SHELTER CONSTRUCTION TECHNIQUES FOR WINTER WEATHER

By Nick Weighton, October 2012

This document augments the Survival Section in your Student Manual and is a Supplement to the website article titled "Moderate Weather Survival Shelter Construction Techniques." It is intended for those planning to venture into the mountains during winter months or high altitudes where snowfields exist throughout the year and snow storms can occur any season.

Cold weather shelter construction requires advance techniques very different and more demanding than those for moderate weather conditions. Contingency planning, prior preparation, and additional gear are essential. Besides the basic items for moderate weather survival, a wide assortment of extra equipment should be considered. Specialized and extra clothing, sleeping bag, tent, snowshoes, ski poles, metal snow shovel, snow saw, spare space blankets, alcohol stove, metal cup/pot for melting ice/purifying water, and many other items could be useful.

A number of shelters are discussed for winter environments and include dimensions, resources, and construction techniques for each. Winter shelters are primarily intended for two survivors. Dimensions are approximate measurements, your final dimensions may vary. Common sense and good judgment must be applied during construction.

All shelters discussed require natural materials and are thus dependent on available resources and the tools/equipment you bring. All the shelters use layers of natural materials as insulation for walls, roofs, and floors. Snow is a key insulation layer. Where "pine boughs" is stated, it is understood other materials can be substituted.

Common Guidelines Applicable to All Snow Shelters

- Site Selection: Pick a place safe from avalanche threat on the leeward side of a drift, small hill or ridge where there is a natural windbreak and snow is deeper from wind transport. Before starting, check snow depth to determine the best shelter choice and probe for obstacles. Goal is to choose a shelter that offers protection from the elements that you can safely and efficiently build.
- Safety: Do not construct shelters on avalanche prone slopes, in avalanches paths, on or below unstable rock outcrops, beneath standing dead trees or where they might fall during a storm, or in drainage paths. Ensure you are not setting up on an ice covered pond, lake or stream. Mark the outside of your shelter since you are camouflaged. This helps rescuers find you and could prevent tracked vehicles, dog sleds or other people from collapsing your shelter and trapping you inside.
- Construction Limitations: Short daylight and severe weather will greatly impact survival procedures. Limited daylight or reduced visibility will hinder site selection and shelter construction. Stormy conditions and/or deep snow will hinder locating and transporting building materials. Completion time for a shelter will increase in adverse conditions. Hidden obstacles can force you to stop work on a shelter and start again elsewhere. Cold temperatures and/or wetness will affect survivors during construction

requiring clothing changes and close observation for hypothermia or frostbite. Darkness will severely impact procedures.

- Shelter Alignment: On sloping terrain, align the long axis of a snow trench or snow block shelter perpendicular to the fall line and run an entry tunnel down slope. This provides level ground for flooring and keeps the height of the ceiling low. On flat terrain the shelter can be aligned in any direction as long as the entrance is downwind and the exterior entry area is preferably lower than the shelter floor.
- Entry Tunnel: A logical and effective addition to a snow shelter is a 6-10 foot long "extended entry tunnel." Make it about 2' wide and 3' high and down slope or downwind from the main shelter opening. Cover with log rafters, pine boughs, and snow. Leave tunnel floor uncovered. Construct an outer door closure of some type. Result gives you two entry closures (main shelter door and outer tunnel door) allowing transition when entering/exiting the shelter. Since only one door is open at a time, the effects of outside wind, cold, and blowing snow are minimized. Don't put 90 degree turns in the tunnel, it's easier to crawl along a straight line or banana curve.
  - "Cork in a bottle" concept. The cork will conform to the shape of a small entrance. Avoid filling with snow, it freezes solid and can be hard to remove and replace during the night. Use snow if nothing else is available.
  - "Log cabin door" made from short logs (3-4' long) lashed together side by side to upper and lower perpendicular logs. It's very helpful in cold weather to wrap and lash a spare tarp or trash bag around the log door.
  - Snow blocks are good closures but will freeze in place and may require breaking to remove. Use a snow saw to free up the blocks before moving.
  - Use a tarp as a last result. Make sure it is securely anchored into the entry roof and anchor the bottom with logs, rocks, pack or snow block to prevent high winds from opening it.
- Shelter Strength: Build a snow shelter for worst case scenarios. The roof will be heavy after adding pine boughs and snow so your rafter materials must be strong enough to support it. And what if there's a snow storm later?!
- Insulation: Floor insulation can consist of foam pads and/or natural materials like pine boughs, needles, leaves, logs, etc. Roof and outer wall insulation can consist of natural materials like pine boughs and snow. For flooring put 12-18" of natural materials and for roofs put 12-18" of both boughs and snow.
- There are two floor level options depending on snow depth and slope of terrain:
  - In shallow snow and/or flat terrain, shelter floor needs to be the same as or higher than surface snow to allow a lower entry area. The floor can be raised with 1-2 feet of pine boughs, logs, snow, snow blocks or combination.
  - In deep snow and/or sloping terrain, shelter floor can be 2-4 feet lower than surface snow as long as an entry tunnel floor is lower than the main floor. If available, snow blocks can be combined with a shallow trench to build up short walls above surface level.

