



# IPGA

INTERNATIONAL  
POLAR GUIDES ASSOCIATION

# SEVERE WIND MANAGEMENT RECOMMENDATIONS

**For guided polar expeditions and trips**

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The purpose of these recommendations is to emphasise the necessity for all polar guides to prepare thoroughly for trips into severe wind environments, including recommended clothing and equipment, usage, wind-deflection structures and safety. The recommendations can be used to manage and prevent wind-related incidents and mitigate the detrimental effects of severe wind on an expeditioner or team.

IPGA recognises that alternative techniques, strategies and equipment exist and that it is the choice of the Polar Guide to adopt those that apply best to their own experience, knowledge and circumstances.

These recommendations are the result of an ongoing IPGA charter to document advances and improvements in skills and practices.

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# INTRODUCTION

## What is Severe Wind?

Severe wind can be regarded as any wind strength that either alters the natural stance or gait of an average size adult or alters the behaviour or course of a typical cycle on an expedition (camping, travelling or resting). For example severe wind may necessitate the building of a protective wall, roping up participants, use of atypical techniques to anchor a tent or configure a camp, removal of accumulated drift snow or response to a wind-related ailment. Severe wind begins around Beaufort 7.

The below Wind Speed Comparison Chart is a general indicator of wind speed, description and effects seen in a typical polar expedition environment. Wind gusts can be up to 40% higher than average recorded wind speeds and can result in effects seen across a wide range of wind speeds. In some circumstances such as local wind effect or absence of snow source, snow redistribution (drifting snow) and accumulation may not be evident.

Descriptions are a useful tool that can be used when a wind meter is not available or malfunctions.

WIND SPEED COMPARISON CHART						
BEAUFORT	DESCRIPTION	EFFECTS	WIND SPEED (approx)			
			metres per second	kilometres per hour	knots	miles per hour
0	Calm	Exhaled breath vapour is motionless	<1	<1	<1	<1
1	Light Air	Exhaled breath vapour indicates wind direction	1-1.5	1-5	1-3	1-3
2	Light Breeze	Fur on ruff flutters. Wind vane (lightweight waterproof ribbon) flutters at up to 45° from vertical	1.5-3	5-11	4-6	3-7
3	Gentle Breeze	Fur on ruff in constant motion. Vane flutters 45 to 90° above vertical	3-5	11-18	7-10	7-11
4	Moderate Breeze	Sporadic drift snow on the surface, some tent wall movement	5-8	18-29	11-16	11-18
5	Fresh Breeze	Drift snow on the surface, uncomfortable facing wind	8-11	29-39	17-21	18-24
6	Strong Breeze	Some buffeting of an average size adult	11-14	39-50	22-27	24-31
7	Moderate Gale <i>(Arctic Hurricanes can form)</i>	Resistance felt walking into the wind, tent buffeting	14-17	50-61	28-33	31-38
8	Fresh Gale	Blowing snow accumulates quickly in eddies, require full facial and shell protection	17-20	61-74	34-40	38-46
9	Strong Gale	Airborne blowing snow, tent walls concaving, upright skis swaying	20-24	74-87	41-47	46-54
10	Storm	Tents destroyed without protection. Rapid and heavy snow accumulation,	24-28	87-102	48-55	54-63
11	Violent Storm	Unprotected tents and unsecured heavy sleds blow away. Air may be filled with blowing snow, arm-length visibility, massive accumulation, regular tent excavation.	28-33	102-117	56-63	63-73
12-17	Hurricane (katabatic winds in Greenland and Antarctica can exceed Beaufort 12)	Hazard to life, constant tent excavation, threat of tent collapse and burial	>33	>117	>63	>73

- Little to no hazard
- Hazard increases with lower temperatures, requires management
- Requires active management. Unprotected polar-rated tents able to withstand conditions
- Tent-bound. Tents require protection and active management
- Rarely seen in a polar environment, tents unlikely to survive wind or snow loading

## Measuring wind

### Descriptors

Effects noted in the Wind-Speed Comparison Chart above can be used as a rough guide to measure wind strength eg. *drift snow on the surface, uncomfortable facing wind = Bft 6*

### Anemometers

An anemometer is a wind meter or gauge, used primarily to measure wind speed and direction. More advanced versions are also capable of recording maximum gusts, temperature, barometric pressure, altitude, humidity, wind chill, wet bulb, dew point and logged histories of each function.

An anemometer suited to polar conditions must be: capable of using lithium batteries, waterproof, have a readable screen in high contrast/extreme cold, robust, compact and lightweight.

Kestrel is a commonly-used brand of anemometer.

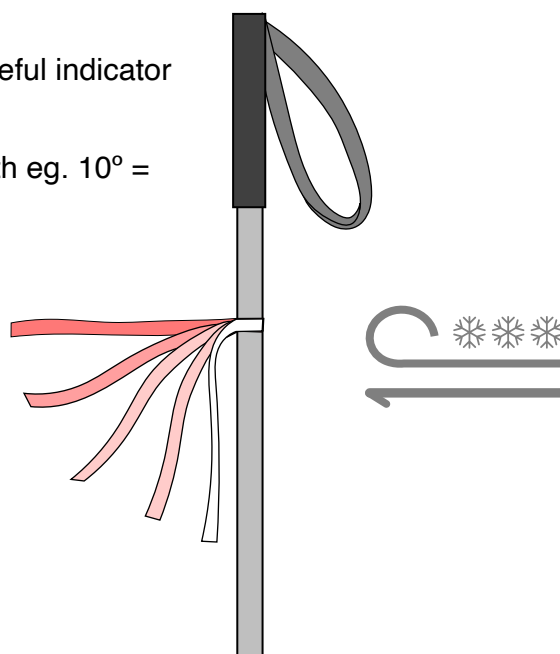
### Tell-tales

Lengths of ribbon or light string attached to ski poles is a useful indicator of wind strength.

The angle of material from vertical can indicate wind strength eg.  $10^\circ =$  Bft 2,  $45^\circ =$  Bft 6,  $90^\circ$  (horizontal) = Bft 10 etc.

Weight of material will affect the reading and should be calibrated by the user.

Important for wind flow to be uninterrupted by the skier - a ribbon on each ski pole allows user to select upwind pole.



## 1. WIND-RELATED AILMENTS

Most wind-related ailments are cold-related ailments with a faster onset. The chilling effect of wind can be exacerbated with the introduction of moisture on the skin (evaporative cooling), added either environmentally (rain, humidity) or locally (perspiration, submersion and snow melt).

See *SEVERE COLD-MANAGEMENT Recommendations, Cold-related ailments common on polar expeditions*

## 2. TYPES OF POLAR WIND SYSTEMS AND EVENTS

### **Polar Vortex**

A polar vortex (cyclone) is a persistent, large-scale, upper-level low-pressure area, less than 1,000 kilometres (620 miles) in diameter, that rotates counter-clockwise at the North Pole and clockwise at the South Pole. The vortices weaken and strengthen from year to year. As with other cyclones, their rotation is driven by the Coriolis effect.

