Table of Contents

15.0 Snowmobiles

Introduction

Snowmobiles are commonly used in extremely adverse weather conditions with sub-zero temperatures; therefore, employee safety relies heavily on their dependability. Snowmobiles should be kept in good operating condition and be equipped with emergency supplies. For this reason, it may be advisable for companies to consider leasing new snowmobiles each season rather than purchasing them and attempting to maintain them over several years.

Definition

Snowmobiles (snow machine, sled, skidoo) are part of a specialized class of all-terrain vehicles; they are powered by a two or a four stroke gasoline engine and move on a continuous rotating track and skis.

15.1 Risks and Hazards

Serious injury or death may result if a snowmobile is not operated according to the manufacturer's instructions. Statistics associated with general snowmobile use indicate that:

- Collisions with a stationary object are the #1 cause of death
- Drowning when a rider breaks through ice are the #2 cause of death

Specific risks and hazards associated with snowmobile use include:

- Injuries:
    - Back strains caused by lifting a snowmobile stuck in slush or righting an overturned one
    - Impact injuries caused by excessive speed, not wearing a helmet, collisions with objects or other snowmobiles
    - Slips, trips and falls on slippery surfaces
- Cold injuries (hypothermia, frostbite, cold water immersion hypothermia) caused by wearing inadequate clothing, excessive speed that increases the effect of wind chill, extracting a snowmobile stuck in overflow or slush
- Thin ice caused by unrecognized variable ice thickness due to underwater currents and/or temperature variations, pressure ridges, undetected cracks (snow covered)
- Breaking through ice caused by lack of local knowledge regarding hazards and/or location of thin ice, inaccurate measurement of ice thickness, inaccurate measurement of the total load
- Stranding – potential survival situation caused by mechanical breakdown, running out of gas or oil, whiteouts, avalanches blocking the route
- Getting lost – potential survival situation caused by loss of battery power of GPS and/or communication equipment, whiteout conditions, wrong type of equipment for the area

- Avalanche-related death or injury caused by using snowmobiles in avalanche prone terrain, lack of expert advice, lack of avalanche safety equipment and/or training, not following SOPs and ERPs, poor planning

15.2 Responsibilities (Due Diligence) Regarding Snowmobiles

As presented in chapter 1, section 1.2 Due Diligence, companies should be able to demonstrate due diligence with regard to safety at their project sites. To comply regarding the safe use of snowmobiles, each company, its supervisors and employees should fulfil responsibilities that include, but are not limited to, the following measures:

Exploration Companies

- Develop written safe operation procedures (SOPs) and site specific SOPs (as needed) that apply to snowmobiles.
- Develop written emergency response plans (ERPs) that address potential emergencies related to snowmobile use.
- Carry out risk assessments including assessments specific to working on ice.
- Make sure supervisors are trained and competent.
- Provide training and education for employees regarding SOPs and work related hazards.
- Carry out routine inspections and maintenance of snowmobiles.
- Monitor the use of snowmobiles and implement consequences when SOPs etc., are not followed.
- Documentation: Keep records of all training, accidents, incidents and corrective actions, mitigation of hazards, inspections, maintenance, infractions etc., that apply to snowmobiles.
- Provide required personal protective equipment (PPE).
- Carry adequate insurance.

Project Supervisor/Camp Manager

- Develop site specific SOPs and ERPs that address local risks and hazards.
- Implement company SOPs and those in the manufacturer's operator manuals.
- Advise, instruct and monitor employees regarding the safe use of snowmobiles.

Operators

- Follow all company SOPs and training regarding snowmobiles.
- Be familiar with the warning decals on snowmobiles.
- Carry and use PPE and safety equipment as directed.
- Report hazards and dangers to the supervisor.
- Be familiar with project ERP procedures regarding potential snowmobile-related emergencies.

15.3 Safe Operating Guidelines for Snowmobiles

The following guidelines may be used in conjunction with a manufacturer's operator manual to develop site specific safe operating procedures (SOPs):