- Goal with all shelters is to make the main shelter floor higher than the area immediately outside the door. Cold air flows downward via gravity and you want to minimize it flowing into your shelter.

- Anchoring and Sealing Up a Shelter: Refer to "Moderate Weather Shelter Construction Techniques" for review. Snow will be a primary covering and insulator on most winter shelters.
- Foam Ground Pads: Essential for winter shelters above tree line or where natural flooring materials aren't available. Ground pads can be laid on a base layer of pine boughs or small logs to provide additional insulation and keep pads off cold, rocky, snowy or wet ground.
- Tarps and space blankets do not insulate you. Blue tarps are not as visible from a distance as you might think. Thermal blankets are strong enough to use in constructing a shelter, punctures can be patched with duct tape. Space blankets (gold/silver foil) are excellent for reflecting radiant body heat. Avoid using for construction, they tear easily and shred apart.
- Ventilation: Never use stoves in a snow shelter for cooking, melting ice/snow or warming the interior. Carbon monoxide buildup could kill you. Snow trenches and blowout shelters usually cannot be sealed tightly enough to prevent natural ventilation but still use caution and use at partially open entrance to vent fumes. Snow shelters with entrances below floor level require venting of carbon dioxide from breathing and non-toxic heat devices such as candles. Make at least two vent holes 1-2" in diameter in snow cave and quinzee roofs. Clear the holes periodically.

I. SNOW TRENCH

- Very good winter shelter. Takes 2 hours or more to build depending on proximity of trees.
- Dimensions: 4' wide, 4' high (interior roof height) and 7-8' long with a small entrance (2'x3').
- Interior size is important. Too small won't give you room to maneuver, too big means more cold air that will rob heat you generate.
- You don't need snow four feet deep to make a snow trench, 1'- 2' is adequate. Pile snow into a large mound about 10'- 12' long, 7'- 8' wide and 3' high. Allow 45 minutes or more for snow to reconstitute then dig out interior to desired dimensions. (Reconstitution time depends on snow and weather variables.) Use interior snow to build up wall height to 4'. (While snow is reconstituting, cut down and transport trees to the survival site then chop off the limbs for use later. This will be labor intensive and time consuming.)
- Before digging, trace an outline of the trench on the snow surface with a shovel or stick. Start shoveling at the shelter entrance and work toward the "back end" of the trench. Dig the trench about one foot shorter and narrower than the final dimensions so you can enlarge it as needed. You can always make it wider or

longer but you can't always put snow back if you dig it too big. Once the trench is partially dug then widen, lengthen or deepen to desired size.