### **Polar Easterlies**

The polar easterlies (also known as Polar Hadley cells) are the dry, cold prevailing winds that blow from the high-pressure areas of the polar highs at the North and South Poles towards the low-pressure areas within the westerlies at high latitudes. Like trade winds and unlike the westerlies, these prevailing winds blow from the east to the west, and are often weak and irregular. Due to the low sun angle, cold air builds up and subsides at the pole creating surface high-pressure areas, forcing an outflow of air toward the equator that outflow is deflected westward by the Coriolis effect.

Mid-latitude Westerlies (winds at the surface level between 30° and 60° latitude from the west) increase in strength and are persistent when the polar vortex is strong.

### **Katabatic Winds** (sometimes spelled Catabatic, sometimes called Fall Winds)

A katabatic wind is a drainage wind that carries high-density air from a higher elevation down a slope under the force of gravity, most commonly from large elevated ice sheets of Greenland and Antarctica. Where these winds are concentrated into restricted areas in the coastal valleys, the winds blow well over hurricane force, reaching around 300 km/h (the record stands at 327km/h at Dumont d'Urville Station) Most katabatic winds are 10 knots (18 km/h) or less.

A **piteraq** is a cold katabatic wind which originates on the Greenlandic icecap and sweeps down the east coast. On February 6, 1970 the community of Tasiilaq was hit by the worst documented piteraq ever in Greenland (estimated at 90 m/s — about 325 km/h or 200 mph) causing severe damage.

### **Polar Low**

Polar lows are defined as small but intense maritime meso-scale cyclones that form in cold polar or Arctic air advected over relatively warmer water. Polar lows are much smaller and more transient than a regular mid-latitude depression. Their scale varies between 100 to 500 km and typically they last for anything between 12 to 36 hours.

In mature stage the most prominent hallmark of a polar low are the spiral cloud bands often forming a clear eye at the the centre of the cloud vortex suggesting an analogy with tropical cyclones. This is why such systems are also known as **Arctic hurricanes**. Mean wind speed varies around 15 m/s which is only Beaufort 7 or 'near gale'. However, frequently strong wind gusts easily reach Bft 10 and thunderstorms and even waterspouts are possible. Heaviest snow showers and strongest winds are located close to the centre, winds within the 'eye' are calm.

Polar lows have been referred to by many other terms, such as polar mesoscale vortex, Arctic hurricane, Arctic low, and cold air depression. Today the term is usually reserved for the more vigorous systems that have near-surface winds of at least 60km/h (38 mph).

## **Blizzards**

A blizzard is a cold climate weather event of sustained and prolonged wind-driven falling snow that generates around Bft 7 and can deteriorate to a hurricane.

More typical in polar environments are **Ground Blizzards**, where extreme wind redistributes snow. Symptoms of all blizzards include severe wind, snow accumulation, reduced visibility and an increase in ambient temperature due to an associated intense low pressure system.

Blizzards are often followed by a rapid decrease in temperature.

### 3. PREDICTING SEVERE WIND EVENTS

#### Observations

Observations are a key ingredient for accurate predictions from hours to years ahead. They are used in numerical weather prediction (NWP) systems to create the initial conditions for weather forecasts, using data assimilation techniques which blend observations and models to create the best possible reconstruction of the current state of the Earth weather system.

Polar regions are sampled (from radiosonde launches, surface observations or deployment of buoys in the ocean or over the sea ice) at higher temporal frequency than any other region on the globe, thanks to the fact that Low Earth Orbit (or polar-orbiting) satellites pass over the pole at each orbit. For example, the number of observations assimilated in the ECMWF Integrated Forecasting System (see below) in a period of 12 hours from one of these satellites is up to 8 to 10 times larger north of 70°N than in the mid-latitudes.

#### Forecasting

Meteorological forecasting using the ECMWF (European Centre for Medium-Range Weather Forecasts) HRES model provides the most accurate prediction of weather and severe wind events. For the most up-to-date forecasts a polar guide should be in daily contact with a base camp contact capable of sending the latest ECMWF data for the specific region of operation, or obtaining the data direct from a forecasting service.

In the event a guide will not have daily contact, some weather apps (such as *Windy*) use the ECMWF model and can forecast up to 10 days ahead. Screenshots of weather forecasts can be a useful tool in anticipating weather for trips less than 10 days but do not benefit from increasing resolution.

#### Environmental indicators

Severe wind events can often be anticipated by observing atmospheric and surface features.

- high-level cirrus clouds - often arrive in advance of storms associated with frontal systems
- rapid changes on the horizon - light, cloud, fog
- rapid change in wind speed
- lenticular clouds - indicate localised strong wind but not necessarily an indicator of an approaching severe wind event
- blowing snow on mountaintops - as per lenticular clouds
- large sastrugi - indication of former wind events and their orientation
- scouring - areas of high wind are often void of sediment, sand or gravel

## 4. PROTECTIVE CLOTHING

The following clothing and equipment items are the minimum required for exposed travel in severe wind. Items need to be layered or combined in order to achieve the desired protective effect, particularly as temperature decreases/wind increases.

### a. Headwear

ITEM	COMMENT
Polar hat	windproof, generous ear protection
Liner beanie	can be worn under polar hat
Beanie	more breathability, only useful under shell hood
Face mask	windproof, with adequate breathing holes while minimising skin exposure
Neck gaiter	protects neck
Fur ruff	attached to shell hood, with long guard hairs to break up wind
Goggles	UV-rated, adequate ventilation to avoid icing, nose protection
OPTIONAL	
Balaclava	windproof, with adequate breathing holes

#### Considerations:

- all items must be fitted, cinched or tethered to avoid loss or dislodgement in severe wind
- wind-proofing and skin coverage are increasingly important with increase in wind
- adequate ventilation reduces perspiration and icing
- items must be able to mesh together to create a barrier impervious to wind
- apply surgical tape to areas of exposed skin not covered by headwear

#### Avoid:

- use of garments that are not protected by a wind membrane or shell

### b. Handwear

#### Mittens (mitts)

2-section handwear, one for the thumb and one for all four fingers  
reduces dexterity but increases warmth due to skin-to-skin contact

#### Gloves

handwear with separate sections for each finger  
increased extremity but decrease in warmth

#### Fingerless

Mittens or gloves with tips exposed or removable  
Not recommended for use in severe cold or wind conditions

ITEM	COMMENT
Outer (shell) mitten	windproof, with long gauntlet
Inner mitten	wool or synthetic with adequate loft
Liner mitten	wool or synthetic
OPTIONAL	
Pogies	insulated hand covers worn on ski pole handles
Ski gloves	for those with good circulation, wool or synthetic liner, modular for drying

#### Considerations:

- Outer mittens should be tethered to avoid loss in severe wind
- prevent removal of outer mittens to minimise build up of drift snow within handwear
- be judicious in use of pogies, may not be suited to some people and in circumstances where hands are required often (pressure ridges, crevasse fields etc.)