1. Comply with the manufacturer's safe operating procedures in the operator manual. Most manufacturers supply comprehensive operation and maintenance procedures. Some manufacturers also supply safety videos for their machines.
2. Obey the laws of the country, province, territory, state and municipality that apply to snowmobiles. Snowmobiles should carry valid registration and insurance documents. Companies may choose to specify that riders carry a valid driver's license, depending on liability and insurance issues.
3. Riders and passengers should wear appropriate personal protective equipment (PPE). This includes a Canadian Standards Association (CSA), Department of Transport (DOT) or Snell approved helmet, face visor and/or goggles, good quality boots (preferably with felt liners), warm gloves or mitts, and appropriate winter protective clothing. If working on ice, riders and passengers should wear a floater snowmobile suit or a personal flotation device (PFD) if there is even a remote chance of breaking through ice. (See section 15.10 Working on Ice.)
4. Snowmobiles should carry required and appropriate safety equipment as recommended in section 15.4. Essential equipment includes:
    - The machine should be equipped with a first aid kit, tools and spare parts, communication and safety equipment appropriate for the trip.
    - Each rider and passenger should carry an essential survival kit on their person (knife, fire starter kit, whistle, and compass etc.) and ice rescue picks when working on ice.
    - Carry appropriate navigation and communication equipment (radio, satellite phone or cell phone), a GPS (Global Positioning System) unit with extra batteries and be trained to use them.
5. Develop an emergency response plan (ERP). Develop procedures that address breakdowns, overdue snowmobiles, whiteouts, stranding, getting lost, breaking through ice, and other site specific risks such as avalanches. Riders should carry a written copy of emergency procedures.
6. Each project or camp should establish communication schedules with routine check-in times that reflect the working conditions. Employees should adhere to their check-in schedule and inform the person in charge of changes in plans.
7. Employees should inform the person in charge of the tracking system of their daily planned route with estimated time of arrival or return. The information should be recorded on a map. The person in charge should be familiar with the ERPs and know what to do if a rider does not arrive or return as planned, or if they do not check in on schedule.
8. New riders should be trained to operate and maintain snowmobiles. They should be given a copy of the manufacturer's operator manual. All riders should be able to perform typical field emergency repairs.
9. Travel using the "buddy system" whenever possible, especially on long traverses, but do not team two inexperienced operators together. Travel with separate machines for safety. If it is necessary to work alone, follow the guidelines in section 2.1.1. Working Alone Versus the "Buddy System". It is advisable to carry a satellite phone, which is the most dependable means of communications, especially in remote areas.
10. Maintain a safe speed and keep the snowmobile under control.

11. Obtain permission to cross private land. Leave gates as they are found.
12. Do not ride a snowmobile if you have consumed alcohol or taken medication or drugs that might affect your ability to ride. Consumption of alcohol and exposure to cold temperatures increase the chance of developing hypothermia and frostbite. Alcohol is a major contributing factor in many snowmobile accidents.
13. Snowmobiles should not be used for chasing or harassing wildlife; provincial and territorial legislation prohibits these actions.
14. Use caution when riding along the edge of paved roads or railroad right of ways. Check local regulations, as it may be illegal to do so.
15. Companies should consider establishing guidelines regarding the use of company owned or leased snowmobiles for recreational purposes.
16. Ride to protect the environment; do not ride over shrubs, young trees or fragile environments without sufficient snow depth. Use dedicated paths for snowmobiles whenever possible.

15.4 Equipment Lists for Snowmobiles

Snowmobiles are usually used to travel short distances between a winter camp and drill site and a person can snowshoe to safety under most conditions. When selecting equipment, consider (1) the distance to the work site; (2) the location (on land or ice); and (3) the weather. Equipment requirements for long traverses will be significantly different. Be sensible and take sufficient equipment. Use the following lists to assemble appropriate equipment for the circumstances. Essential equipment for all wilderness travel is indicated in bold.

Carry more equipment if you are travelling:

- More than a reasonable distance to snowshoe – perhaps 3 km for a healthy person depending on snow conditions
- In very cold conditions
- In a very small group

Personal equipment recommended or required by law (operators and passengers)

- Helmet, preferably with visor
- **Boots**
- **Mitts**
- **Multiple layers of clothing**
- **Sunglasses or goggles**

Note: Although a helmet is recommended or compulsory for snowmobile travel, under certain working conditions when speeds are low, stops and non operating periods are long and/or frequent, it may be safer to wear warm headgear rather than a helmet. Helmets make it more difficult to be aware of your surroundings due to poor side vision, and they make it difficult to communicate as they obstruct hearing. Helmets may make it more difficult to safely operate tools such as ice augers or water pumps.

Equipment that may be required, as necessary

- Snowshoes
- Communication equipment (radio, satellite phone, cell phone, as appropriate) and extra batteries
- Location equipment **(compass and maps,** GPS and extra batteries)
- Spare ignition key
- Spare drive belt, spark plugs, headlight bulbs
- Tools, including manufacturer's tool kit
- Axe
- First aid kit
- Small shovel, probe pole, beacon (essential in avalanche terrain)
- Safety throw-rope to aid recovery if partner falls through ice (depending on season)
- Extra fuel and oil
- Food
- Operator manual
- **Waterproof matches, lighter, fire making equipment**
- Knife
- Gas line antifreeze (isopropyl based), as required by manufacturer
- Survival kit
- Flashlight and extra batteries
- Large space blanket (1 per person)
- Duct tape and wire
- Candle, sterno cans
- Flares
- Work gloves
- Large metal cup
- Log book