- Make walls vertical and the top of them flat. Avoid a "bomb crater" effect where upper interior walls slant outward and the tops of walls make a sloping berm. These slanting areas will create extra dead air under the roof that steals interior heat you've produced.
- If time and resources allow, dig an extended entry tunnel.
- Cut 3-4 inch diameter trees 8'- 12' long depending on snow density. The softer the snow, the longer the logs need to extend further onto surrounding snow for support.
- Drag trees to the shelter site then trim off limbs to use later for insulation. Saves excess trips hauling loose limbs to the site.
- Place long roof rafters across the narrow width of the trench starting at the back end of the shelter and work toward the entrance. Place rafters a foot or so apart. (If snow is extra soft, put a row of "footer logs" 1-2 feet out past and parallel to the edges of the trench to make a foundation for roof rafters to rest on. Stack several logs on top of each other if necessary to build up the foundation.)
- After working your way to the entrance, place a second layer of long rafters perpendicular to first row. Lay any bare limbs that do not have needles or leaves on top of the rafters as extra filler to keep pine boughs from falling through.
- Cover the main shelter floor with foam pads or natural insulation like pine boughs. You can cover the floor with natural materials for added insulation even if you have a foam pad. Don't insulate the tunnel floor, you can move easier on snow. When snow is soft and walls might collapse while installing rafters, layer the floor later in case part of a wall breaks down during construction. It will be easier to shovel out and you won't have to shake snow out of your floor insulation. When snow is strong, layer the main floor with boughs before installing rafters.
- Can build vertical interior log walls to insulate you from snow walls and/or a make a log floor to place foam pads or boughs on. If doing so, dig the trench slightly bigger and construct log walls and floor before installing rafters.
- Cover the extended tunnel with roof rafters then cover the entire shelter system with boughs and snow.
- Snow blocks can be placed on rafters instead of pine boughs as an option for constructing a roof. This is a good technique where there are deciduous trees with no boughs or leaves or if using bare deadfall logs.
- If expecting rain or wet snow, dome shape the roof boughs and cover with tarps. Be cautious about covering a shelter with snow if it will rain due to snow becoming dangerously heavy from saturation as well as dripping into the interior.
- Close up the inner shelter entrance and outer tunnel entry using closures of some type.

- Above tree line, you can use climbing rope and skis as roof rafters, and poles and ice axes as anchors. Dig a standard trench, zigzag the rope back and forth across the top of the trench and skis, anchor the rope at each turn with axes, dismantled poles, and other devices. Lash roof tarps to the rope and anchors and cover lightly with snow. Use foam pads and/or packs for floor insulation. Close up the entry with snow blocks, sled or packs.

II. TREE BLOWOUT OR "DONUT"

- Good winter shelter. Incorporates a trough area blown out by the wind swirling around the trunk of a large tree. Takes about 1½ - 2 hours to build. Uses similar techniques as a snow trench.
- You can use a blowout as the starting point for a circular, half moon or rectangular snow trench. Will need to dig out a portion to enlarge a living area. Can use all or a portion of the blowout depending on how large it initially is and number of survivors.
- Dimensions are similar to a snow trench but can be circular around the tree or rectangular going away from it. Circular: 3-4' radius from the tree, 3-4' interior roof height at the outer circumference, and long enough for survivors to lie down. Rectangular: same as snow trench, possibly use tree trunk and its lower limbs as a sheltered entry point. Build a small entrance (2'x3') for both designs.
- Enlarge the blowout to fit your needs and use dug out snow to raise wall heights or fill in an unused section of the blowout.
- Lash roof rafters to the tree trunk or lower tree limbs a couple feet higher than the snow level. Form a slanting roof in a "spoke pattern" for a circular design or long wedge for rectangular design. Cover rafters with pine boughs and snow to insulate the shelter.
- Insulate the floor with foam pads or pine boughs and close up the entrance. You can make an entry in the roof ("manhole cover/tank hatch") or a horizontal entry tunnel like with a snow trench.
- If you are sitting up, lean against the tree not the snow. Wood is an insulator, snow will chill you via conduction.

III. SNOW BLOCK SHELTER

- Very good, strong winter shelter. Equates to an above ground snow trench. Sometimes nature provides well packed, ready to cut snow you can use to build a shelter. Can construct using only blocks or combine with a shallow snow trench by building block walls above snow level. Takes 2 hours or more to build. Very good for extended survival.

- If firm snow is not available and there is time, stomp down an area about 20’ by 20’ with snowshoes and let it reconstitute until moderately firm (30-60 mins or more depending on type of snow and conditions). Do other survival tasks while the snow is setting up.
- Can stomp down an area Day 1 to use blocks later that day or the next for other uses such as extended entry tunnels and windbreaks.