#### Avoid

- removal of outer mittens to minimise build up of drift snow within handwear
- tight-fitting handwear
- use of glove liners, which prohibit finger warming through skin-to-skin contact
- vapour-barrier liner gloves

### c. Bodywear

ITEM	COMMENT
Base top layer	2 minimum, wool, synthetic
Mid top layer	2 minimum, wool, fleece
Windproof shell jacket	with generous hood, storm collar and pit zips for ventilation, unlined
Puffer vest or jacket	fit over previous layers, down or synthetic
Insulated outer jacket	with hood, down
Base bottom layer	2 minimum, wool, synthetic
Mid bottom layer	2 minimum, wool, fleece
Shell overpants	windproof, full-length side zippers and/or zippered drop-seat, unlined
Insulated skirt, shorts or trousers	minimum knee length, to fit over previous layers, full-length side zipper/s, down or synthetic fill

#### Considerations

- extensions on zip sliders to accommodate limited dexterity
- bib/brace on shell overpants to minimise exposure of waist
- thumb loops on sleeves
- shell pockets located in convenient areas unhindered by sled harness

- pockets added to base and fleece layers for keeping batteries and devices warm
- fleece or windproof layer sewn to front of underpants, particularly for males
- add knee insulation to shell overpants
- add modular layers to warm body sections - skirt/shorts, sleeves, vest

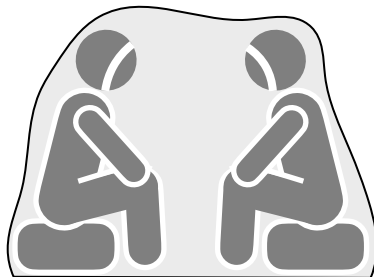
#### Avoid

- cotton
- waterproof zippers
- 3-layer Gore-Tex
- mesh- or fleece-lined shells
- tight fitting clothing
- overdressing - results in excessive frost on outer clothing

## 5. TRAVELLING DURING SEVERE WIND

It is not uncommon for teams to be travelling during severe wind. Subtle or fast onset, necessity to exit a hazardous area, desire to reach shelter etc. can result in teams being caught in extreme wind conditions. Considerations include:

- establishing hand signals
- traveling closely in single file with a selected leader and tail
- guide in visual contact with all participants, from behind may be preferable
- checking any exposed facial skin regularly, cover if necessary
- regular short breaks to both check on status of group and to communicate
- rope up if required
- lightweight bivvy or bothy shelters provide instant protection from the wind, very useful in emergencies



- using a Camp or Continue Risk Matrix for determining when to stop (see Appendix 1)
- travelling while snowkiting has extenuating circumstances (see Appendix 2)

## 6. SHELTERS

When pitched, prepared and protected optimally, a polar-rated shelter, most commonly a tent, should be able to withstand most severe-wind conditions. All components - design, fabric, stitching, poles, stakes, ventilation, usable space etc - must be capable of tolerating sustained severe wind and wind-driven drift snow from all directions.

Tents covered here are those typically used on lightweight polar expeditions, weighing around 5kg or less.

The following assumes the tent is pitched to manufacturer recommendations.

### a. Tents

#### Dome

A dome tent is a hemispherical geodesic configuration that utilises crossover poles to distribute structural stress across multiple triangular and polygonal fabric sections.

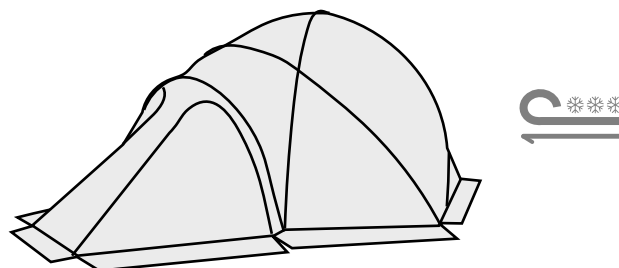
A geodesic dome is the preferred design for extended exposure to severe wind, as evidenced by the exclusivity of dome tents at South Col on Mt Everest

##### Advantages

- most superior geometry for severe wind due to higher percentage of pole coverage in relation to fabric
- tolerates changes in wind direction
- able to withstand heavy snow loading
- freestanding inner tent

##### Disadvantages

- longer pitch time
- less optimal use of internal space
- often heavier



#### Tunnel

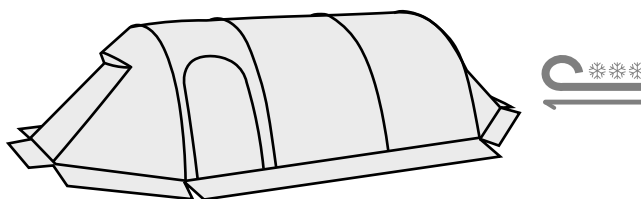
A tunnel tent is an oblong configuration that utilises parallel hooped poles to maximise internal space.

##### Advantages

- easier and safer to pitch in strong wind
- superior use of internal space
- faster pitch time
- lighter
- excellent wind tolerance when aligned with wind direction

##### Disadvantages

- less stable, particularly with side wind
- less tolerant of snow loading
- inner tent is not freestanding



#### Other

Alternative types include pyramid, A-frame and base camp tents, not commonly used in polar environments due to their increased panel exposure to wind.

## b. Fabric

Tent fabric must be of the highest quality and, together with some wind deflection, able to withstand hurricane-force wind. The following fabric specifications are the minimum required to tolerate severe wind conditions:

- 40 denier ripstop nylon
- 18kg /40lb tear strength
- UV resistant
- double-sided silicone coating
- 3000mm/399kPa hydrostatic head (waterproofness under load)

## c. Poles

Poles are a critical component of any tent. Lightweight polar-rated tents should have a minimum diameter of 9mm and be made from alloy for optimum strength and flexibility. *DAC Featherlite NSL 9mm* is currently the most common pole brand/diameter used by high-end tent manufacturers however diameters of 9.6 and 10.25 are also available from DAC. Pole section ends must be fully seated to retain the manufacturer-recommended pole strength.

Polar-rated tents must have the capacity to 'double pole' - running two poles in each sleeve to significantly increase tent strength.

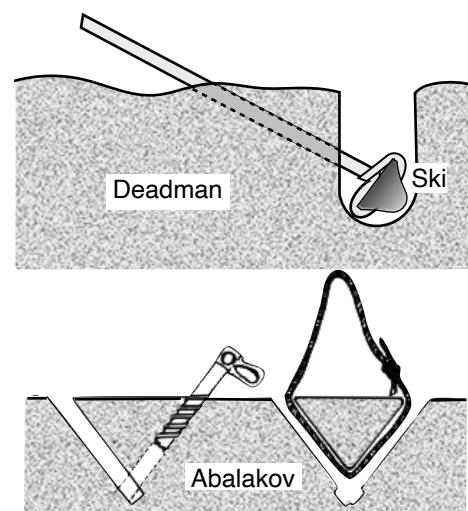
Severe wind increases the abrasive effect of pole ends on fabric, requiring pole sleeve ends to be reinforced with abrasive resistant material.

Tent poles must be easily repairable. Internal shock cord must be easily removable to replace broken pole sections. Pole repair sleeves should also be carried.

## d. Anchors

Standard tent anchors (pegs) are not suitable for most polar conditions and should be replaced with anchors appropriate to the chosen polar environment.