Additional equipment for long traverses and/or very cold conditions

(Refer to Chapter 8. Survival for additional recommendations)

- Extra clothing
- Winch
- Sleigh for hauling equipment
- Sleeping bag rated for Arctic conditions, 1 per person
- Tent suitable for climate conditions and number of passengers
- Small gas cylinder and stove burner attachment
- Satellite telephone and extra batteries
- Sleigh for hauling equipment and survival gear, as required

If working on ice, each snowmobile should carry a hypothermia kit that includes:

- Waterproof matches

- Fire starting material (2 kinds)
- Chemical hot packs
- Floating throw-rope packet
- Spare clothes
- Sleeping bag
- Small gas cylinder and stove burner attachment
- Food and drink mixes
- Ice rescue picks (one set on each person)

Ice rescue picks should be kept readily available on your person to pull yourself up onto the ice should you break through. Commercial ice picks can be purchased or they are easily made (cover the end with rubber tubing for protection). For more information, visit:

http://6fbd21e64bc817fd097aa54148bd3dab37bc10ee.gripelements.com/documents/MT-2002-q3-IcePicks.pdf

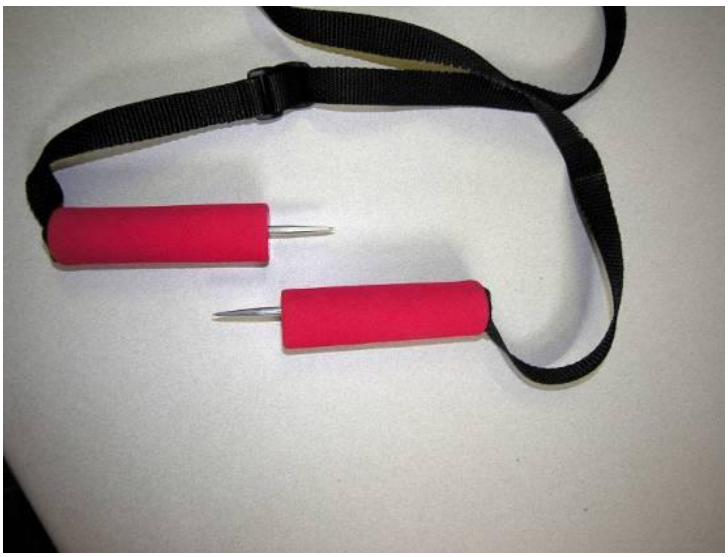

Figure 15.1: Commercial ice rescue picks © Courtney Mitchell

Figure 15.2: Carry snow shoes appropriate for snow conditions © Lorne Burden

15.5 Inspections, Maintenance and Fuelling Guidelines

15.5.1 Inspections

Do not use a defective machine. Only use snowmobiles in good repair; your life may depend on it being in good working order. Report all defects to a supervisor and have them repaired before use.

Pre-ride Inspection

Inspect the snowmobile before each trip. Do a two part inspection – before and after starting the engine.

Before starting the engine:

- Remove any snow and ice from the lights, controls, footrests, seat etc.
- Open the engine cowling and remove any buildup of snow or ice in the engine compartment.
- Check all cables for damage; remove accumulated ice or snow that might restrict movement.
- Check that the track and runners are in good condition.
- Check that the tracks are not frozen and that no debris is caught in the tracks (e.g. sticks, grass). Clean the tracks after use or each morning to remove embedded snow and/or ice using the method described in the operator manual.

- Make sure the fuel and oil tanks are full including any reserve tanks. Check for leaks. Carry extra fuel in certified containers, as necessary.
- Check that the steering linkages are tight and function correctly.
- Verify that the handlebars are able to steer the skis easily and that the throttle and brakes operate smoothly with the handlebars in all positions. The throttle must move freely before starting the machine. Do not operate a snowmobile if the throttle malfunctions.
- Check the condition of the drive belt.
- Check the air filter and remove ice or snow.
- Check the radiator regularly if the machine has one.
- Check that all required equipment is present and in good working order.
- Check that the hood and storage compartments are latched.