Two Basic Designs: 1-Person A-Frame and 2-Person Rectangular

“A-frame” Design: Uses slanting roof blocks that support each other but the shelter is confining and good for only one person. Dimensions: 2-3’ interior height, 2-3’ wide at bottom level, 7-8’ long. Height and width depend on size of blocks one can cut and manage. Takes 1 hour or less to build. Very restrictive but an effective shelter.

- It helps to dig a shallow trench then add the slanting roof. This adds more height to the shelter and possibly more width at the base. Cut blocks as large and thick as snow density allows and you can still pick up and put into place.
- Starting at the “back end” of the shelter, lean blocks against each other. “Offset" opposing blocks so their edges (side seams) don't line up across from each other. Offset seams reduce the chance of blocks dislodging the one opposite them and collapsing the roof. Position each block so it tilts against half of two opposite blocks resulting in an alternating array of seams.
- Block up the back end of the A-frame and cover entire shelter with snow to seal up joint seams. Can cover with bright colored tarp to keep out rain and simultaneously mark your location for rescuers. Or attach a bright colored item to a ”flag pole” next to your shelter as a marker.
- A foam pad for flooring is preferred since ceiling height and interior space will be limited and natural insulation like pine boughs will raise the floor too high. If using natural flooring, dig at least a foot-deep trench to compensate for flooring height.
- Will need to go in the shelter feet first so you can close up the front door with a pack or snow blocks after entering and easily exit later. Allow room for your pack at the front for access during the night.

Rectangular 2-Person Design: Excellent shelter for 2-3 people. More functional than the 1-person A-frame but requires roof rafters for added support and safety. Dimensions: Same as snow trench (4’ wide, 3-4” interior roof height, 7-8’ long). Interior height depends on whether you’re using foam pads or natural flooring.

- Block dimensions: Cut wall blocks 16-18” long, 8-10” deep (front to back) and 8-10” thick (top to bottom). Size of blocks depends on length of saw and snow density/strength. Cut uniform blocks for consistency and easier construction of walls. Roof blocks can be slightly longer, wider, and thinner if snow strength allows. Roof blocks can be 4-6 inches thick if covered with several inches of shoveled snow. If loose snow is in short supply, add a second layer of 4-6 inch thick blocks for good roof closure and added insulation. If you must obtain blocks

away from the shelter site, several blocks can be carried on a fabricated "stretcher/litter" of two trees/limbs 5-7' long.

- Starting at the entry, lay out one entire foundation row/layer of cut blocks to establish the entire outline of the shelter. Include entry tunnel in the initial pattern but if limited on time it can be added later. Adjust the pattern if needed to get the dimensions right before adding more rows. Blocks will freeze together quickly and break apart if you try to remove 2d or 3d layers to correct for dimension errors later.
- Build walls with each row of blocks overlapping underlying joints like a brick wall for strength. Never stack blocks in "columns," they could collapse. Push snow in vertical joints between adjoining ends of blocks but don't worry about filling in horizontal joints initially. If snow is piled against the outer walls and on the roof after construction, joints will be filled in automatically. Otherwise fill in all joint gaps as a last step, get the shelter built before doing finishing touches.
- Use log rafters or skis to support flat roof blocks. There are limits on how wide a span snow blocks can cover. Beyond 2 feet or so, unsupported blocks tend to fracture and collapse into the shelter possibly injuring or trapping occupants.
- When constructing a flat roof with rafters, place a single layer of logs 6-10 inches apart starting at the "back end" of the shelter. Run logs perpendicular across the narrow shelter width. Ends of logs can extend beyond the walls but they might interfere with standing close to the shelter to install roof blocks. Two options for logs: Position them flush with the top layer of blocks by cutting shallow troughs to rest them in. Or rest logs on top of walls and pack snow between them to close up air gaps.
- An efficient technique is to install several rafters then place a row or two of roof blocks as you work to the entrance. Work in pairs with one person in the interior installing rafters and blocks handed to them by a person outside the shelter. It also avoids straining your back while lifting heavy logs or blocks from outside the walls. If blocks are not heavy, all rafters can be installed first then blocks added afterwards. Offset roof block joints to prevent continuous seams that might fracture.
- After building your shelter, consider using blocks to build windbreaks for a cooking area, fire pit or latrine.