- snow pegs - made from hardened aluminium, snow stakes are up to 30cm long with a curved profile. Hold well in moderately firm snow.
- poles - often made from tent pole sections, aluminium, wood or bamboo poles are lightweight and hold well in firm snow. Should be 50cm minimum length.
- skis - placed tail first with edges inward, skis provide excellent tent anchorage in very strong wind. Can sway violently in severe wind.
- deadman - any anchor that is buried perpendicular to a guy rope that is affixed to its centre point - snow picket, filled stuff sacs, skis, poles etc. Strongest form of snow anchor.
- ice screws - used on sea or freshwater ice. Not suited to snow.
- Abalakov (V) thread - made from two joining ice screw holes
- snargs - hammer-in fine-threaded ice screws. Not suited to snow or fragile ice
- sleds - must be heavy, anchored or overturned
- snow valances (snow flaps) - once covered in snow, valances prevent ingress of drifting snow and provide additional anchorage. Valances retard tent ventilation
- ice bollards



### **e. Features**

Polar-rated tents should have features designed for extended survival in severe wind conditions.

Features should include:

- large vestibules for storage of food and fuel and for toileting
- provision for double-poling to increase resistance to wind and snow loading
- provision for internal rope bracing
- snow valances for additional anchoring and minimising entry of drifting snow
- all anchor loops and guy ropes should be large enough to accept a ski
- optimum ventilation for all situations including high humidity, in-tent cooking and snow burial
- multiple anchor points or provision for addition of supplementary guy lines
- dual walls - tents with inner and fly provide additional security and reduce condensation on the inside of the inner tent. Single-layer Gore-Tex reduce condensation but do not have the same protective value.
- zippers are a weak point on tents. Most high-end manufacturers use YKK zippers. Watertight zippers (fine teeth) are more prone to icing.
- minimal noise - tents can be extremely noisy in severe wind conditions, a taut tent is quieter. External zipper flaps often catch the wind and create a drum effect which can be eliminated by severing the bottom of the flap to allow wind to exit.

### **f. Preparing tents for severe-wind use**

Tents should be modified for use in any area prone to severe wind. Modifications may include:

- attachment of snow valances
- reinforcement or attachment of storm guy lines
- guy line tension cleats should be easily accessible during drift accumulation
- modification of buckles, tension straps etc. to be useable with mittens
- double poling
- tent poles are stored within the sleeves to minimise pitch time, permanently attached to one side of the tent and folded in half or thirds for storage inside a long tent bag. It is also useful to glue or tape unused tent pole sections together to avoid unseating
- attachment of a looped storm lanyard that can be secured to a stake/sled before pitching, prevent loss of an unsecured tent
- attachment of 'handrail' security line that can be used when occupants are outside
- regular maintenance to ensure integrity of all tent features

### **g. Other shelters**

Snow cave

- excellent form of wind shelter
- carbon monoxide poisoning and entrance burial present significant dangers

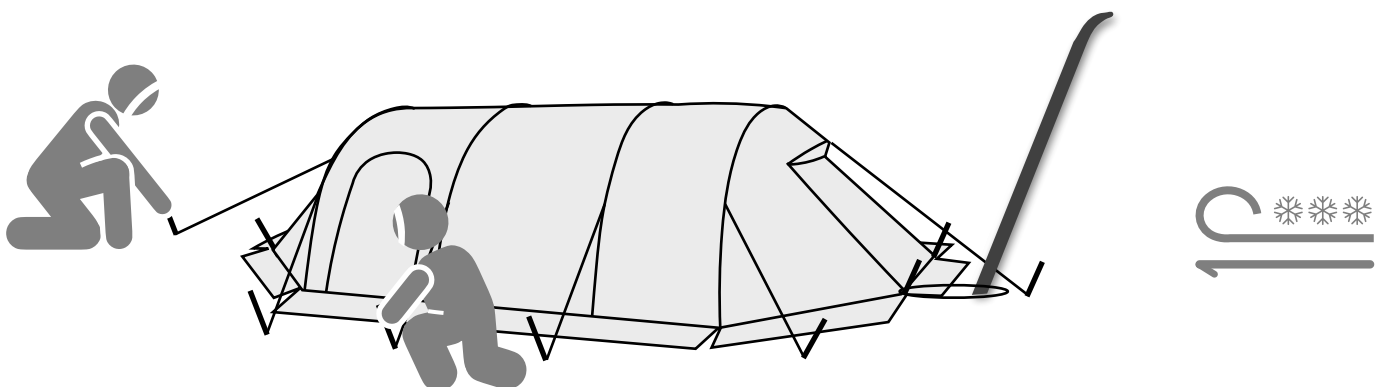
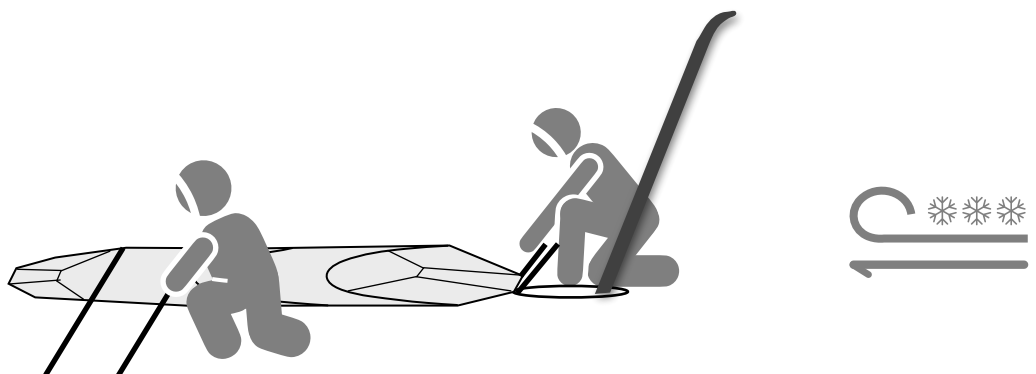
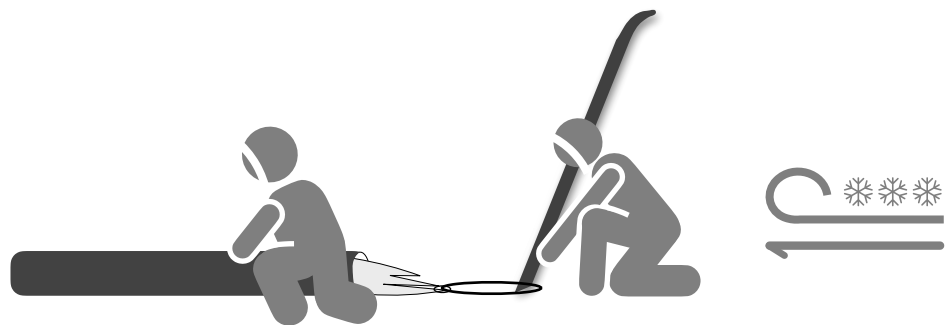
Igloo

- can be an excellent form of wind shelter
- prone to ablation in severe wind
- carbon monoxide poisoning and entrance burial present significant dangers

## 7. PITCHING

Pitching a tent in severe wind must be a precisely orchestrated event where every person knows their role. A correctly prepared tent should be securely pitched within 5 minutes. The following procedures are commonly used where a wind deflection structure has not been constructed:

- ensure allocation of roles for each person
- digging the tent platform 20cm or more into the snow reduces tent exposure to wind
- prepare a secure storm anchor for the tent - snow picket, ski, heavy sled etc
- before removing tent from bag, clip available storm lanyard attached to upwind vestibule of tent to the anchor
- remove tent (store tent bag), one person downwind to secure the bundled tent to avoid it inflating
- working with backs to the wind, spread out tent, perhaps add heavy objects inside, seat pole sections and clip into tent, leaving hoops flat on the surface
- anchor upwind fly, pull tent downwind allowing hoops to rise, anchor downwind fly
- secure remaining anchors
- apply snow blocks to outer valances for additional anchoring and prevent snowdrift entering between tent walls
- tents may need to be pitched by the team alternately



## 8. TOOLS

Expeditions into severe wind locations should carry a selection of high-quality tools for both excavating snow and building protective walls.