Start the snowmobile engine:

- Follow the correct starting procedure described in the manufacturer's operator manual. Start the snowmobile outdoors – not inside a building or enclosed space. Exposure to carbon monoxide (CO) in exhaust fumes is dangerous even for a short time.
- Warm the snowmobile for the time recommended in the operator manual, which will depend on the outside temperature. If this routine is ignored, the belts etc. may wear out very quickly and break even when new.
- Check that the throttle and all switches work properly, including the emergency stop.
- Check that the brakes, headlights and taillights work properly.
- Clearing the track: If the track is raised off the ground, make sure it rotates at the slowest possible speed. Make sure no one is nearby as blocks of ice and snow may be sent flying. It is not advisable to lift the rear of the snowmobile and spin the tracks to achieve this, as you may injure your back or be hit by chunks or snow or ice. Operator manuals usually recommend that to clear or inspect the track, you should tilt the sled on its side and remove a blockage with a piece of wood or a branch.

15.5.2 Maintenance

Maintain all snowmobiles in good operating condition. Poorly maintained snowmobiles present a risk to riders, as they may break down at any time.

- Follow the maintenance schedule and procedures outlined in the manufacturer's operator manual.
- Two daily maintenance measures are important:
    - Lift the engine hood and remove any snow or ice buildup in the engine compartment, including around the steering gear.
    - Clear the tracks to remove embedded ice and snow.
- If possible, store the snowmobile at the end of the day with the track elevated off the snow to prolong the life of the track.

- Protect the engine compartment with a cover or tarp when parking for extended periods (outdoors). In the Arctic, blowing snow can pack up in an engine compartment and cause icing so the machine will not operate. Shelters for snowmobiles are the best solution.
- Correct carburetor calibration is essential to prevent engine damage when the snowmobile is used in very low temperatures. Check the operator manual.
- Make sure the snowmobile is adjusted correctly for the altitude.
- Service the snowmobile at the end of the season before it is stored.
- Maintain a log book and record servicing, repairs and modifications to snowmobiles.

15.5.3 Fuelling Procedures

- Use the correct fuel. Know which gas and which oil the snowmobile requires and the correct ratio. Newer models use gasoline in one tank and 2-stroke oil in a separate tank. Be very careful to fill each tank with the correct product. Snowmobiles in the far north may have the oil injection tank removed or turned off as they tend to freeze up, in which case the oil is mixed with the fuel.
- If the snowmobile is an older model that requires pre-mixed fuel, mix it in a safe location. Use a clean CSA approved container to mix the gas with the recommended amount of oil and shake well. Follow the specific procedure in the operator manual.
- Fuel a snowmobile in a well ventilated place with the engine stopped.
- Do not fuel a machine near another machine with the engine running or while it is in the bed of a pickup truck with a vinyl bed liner.
- Do not smoke. Do not allow open flames or sparks in a fuelling area.
- Use a dipstick or flashlight to check fuel levels. Never use a lighted match as fuel fumes are explosive.
- Do not fill the tank too full; close the tank cap securely when fuelling is completed.
- Add appropriate gas line antifreeze at each fuelling. Check the operator manual for details.
- Clean up any fuel spills completely with spill kit materials and dispose of contaminated materials in appropriately marked containers.
- Portable containers for fuel must be CSA approved. When filling them, always place portable containers on the ground outside a pickup, an enclosed vehicle or a trailer so they are properly grounded (earthed). The vinyl bed liners in pickups prevent grounding. Fuel flowing into a container can create static electricity and it is possible to generate a spark and cause fuel vapors to explode if the container is not grounded. Only fill the containers to 95% capacity, as fuel expands as it warms. If possible, store fuel containers in a cool location out of direct sunlight.

15.6 Training for Snowmobile Operators

As a minimum, companies should make sure employees have the necessary training and skills to operate snowmobiles safely and reduce risky behaviour. Training should cover fundamental risks and hazards of operating snowmobiles and how to prevent accidents through the use of SOPs, PPE, and safe riding skills. Make use of manufacturer's operator manuals in addition to material

in this section to develop SOPs and topics for use in training sessions and safety meetings. Keep training records as required by Workers' Compensation Boards and to demonstrate due diligence.

Training programs are available from Canada Safety Council and should be taught by certified CSC snowmobile instructors. Information regarding CSC training can be found at the following website: http://www.safety-council.org/training/Snowmobile/snowmobile.html .