IV. SNOW CAVE

- Excellent shelter but not necessarily the best to build. Takes several hours to make and can be hazardous. Don't attempt if you've never dug one before, survival is not the time to learn by trial and error.
- There are several construction methods discussed later. Snow caves are very labor intensive and can take 2-4 hours to properly construct. You need the right snow conditions, skills, and tools to build one correctly.

- There are added risks -- you might encounter hidden boulders or ice, the roof can collapse during or after construction, and you can get wet while building or sitting inside them. A partner must always be present outside in case of collapse while a person digs out the entry and chamber area.
- Snow should be at least 4-5’ deep and consistent enough to make a good snowball. Powdery or granular snow is not good and can be unsafe for construction. Interior must be dome-shaped, flat roofs will collapse.
- Dimensions: high enough inside to sit upright (3-4’ interior roof height), 8-10 foot wide floor diameter, and dome-shaped like the interior of a VW Beetle without seats. Walls should be at least 12-18” thick and the roof at least 10-12” thick. Check thicknesses periodically with a thin stick or ski pole w/o basket while digging to avoid thinning and collapse. Entry tunnels can be 2-4’ in diameter. A narrow entry might hinder moving snow outward to a partner but is easy to seal up. A large entry makes snow removal easier but needs to be narrowed after the cave is built.
- Sloping Tunnel Construction Method:
  - Start the entry point several feet lower than the eventual floor level of the main chamber.
  - Dig a tunnel horizontally inward 2-3’ then slant upward at 45 degrees for 2-3’ to the chamber floor level. Dig out a dome-shaped interior.
- Vertical Shaft Construction Method:
  - Dig a tunnel horizontally the length of your body then dig a shaft straight up 2-3’ to the eventual chamber floor level.
  - Dig out a dome-shaped interior. Concept is similar to a beaver house. Vertical entry shaft should be near one edge of the chamber floor.
- “T” Construction Method:
  - This design can be done standing up thus keeping you drier but snow must be very deep (deeper than you are tall). You may need to dig down 6-8’ to start into a vertical wall of snow if unable to find a steeply sloped mound or drift.
  - Snow saw and dig out a 2-foot wide vertical corridor as tall as you for 8-10’ into a snow slope or mound. Then dig horizontally to the left and right at waist height in a “T” pattern to form a long trench with sleeping platforms to each side.
  - Dome shape the interior roof over the platforms and corridor then block up the front, upper half of the “T” with snow blocks. The bottom half of the T forms an entry door lower than the platforms with a walking trench the length of the shelter.
- Smooth the interior roof and walls to prevent water dripping on you and poke a couple 1-2” wide holes through the roof for ventilation.
- If digging into a snow mound or drift where snow is not deep enough for a

sloping or vertical shaft entrance, make a U-shaped ("P-trap") entry tunnel to create a trough lower than your floor where cold air can settle.

- Insulate the interior floor of a snow cave with pine boughs or foam pads and close up the entrance.
- Snow caves are naturally insulated and provide excellent protection from the elements. Body heat and heat generating devices can significantly raise the temperature inside. Be aware this can cause walls and ceilings to melt resulting in dripping and puddles.

V. QUINZEE

- An "above ground" snow cave. Can take half a day to build. It takes too long to build as an initial shelter but could be constructed Day 2 in extended survival.
- Dimensions: Same as snow cave.
- Shovel snow into a large mound a few feet higher and wider than your intended interior area.
- Helpful technique is to push dozens of 6-8 inch long sticks into the outer dome. They will indicate when to stop digging out the interior chamber as you encounter ends of the sticks. It is very easy to dig the dome too thin in places and have it collapse. A small cave-in of the roof could render the shelter nearly useless.
- Wait several hours for the snow to harden up and dig out the interior like a snow cave.
- A quinzee has risks like a snow cave – collapse and dripping water.

VI. IGLOO

- Igloos are too complex and time consuming to initially build for survival situations. They take special snow conditions, skills, and experience to construct.
- There are inherent risks of collapse that could injure or trap survivors.
- When properly built, they are excellent shelters and could be considered in extended survival if you have the knowledge and ability to build them.

It is hoped you are never in a survival situation, but if circumstances force you to remain in the field, think before acting, evaluate all resources and options then determine the best shelter for your specific situation. Approach survival with a positive attitude, work as a team and be determined to survive.