### a. Shovel

Avalanche rescue shovels are ideally suited to snow excavation. Features should include a curved alloy or steel blade (a large volume blade moves more snow, a low volume blade is less fatiguing), long telescopic shaft (long is better for moving large volumes, short provides more manoeuvrability), D-handle grip, conversion to hoe may be useful.

Straight-edge blade is preferable for cutting snow blocks.

Shovels are your most important tool, both during a wind event and after. The loss of a shovel will severely hamper both your ability to survive and to extract your camp.

Minimum 1 shovel per tent, 1 per person in some environments



### b. Snow saw

A snow saw can cut precision snow blocks much faster than a shovel but is not suited to surfaces such as glacier ice or sea ice. Common features include a 35cm alloy blade (folding blade is more prone to breakage), handle suited to mittens, provision for attaching to a ski pole or shovel shaft for additional leverage, storage inside shovel shaft or protective sheath.

Minimum 1 saw per team, depending on location



### c. Ice axe

On polar expeditions an ice axe can be a useful utility tool but is more often used as tent anchor than for glacier travel or climbing. As an anchor, an axe can be used as a stake or a deadman.

Useful for digging slots for ski/pole deadmen

Minimum 1 axe per team, depending on location



### d. Ice hammer

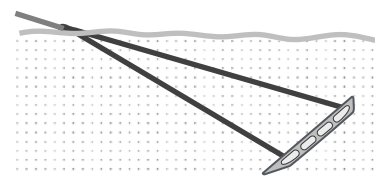
Required for use with *snargs*. Other limited uses though additional weight of a hammer often precludes its inclusion as a tool.



### e. Deadman

A Deadman is a buried anchor to which a guy rope is girth-hitched the anchor's mid-point.

- snow stake, ice axe, ski, ski poles - buried perpendicular to the guy rope
- snow bag - a bag filled with snow
- aluminium fluke - most common commercially available deadman, not commonly used on polar expeditions



### f. Probe

An avalanche probe or similar is a useful tool for determining depth of firm snow layer.

Lanyards attached to tools may prove useful in preventing loss.

## 9. SELECTING AND PREPARING TENTS AND TENT SITES

Optimal selection, preparation and arrangement of a camp will maximise safety during a severe wind event.

### a. Positioning

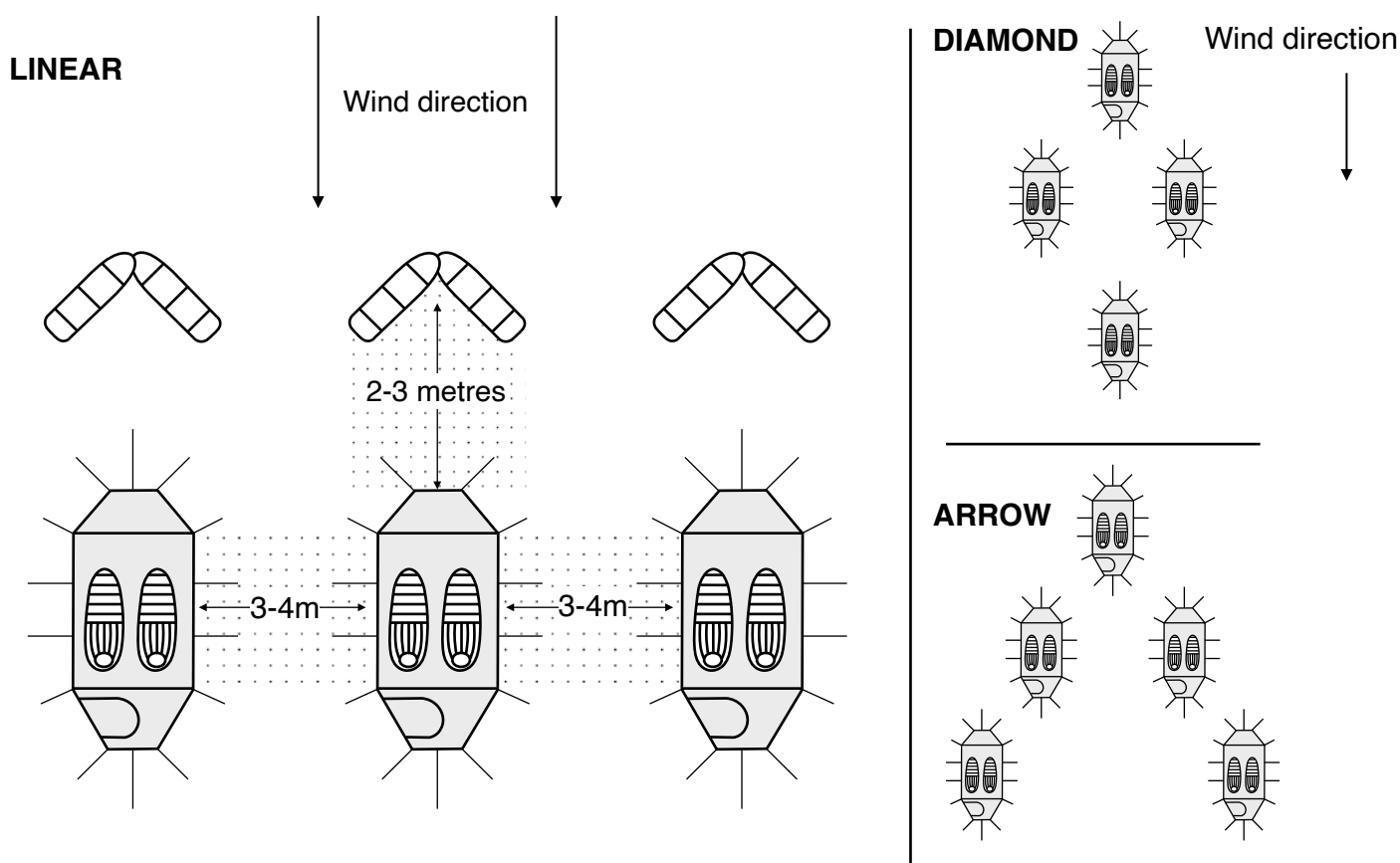
The positioning of a tent site is not always a straightforward task and a host of determining factors should be taken into account. Ultimately every tent should be prepared and pitched so that it is optimised for severe wind from any direction.