1. Training should promote safe riding skills (see section 15.8) and include the following:
    - A thorough understanding of snowmobile features and capabilities
    - Hands-on practice of manoeuvring skills, recovery techniques
    - Correct riding positions for various terrain and snow conditions
    - Safe use of snowmobiles on ice (see section 15.10).
    - Emergency braking practice to become familiar with required stopping distances
    - Inspection routines and safe fuelling procedures
    - Emergency maintenance – troubleshooting and minor repairs including how to prime and pull start a machine, if applicable
    - Variation in controls, handling and performance of the different snowmobiles on site
    - Safe loading and towing procedures
    - The responsible use of snowmobiles especially if company owned or leased snowmobiles are permitted for recreational use.
    - New riders should learn to ride in a restricted flat area.
    - Supervisors or trained employees should assess the competency of new riders before granting permission to travel alone to work sites.
2. Each rider should learn to assess risks:
    - Evaluate and understand their personal skill level
    - Recognize how various terrain, weather, temperature and light conditions affect the level of risk and the ability to ride safely
    - Understand the risks of frostbite, hypothermia, and the preventive measures (PPE, clothing, behaviour etc.) to counteract wind chill
    - Understand safe ice testing techniques and safe procedures for working on ice. Mentally assess the risks each time before working on ice, especially near freeze up and breakup.
    - Understand avalanche risks and avoidance. If avalanches are a risk, companies should engage expert help and employees should receive appropriate training from experts. Refer to Chapter 6. Safe Traversing Practices and section 9.4 Avalanches.
3. Each rider should understand how snowmobile SOPs integrate with company and project/camp ERPs, communication procedures, survival and other safety procedures.

15.7 Safety Precautions for Snowmobiles

General Recommendations

- Mark regularly travelled routes: Use flagging tape, wooden pickets painted with fluorescent paint, or even tree blazes (where legal). Marked trails are very helpful when:
    - Travelling in flat light and/or poor visibility conditions
    - Traffic is heavy
    - Safe routes are required when working around heavy equipment
    - Indicating the tested and proven safe route for crossing ice
- Hand signals: Be familiar with appropriate hand signals for communicating with other snowmobilers. Hand signals approved by the Canadian Council of Snowmobile Organizations, the American Council of Snowmobile Associations and the International Snowmobile Council are available at: http://www.ccso-ccom.ca/handsigs.html
- Emergency fuel caches and/or survival equipment caches: Establish and know the location of the caches if conditions warrant them – better safe than sorry.
- Be aware of current and forecast weather conditions before starting out. Postpone a trip if weather is bad or deteriorating.
- In case of a breakdown, follow the established camp ERP procedures if you cannot repair the snowmobile. If you are not within easy snowshoeing distance, stay near the machine and look for or build a simple shelter from wind and weather (e.g., tree hole, quinzee, snow cave in a drift). Communicate your situation to camp and make your position obvious by creating a signal with a smoky fire, large SOS letters in the snow with branches or dirt etc. Leave a note if you choose to hike to camp, but do not do so unless is a *very* short distance and you *know* you can get there safely.
- Carry a spare ignition key or attach it to a lanyard or flagging – a key may be impossible to find if it falls in the snow.
- Use a snowmobile with heated handle grips/throttle and heated foot warmers for long traverses or very cold conditions, if available. They provide an additional safety factor.
- Riding on ice increases the risks. Snowmobiles lose traction and manoeuvrability on ice. Slow down and allow extra distance between machines on ice and for turning. See section 15.10 Working on Ice.
- When crossing a road or railroad tracks, come to a full stop. Check carefully in both directions that there is no traffic, especially if there are more than one set of railroad tracks. Cross at 90°.
- Don’t tailgate. Maintain a safe distance between machines.

Figure 15.3 Wear a helmet and follow at a safe distance. © Lorne Burden

Personal Protective Equipment (PPE)

- Helmets: Wear the correct helmet and fasten the chinstrap securely. Full face helmets offer the best protection. A safe helmet is one that is in good shape – no dents or cracks – with the inner foam padding also in good condition. Choose one large enough to wear a toque or balaclava under it. Snowmobile helmets should comply with federal standards and have a certification sticker from one of the following:
    - Snell Memorial Foundation M2005 Standard (Snell specifications are higher than DOT specifications)
    - US DOT sticker Standard FMVSS 218
    - Meet or exceed Standard D230 of the Canadian Standards Association (CSA)
    - Helmet Replacement: Replace any helmet that has been worn in an accident and damaged. Consider replacing helmets after four or five years, as their safety features (padding and construction materials) deteriorate over time and they do not offer the same protection as when new. Helmets are stamped with the month and date of production.
- Goggles or a visor should be worn to protect your eyes. Goggles should be free of scratches, shatterproof and well ventilated to prevent fogging up. Replace visors when they become scratched or cracked.
- Boots: Wear good boots to keep your feet warm – ones with thick felt liners are recommended. Take extra liners if they are likely to get wet. Do not use old worn liners as they will not provide good insulation.
- Clothing: Wear a comfortable, warm snowmobile suit that is not too tight. Tight clothing restricts blood circulation, which will increase the potential for frostbite and hypothermia. Dress in layers starting with long underwear that wicks moisture away from your skin. Choose polyester or microfiber rather than cotton, which takes longer to dry once it is wet. The middle layers should be fleece, wool, pile etc., for insulation. The outer layer should provide protection from wind and moisture yet “breathe” to allow sweat to evaporate through the fabric. Wearing layers makes it easier to cool down by removing one layer at a time as you work. Have a toque or balaclava available to protect against frostbite. Do not wear loose clothing that may get caught in moving parts of the machine

(e.g., scarf). Keep clothing as dry as possible and dry out boots and clothing when you come indoors. Refer to section 6.3.5 Clothing.

