runs till the last Sunday in October. For the majority of the Antarctic summer UK time will be UTC/Zulu

A6 – Communication frequencies

Please note phone numbers for use with Iridium satellite phones are not included in this Appendix as they regularly change. Ensure you have an up-to-date list of emergency numbers prior to field deployment.

BAS HF frequencies

HF Frequency	Use	Notes
2272	Field Parties	Very close to Rothera, rarely used
3186		Good for work on Peninsula
4067		
4553		
5080	Flight following	Field met obs only, no scheds
5150	Field Parties	
5800		Reliable for Peninsula
6386.5		Good East of KG
7623		Good close to SBR
7775	Flight following	Field met obs only, no scheds
9106		
9115	Flight following and Field parties	Deep field comms and aircraft. E.g. Ellsworth's, Pine Island, Shackleton's
10049		
11055		
11255		
14915		
16040		
16315		Extended range in summer
17975		
23250		South America and beyond
24740		

A6 – Communication frequencies *continued*

Other HF frequencies

HF Frequency	Use	Notes
4530	Flight following and Comms	ALE Union Glacier
5026		
6530		
7980		
11228		
12345		
15026		
17988		
6649	Air Traffic Control	Marsh and Punta Arenas
4125	Local HF	Palmer Station
10024	Air Traffic Control	Punta Arenas
9032	Air Traffic Control	South Pole and McMurdo
11553		
5580	Air Traffic Control	Stanley Tower, FI.
8855		

Aero VHF

Frequency	Use
118.1	General communications
121.5	Emergency

Marine VHF Rothera

Frequency	Use
Channel 01	Main listening channel via repeater on reptile ridge. Good coverage on station through to Trident. Main working channel but not for extended conversation
Channel 06	Simplex channel, often used for vehicle ops
Channel 18	Repeater on ops tower, for extended conversation on station
Channel 16	Emergency frequency for marine use. Monitored by ops and all ships

A6 – Communication frequencies *continued*

Marine VHF Halley

Frequency	Use
Channel 06	Main listening channel
Channel 01	Duplex channel for use with repeater
Channel 08, 11, 67	Non-duplex for longer conversations to keep channel 06 clear

Marine VHF KEP

Frequency	Use
Channel 01	Duplex channel for use with repeater
Channel 08	South Georgia Government
Channel 16	Emergency frequency/Ship hailing

Marine VHF Bird Island

Frequency	Use
Channel 01	Main channel via repeater on Mt Duce
Channel 06	Used for longer conversations to keep Channel 1 clear

Marine VHF Signy

Frequency	Use
Channel 01	Duplex channel covers most of the island
Channel 06	Around station for longer conversations
Channel 16	Emergency frequency maintained for shipping

A7 – List of illustrations

A7 – List of illustrations *continued*

A7 – List of illustrations *continued*

Feedback and further information

We welcome your feedback and comments on this document. These should be addressed to:

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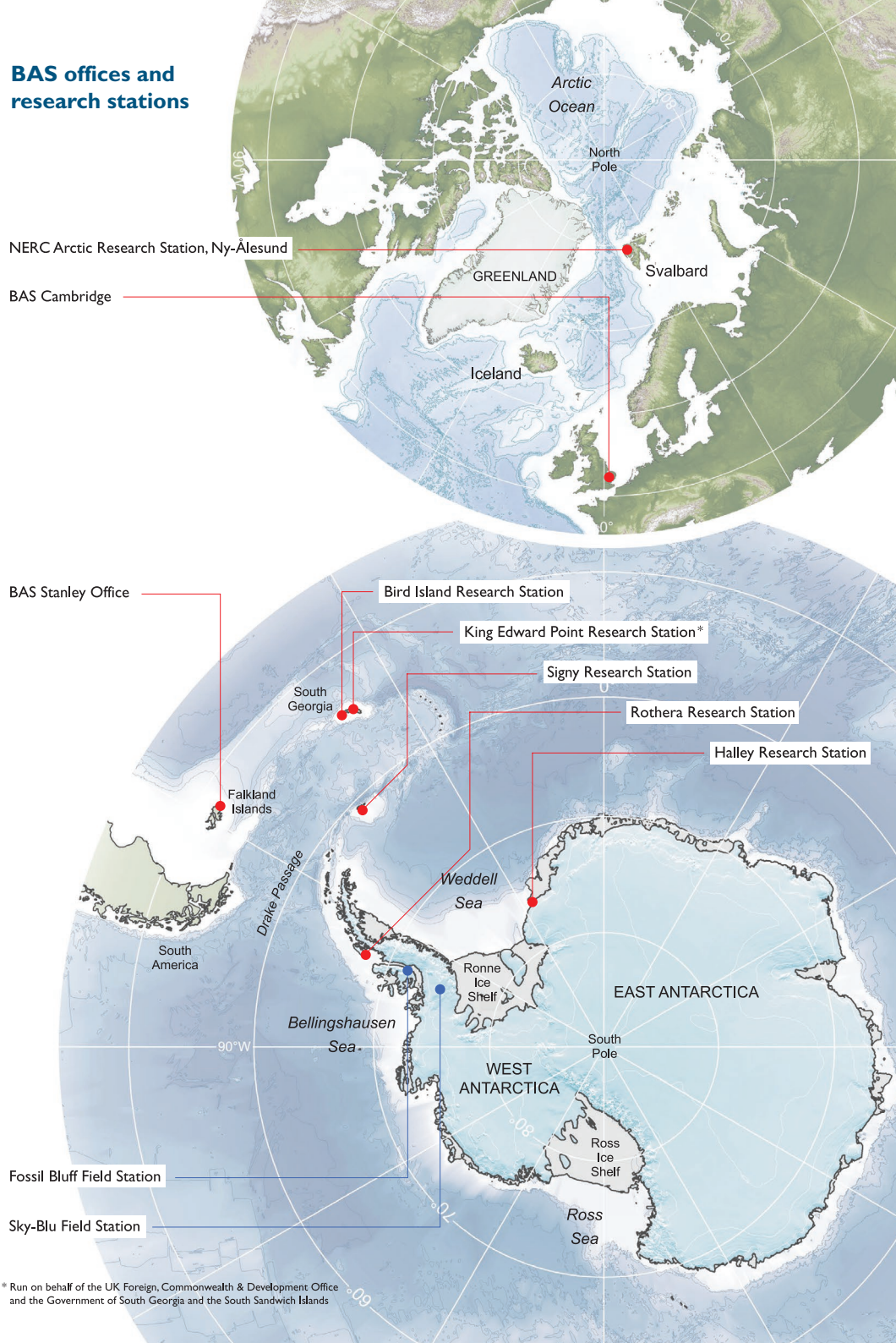

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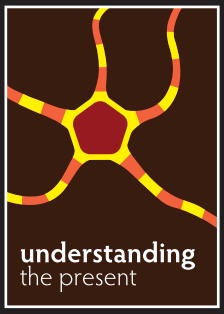

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