- site should be large enough to accommodate all tents in the team
- natural protective features such as pressure ridges, large sastrugi, filled crevasses etc. may provide protection
- avoid camping in areas that are prone to extreme localised wind - narrow valleys in katabatic regions that can funnel and intensify winds
- wind can change direction rendering many preparations useless or even counter-productive
- plan for restructuring or relocation in the event of wind-change
- plan for burial

### b. Clustering

The clustering pattern of tents is an important factor in both managing the camp and minimising burial. Tents should:

- be arranged parallel to the wind with the entry vestibule downwind
- be aligned side by side, not end to end
- maintain a distance of 3-4 metres of space between tents for walking and working (digging snow etc.) and to avoid wind interference from other tents.
- a diamond or arrow configuration may also be a useful clustering pattern in severe wind



### c. Placement of equipment

Equipment such as skis, poles and sleds must be positioned to minimise the possibility of loss or burial. Techniques vary, each are pertinent to weather and ice conditions and guide operations and preferences, and include:

#### Sleds

- placed upwind of the tent, either in a V configuration or or stacked
- may be upturned to eliminate sliding and to reduce damage to fabric covers when digging out
- smaller pulks anchored or secured to each other or clipped to tent
- placed in vestibule if large enough

#### Skis

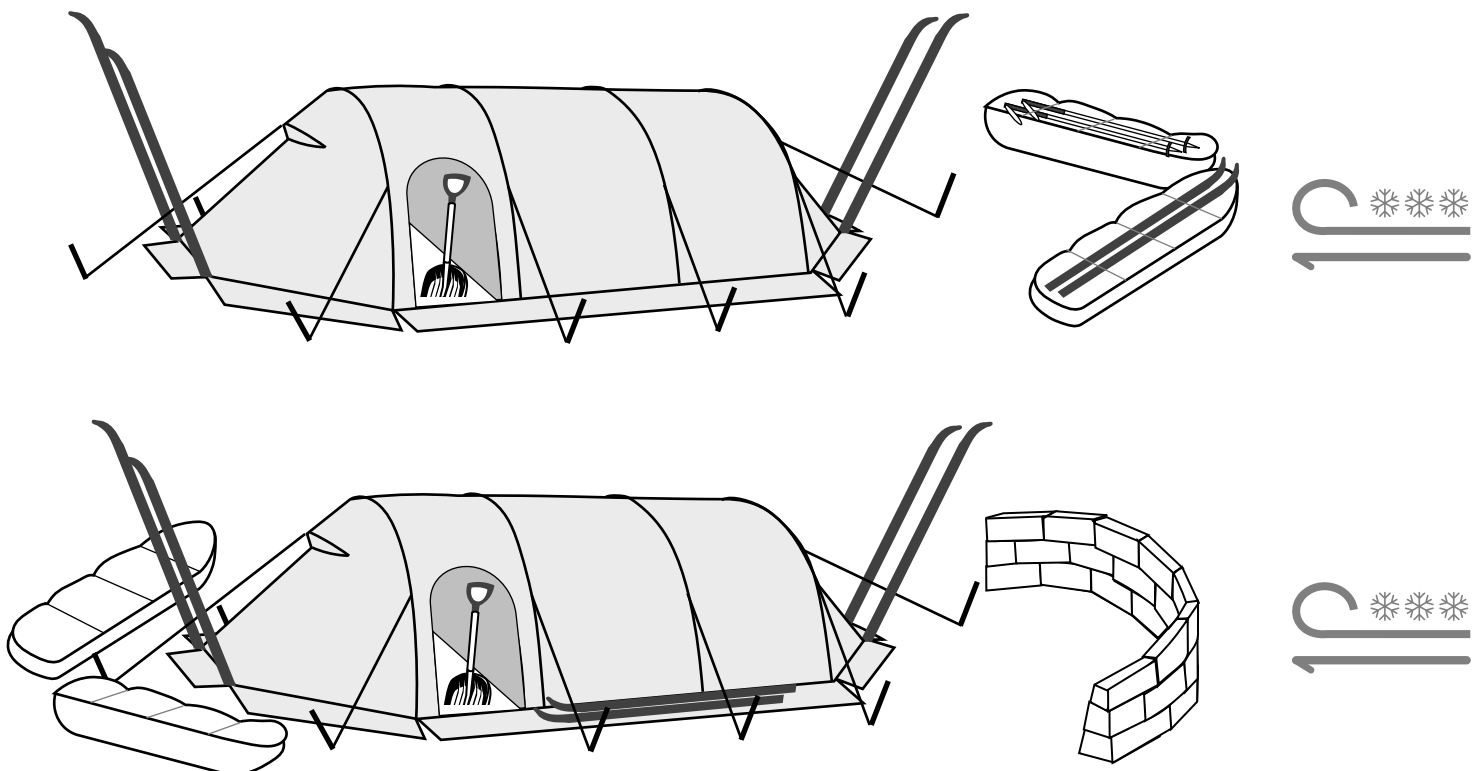
- used as tent anchors - strong but can be noisy, avoid contact between guy ropes and ski edges
- not used as anchors but placed securely upright next to tent or sled
- placed inside sled or under straps
- placed next to sled or tent, important to remember location
- placed in vestibule if large enough however skis placed upright around the camp will provide markers in the event of extreme burial.

#### Ski Poles

- placed inside sled or under straps
- stored with skis between sled and tent
- placed in vestibule, also useful as a polar bear deterrent

#### Shovels

- should be kept in the tent or vestibule
- communal shovel placed upright, downwind between tents



## 10. WIND DEFLECTION STRUCTURES

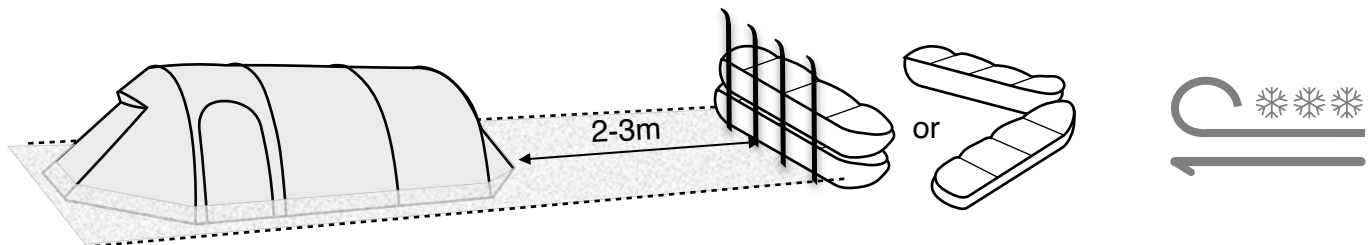
The following wind deflection structures assume the use of polar-rated, double-poled tunnel tents. Such tents, if correctly pitched and well-maintained, should not require deflection in lesser winds. Under such conditions a simple straight wall may be preferable but the additional work required for an arced wall may be a useful strategy in the event of increasing wind strength.

Wind deflection structures should be built prior to erecting a tent.

Snow may not always be suitable for wall construction.