- Gloves: Wear proper insulated snowmobile gloves or mitts. They should be comfortable and allow the use of your fingers and thumb. Wearing thin inner gloves will protect your hands when you remove mitts to do precise work.
- Floater snowmobile suit: If working on ice, this is the safest suit to wear. It is very buoyant and will not absorb much water if you fall through ice in contrast to a regular snowmobile suit. While more costly, it can save your life. At the very least, wear a snowmobile suit that contains some buoyancy material and a personal flotation device (PFD).

Speed

- Keep the snowmobile under control at all times. Always be able to stop within the distance you can see, especially at night. Ride to reduce risks and avoid accidents.
- Ride at the appropriate speed for your skill level, the visibility, terrain, weather and light conditions, and potential oncoming traffic. All these factors play a role in determining a safe operating speed limit.
- A “safe speed” will vary day to day – and even during the day – depending on conditions and visibility.
- Slow down when travelling in rough terrain, confined areas with limited visibility, when towing a sled, carrying a passenger, or where you might expect to encounter traffic or wildlife.
- Ride snowmobiles at a very slow speed within camp or where heavy machinery is operating at a work site.
- Speed kills. Most accidents are due to excessive speed for the riding conditions, as a rider cannot respond quickly enough to an unexpected situation.

Communications and Tracking Routines

- Riders should carry a handheld radio, cell phone or satellite phone and extra batteries, as appropriate. Satellite phones are recommended in remote locations or when an employee must work alone.
- Communication routines: Each project or camp should develop site specific communication and emergency procedures that include job specific “overdue times” after which a search will be initiated. The overdue time may vary according to circumstances (e.g. working on ice, length of a snowmobile traverse, the outdoor temperature). If an employee is working alone, follow the jurisdictional regulations regarding check-in intervals; employees should be prompt about check-in times and notification of changes to plans to avert an unnecessary search.
- Tracking routines: A person in charge of tracking routines should know the itinerary and the planned route of snowmobile riders and record the information on a map in a central location. Riders should notify that person of any changes while en route. If it is a one way trip, either two responsible people should be notified (home base and destination), or the riders should radio or telephone their base from the destination to inform them of their safe arrival. The person in charge must know what to do if a rider does not arrive, return, or check in on time.

Passengers

Riders are responsible for the safety of each passenger.

- It is advisable to carry a passenger only when a snowmobile is designed to carry two people. Do not carry more than one passenger at a time.
- It is not advisable to carry a passenger when towing a toboggan etc., even if the machine is designed for two people. The towed load will affect the safe handling of the snowmobile and the additional weight of a passenger would make handling both the machine and toboggan extremely difficult.
- Passengers should wear the same PPE as riders (approved helmet, visor, boots, mitts, warm protective clothing).
- Instruct passengers (1) to hold on tightly to straps or grab handles, (2) where to safely place their feet on the footrests and (3) how to lean into turns when underway. Always check to make sure the passenger is seated and ready before proceeding. The operator should remember that a passenger only has grab handles to grip rather than handlebars.
- Always reduce speed significantly when carrying a passenger. The extra weight greatly affects the braking and steering control of the machine. The suspension of the snowmobile may need adjusting to compensate for the extra weight. Ride at a speed so the passenger is comfortable and safe.
- The operator and passenger should have mutually agreed upon nonverbal signals so a passenger can tell an operator to slow down or stop, etc. As a passenger cannot see approaching bumps or curves, he or she cannot anticipate them with body movements and risks being injured or even thrown off the snowmobile. The engine is too loud to communicate using your voice so nonverbal signals should include at least the following: "*stop*", "*slow down*", "*accelerate*", "*bump*" and "*slope*".
- When approaching hazards such as an embankment or a large bump, the driver should slow down significantly and signal a warning so the passenger can adjust his or her body weight or even get off the machine. It may be better for a passenger to walk rather than ride over some hazards.
- When it is necessary to tow passengers in a sleigh, confirm signals for communication between the operator and passengers. Agree on a set of signals so the operator can inform the passengers of an approaching bump etc. Passengers should be able to signal the operator to "stop" and "slow down". Consider carrying a whistle loud enough to be heard over the sound of the engine. Make sure passengers are suitably clothed and have a blanket or wrap to keep warm, as they do not have the benefit of a wind break. Check frequently on the well-being of the passengers.

15.8 Safe Riding Skills

The position of the operator's body helps balance and control the machine. When turning corners it is important to shift the body toward the inside of the curve. Check the operator manual for detailed instructions for correct riding positions.

15.8.1 Riding Positions

- Sitting: This is the most frequent position for riding. Keep your feet on the running boards and your body in the middle of the seat.

- Posting: This is a semi-sitting position where you rise up from the seat and keep your feet under your body with the knees bent. Your legs will absorb the shock of travelling over rough terrain.
- Standing: Use this position to see the terrain ahead and anticipate necessary weight shifts.
- Kneeling: Use this position when to climb hills when using the side hill approach. You can transfer more body weight to the uphill side of the snowmobile for stability.
- Do not extend your legs or feet outwards in an attempt to help the snowmobile manoeuvre, whether during a turn or to stop it rolling over. You may seriously injure your legs and/or feet.
- Travel up and down hills with caution. It is possible to roll over, especially if you cannot ride straight up or down and have to traverse the slope at an angle. Be prepared to shift your weight to the uphill side of the machine. Always dismount on the uphill side so the machine does not roll on top of you, especially if a rollover is imminent.

15.8.2 Visibility and Light Conditions

- Always ride so you are able to stop within the distance you can see.
- If it is necessary to ride at night, make sure the headlights are clean and clear of snow. Reduce speed. Be able to stop within the illuminated distance. Do not ride in unfamiliar territory at night.
- Snow blindness may develop if your eyes are not protected from UV radiation. Wear high quality UV protection sunglasses or goggles to cut down on direct and reflecting sunlight. In the Arctic, UV protection is more important during late winter and spring when the sun is higher in the sky. Refer to section 9.10.5 Snow Blindness in chapter 9.
- Some light conditions make it difficult to see hazards.
    - In “flat light” conditions – when daylight is gray or without sunshine to provide shadows – the landscape may appear deceptively flat. It is hard to see ditches, ice ridges, snowdrifts, drop-offs or uneven ground. Reduce speed.
    - In bright sunlight it can be hard to distinguished obstacles and small changes in topography such as ditches. Wear coloured polarized lenses to counteract glare.
    - Consider the different types of available lenses and choose colours appropriate for the conditions you will most likely encounter. Gray or dark green lenses are useful on bright sunny days. Wear amber or yellow lenses on dark days, late afternoon or for flat light conditions. Do not wear sunglasses or tinted lenses at night.
- On sites with heavy equipment or where extra visibility is required, equip snowmobiles with a whip – a bright-coloured antenna flag mounted on rods from 1.2 m to 2.4 m in length attached to the back of the snowmobile. If riding at night is required, the whip should also have a light at the tip. Apply reflective tape to snowmobiles. Riders should wear reflective vests over of their snowmobile suits. Use extreme caution when riding around heavy machinery. Radio communication may be required.
- Tie down or remove an antenna flag while riding in forested areas, as it can get caught on a branch and whip back to hit the rider.

15.8.3 Towing

Towing a load greatly affects the handling and stopping characteristics of a snowmobile. Proceed with care and reduce the speed.

- When pulling a sleigh, sled, toboggan or komatik, make sure it is correctly attached to the snowmobile hitch with a rigid tow bar.
- Only the operator should ride while towing, even if the snowmobile is built to seat two.
- Secure all loads in sleds or sleighs to prevent shifting while underway. Loads should not project outward so they get snagged or cause a hazard to workers.
- If it is necessary to tow passengers in a sleigh, follow the guidelines in section 15.7 regarding passengers.
- When towing another snowmobile, check the operator manual for requirements such as removing the drive belt to avoid damaging the machine in tow. Use a rigid tow bar or attach a tow line to the second snowmobile so the tow line forms a Y or V shape (two points of attachment on the disabled sled). This configuration makes towing much easier. If towing with a rope, someone should sit on the second snowmobile to operate the brakes.

15.8.4 Transporting Snowmobiles

Transport snowmobiles carefully by trailer or in the back of a pickup truck. Tilt bed trailers are usually safest.