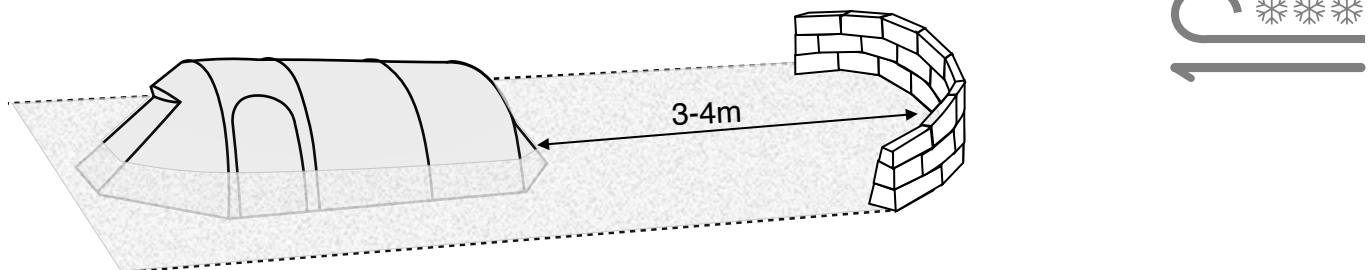
### Suitable to 20mps (Beaufort 8)

- sled wall - in a V formation or double height, 2-3m from rear of tent, must be anchored securely to avoid loss
- 3/4 tent height
- reinforced with skis if required
- tunnel tent buried 20cm copes better with changes in wind direction



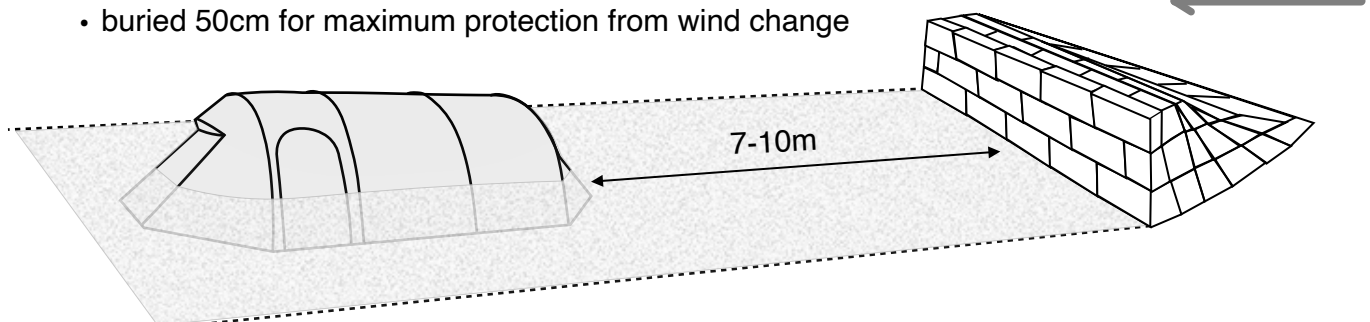
### Suitable to 28mps (Beaufort 9-10)

- curved wall, 3-4m from rear of tent
- 3/4 to tent height
- wider than tent
- buried 30-40cm



### Required beyond 20mps (Beaufort 10)

- ramped wall
- tent height or higher
- wider than tent
- buried 50cm for maximum protection from wind change



## 11. COMMUNICATING BETWEEN TENTS

It is the responsibility of a guide to ensure team members are kept fully informed. Communications between tents is critical and must be maintained through every stage of a severe wind event.

Communications between tents becomes severely compromised during extreme wind. Inter-tent visits can become hazardous and noise prohibits relay of instructions between tents and can hamper conversation within tents. The following assumes voice communication between tents is not possible.

### **Inter-tent**

Tent occupants may be required to visit other tents to inform of critical developments. A handrail of rope or cord can be strung between all tents, preferably anchored downwind and high on the tents to avoid burial. These can be propped using skis.

A perimeter rope can perform the same function and may be more useful for specifying safe areas for snow collection, toileting etc.

### **Communications devices - voice**

VHF radios are ideal for communicating between tents however they are rarely carried on polar expeditions.

Iridium phones are also useful but use more battery power.

Wind noise can easily disrupt conversation, use of headphones is preferable.

### **Communications devices - text**

Devices such as inReach and Iridium phone are useful for short texting but should not be relied on for critical alerts due to delays in satellite transmission.

Texts can be sent using AirDrop on iOS devices and Nearby Share on Android. This method is faster as it relies on near-field technology instead of satellites.

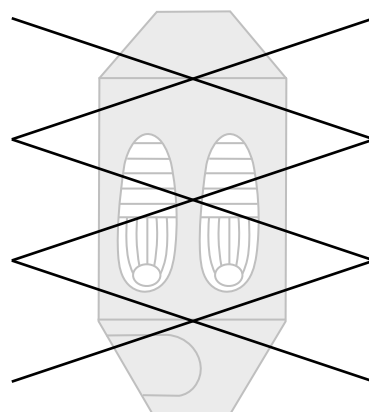
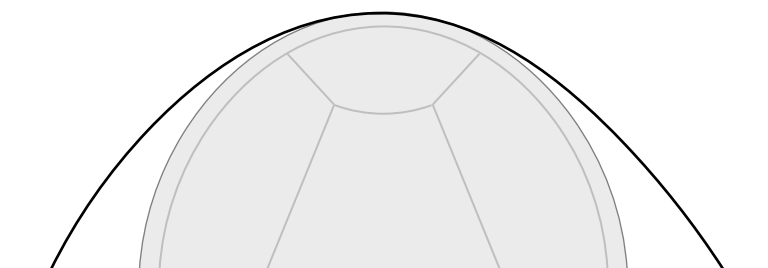
### **Communications devices - whistles**

All team members keep a whistle on their body and follow a pre-established signalling code

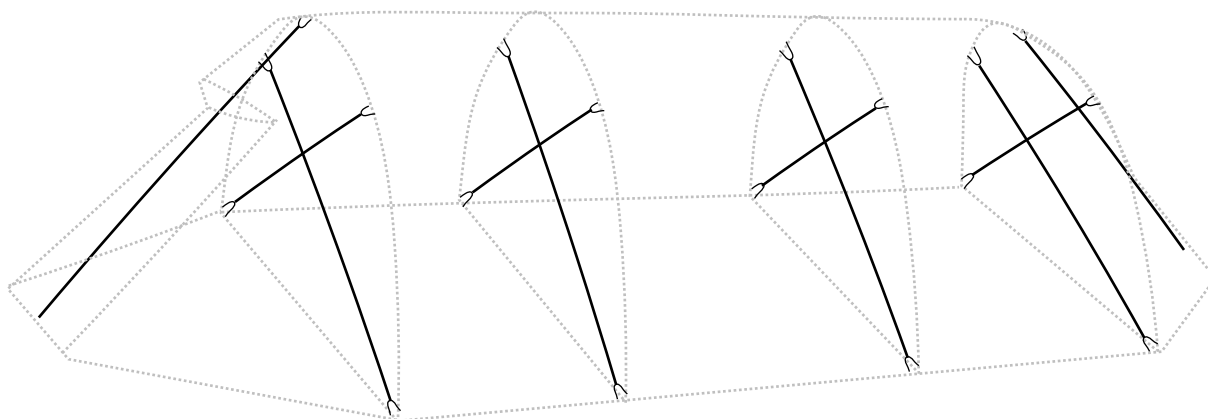
## 12. MITIGATING MEASURES

As wind increases it is advisable to employ every possible technique to prevent loss of tent and increase chances of survival, including:

- regular removal of snow accumulation to avoid tent destruction through burial or..
- permitting tent burial with the intention of preserving the tent and creating a 'snow cave'
- strict monitoring of ventilation, use of stove becomes extremely hazardous
- in the event of a shift in wind direction, collapse tent on lee side, de-stake, rotate on the windward stake and re-erect
- apply external tent bracing using rope or cord, being mindful of chaffing



- apply internal pole bracing using cord or rope (requires pre-placed connectors)



- anchor inner tent to the surface
- build a thick snow wall inside the rear vestibule
- build up compacted snow between the tent walls
- store adequate supply of food and water inside tent
- ensure all communications are at hand and fully charged
- ensure optimal communication between tents
- ensure tent buddy system, maintain constant contact
- occupants are fully dressed and ready for evacuation
- shovels are at hand
- ready to collapse tents if destruction is inevitable

### **13. CATASTROPHIC WIND**

In the event of catastrophic wind conditions where tent destruction through failure or burial is inevitable it is advised to follow mitigating procedures

- alert emergency services
- fill pockets with food, water and comms
- all team members huddle behind any remaining shelter

### **14. AFTERMATH**

A severe wind event will most likely bury a camp, including tents. Only constant snow removal will have prevented tents from becoming buried.

Massive amounts of snow will require removal and may take many hours.

Care must be taken not to damage tents or sled covers during excavation.

# APPENDIX 1: Wind-Chill 'Camp or Continue' Risk Matrix

The risk matrix is based on a critical threshold of -40°C. Guided travel below -40°C, ambient or wind-chill, is not recommended

With increasing strength, wind takes precedence over cold

Assumes ski travel where body warmth is generated through exertion

					AMBIENT AIR TEMPERATURE °C																					
					Continue						Camp if Additional Influences						Camp									
MIN. WIND SPEED	m/sec	km/h	kn	Bft	0	-2	-4	-6	-8	-10	-12	-14	-16	-18	-20	-22	-24	-26	-28	-30	-32	-34	-36	-38	-40	
	0	0	0	0	0	0	-2	-4	-6	-8	-10	-12	-14	-16	-18	-20	-22	-24	-26	-28	-30	-32	-34	-36	-38	-40
	1	4	2	1	-1	-3	-5	-7	-10	-12	-14	-16	-19	-21	-23	-25	-27	-30	-32	-34	-36	-39	-41	-43	-45	
	2	7	4	2	-2	-5	-7	-9	-12	-14	-16	-19	-21	-23	-26	-28	-30	-33	-35	-37	-40	-42	-44	-47	-49	
	3	11	6	3	-4	-6	-8	-11	-13	-16	-18	-20	-23	-25	-28	-30	-32	-35	-37	-40	-42	-44	-47	-49	-52	
	4	14	8	3	-4	-7	-9	-12	-14	-17	-19	-22	-24	-26	-29	-31	-34	-36	-39	-41	-44	-46	-49	-51	-53	
	5	18	10		-5	-7	-10	-12	-15	-17	-20	-22	-25	-27	-31	-32	-35	-37	-40	-42	-45	-47	-50	-52	-55	
	6	22	12.0	4	-5	-8	-11	-13	-16	-18	-21	-23	-26	-28	-31	-33	-36	-38	-41	-44	-46	-49	-51	-54	-56	
	7	25	13.5		-6	-9	-11	-14	-16	-19	-21	-24	-27	-29	-32	-34	-37	-39	-42	-45	-47	-50	-52	-55	-57	
	8	29	15.5	5	-6	-9	-12	-14	-17	-19	-22	-25	-27	-30	-32	-35	-38	-40	-43	-45	-48	-51	-53	-56	-58	
	9	32	17.5		-7	-9	-12	-15	-17	-20	-22	-25	-28	-30	-33	-36	-38	-41	-43	-46	-49	-51	-54	-57	-59	
	10	36	19.5	6	-7	-10	-12	-15	-18	-20	-23	-26	-28	-31	-34	-36	-39	-42	-44	-47	-49	-52	-55	-57	-60	
	11	40	21.5		-7	-10	-13	-15	-18	-21	-23	-26	-29	-31	-34	-37	-39	-42	-45	-47	-50	-52	-55	-58	-61	
	12	43	23.5	7	-8	-10	-13	-16	-18	-21	-24	-26	-29	-32	-35	-37	-40	-43	-45	-48	-51	-53	-56	-59	-61	
	13	47	25.5		-8	-11	-13	-16	-19	-21	-24	-27	-30	-32	-35	-38	-40	-43	-46	-49	-51	-53	-56	-59	-62	
	14	50	27	8	-8	-11	-14	-16	-19	-22	-25	-27	-30	-33	-35	-38	-41	-44	-46	-49	-52	-54	-57	-60	-63	
	15	54	29		-8	-11	-14	-17	-19	-22	-25	-28	-30	-33	-36	-39	-41	-44	-47	-50	-52	-55	-58	-61	-63	
	16	58	31	9	-9	-11	-14	-17	-20	-22	-25	-28	-31	-33	-36	-39	-42	-45	-47	-50	-53	-56	-58	-61	-64	
	17	61	33		-9	-12	-14	-17	-20	-23	-25	-28	-31	-34	-37	-39	-42	-45	-48	-50	-53	-56	-59	-62	-64	
	18	65	35	8	-9	-12	-15	-17	-20	-23	-26	-29	-31	-34	-37	-40	-43	-45	-48	-51	-54	-56	-59	-62	-65	
	19	68	37		-9	-12	-15	-18	-20	-23	-26	-29	-32	-34	-37	-40	-43	-46	-48	-51	-54	-57	-60	-62	-65	
	20	72	39	9	-9	-12	-15	-18	-21	-23	-26	-29	-32	-35	-38	-40	-43	-46	-49	-52	-54	-57	-60	-63	-66	
	21	76	41		-10	-12	-15	-18	-21	-24	-26	-29	-32	-35	-38	-41	-44	-46	-49	-52	-55	-58	-60	-63	-66	

<b>Additional Influences</b> that initiate earlier onset of critical threshold	Headwind
	Visibility - tail cannot see lead or guide cannot assess surface hazards
	Altitude - above 3000m
	Morale - 80% or more of team are not comfortable with tolerating wind/cold

## **APPENDIX 2: Travelling with kites**

Snowkiting and Wind-craft sailing are modes of travel that use a wind traction device to propel a skier, boarder or craft. Unlike other modes of travel that prefer the absence of wind, snowkiters and wind-craft sailors rely on the availability of wind to facilitate progress.

Guided snowkite expeditions require special preparation, skills and judgement in order to manage severe wind challenges. Wind-craft expeditions are uncommon but should employ similar strategies if travelling in a fleet.

A multitude of factors must be considered in managing a safe kiting expedition, particularly in deteriorating wind and visibility, including but not restricted to:

- wind speed and direction
- kite sizing, models and safety features
- sled weight and trace length
- collective skill levels
- team spacing and clustering and guide positioning
- anticipation of changes in wind direction and speed, gusts and kite groundings
- signalling and communications
- separation and SAR procedures

Snowkite expeditions, or expeditions of multiple wind-craft, should not proceed in any conditions where constant visibility of all members is compromised or where loss of visibility is imminent.