- Choose a flat unobstructed site to load the snowmobile.
- Sometimes a stable snow bank can be used instead of a ramp by backing a trailer or pickup into it and driving the snowmobile onto the bed.
- If using a trailer, use the correct hitch and safety chains. Make sure all trailer lights for brakes and turn indicators function properly.
- To avoid spills, make sure the snowmobile oil reservoir and fuel tank caps are secure and the fuel line is shut off.
- If using detachable loading ramps, use cleats or brackets and straps that attach to the truck or trailer to make sure the ramps do not come off during loading procedures.
- When transporting a snowmobile in an open truck or trailer, the windscreen should be removed to prevent loss or damage.
- Load the machines with the skis forward and centred over the loading ramps. If possible, winch the snowmobile onto the carrier, as accidents may happen while riding onto the truck or trailer. If necessary, ride the snowmobile slowly and carefully up the ramp.
- If only one machine is transported, make sure it is centred on the trailer or pickup bed.
- Secure the snowmobile to the vehicle or trailer with approved straps, harnesses, blocks and/or chains that are in good condition. Make sure the snowmobile will not shift while en route, hit the back window or come free in an accident. Cover the snowmobile to protect it.
- Make sure any additional cargo will not shift en route and damage the snowmobile.

- The following website has additional safety tips regarding the use of trailers: http://www.saferoads.com/pdf/snowmobile/TrailerTips.pdf

15.9 Safe Riding Strategies

15.9.1 Weather and Terrain Tips

- Check forecasts and current weather conditions and ride accordingly. Postpone a trip if weather threatens to deteriorate or if there is a significant risk of avalanche conditions.
- The combination of speed and weather conditions may lead to severe wind chill and cause frostbite and hypothermia. Dress appropriately and stay dry. Refer to sections 9.9.3 Hypothermia and 9.9.5 Frostbite.
- If it is necessary to operate a snowmobile in fog, heavy snow or near whiteout conditions, use the headlights on low beam and proceed very slowly. Be very alert for approaching hazards. Check your GPS frequently to confirm your location. If unsure – stop until you can determine your location.
- Avoid travel during whiteout conditions. Whiteouts may occur in the Arctic, open areas without trees (especially on plains) or in mountain regions. Where they occur, employees should be trained and prepared for whiteout conditions. Mark all regularly travelled routes with fluorescent orange painted pickets every 10 to 20 metres. Map routes carefully with a GPS and label each picket so riders can identify their position at each stake. Windblown snow may fill tracks or trails very quickly so the pickets may be the only trail indicators (refer to section 9.3 Whiteouts).
- In the barrens or tundra, mark the regularly traveled trails as described above. In these regions, snowmobile operators should be supplied with maps, waypoints and a GPS so they can find their location should they become lost or if weather or visibility conditions deteriorate. These methods are not intended to be used as routine navigational methods when conditions are poor. It is best to avoid travelling when visibility and weather conditions are poor.
- In mountain country, be prepared for avalanche dangers. Consider hiring an avalanche specialist for any project work where avalanches are a hazard. Working with snowmobiles in mountainous areas should only be permitted after workers receive thorough professional avalanche safety training and extra snowmobile training (refer to section 9.4 Avalanches). When avalanches are a potential risk:
    - Regularly check any available avalanche bulletins for the area, especially when planning travel routes. Refer to the websites listed at the end of this section.
    - Each snowmobile should be required to carry avalanche safety equipment including shovels, probe poles and appropriate communication equipment (with spare batteries) for summoning help. Riders should be trained to use the equipment correctly.
    - Each rider should be required to wear an avalanche beacon. The beacon should be *turned on* when riding in any terrain where there is a potential for avalanche.
    - It is critically important that riders never travel alone; use the “buddy system” in separate machines.
- Avalanche terrain: Avoid riding snowmobiles or snowshoeing on slopes where avalanches are most likely to occur (between 25º and 45º), avalanche chutes, run out paths and areas prone to snow slides. Avoid gullies, creek beds and steep valleys, which

minimize your chance of escape. Be alert to changing weather conditions that increase the risk of avalanches; this can occur in a short time span – overnight or during a day. The safest routes to travel are along ridge tops (watch out for cornices), in heavily treed areas and along flat areas or broad valley floors away from the runout paths of avalanches.

- Do not allow more than one person at a time to cross a slope where an avalanche might be triggered.
- Watch for and be able to recognize signs of avalanche activity (e.g., small trees bent over in the downhill direction, scars and missing branches on the uphill side of trees, and snow containing broken branches, rocks and debris).
- Check avalanche warnings and heed them. Be familiar with the Avalanche Warning Hazard scale used in the country where you work. Know how and where to obtain up-to-date avalanche hazard warnings for the project area.
- The following websites provides information about avalanche safety and links to organizations with information about safety and training courses:
  http://www.avalanche.ca/
  http://www.altasnowmobile.ab.ca/admin/contentx/default.cfm?h=11036&grp=1&PageId=11036

15.9.2 Retrieving a Snowmobile

Retrieving a bogged down snowmobile is the cause of many injuries, especially back strains. If your snowmobile becomes bogged down in snow or slush:

- Turn off the snowmobile. Never try to dig out a machine with the motor running.
- Dig the machine out using a snowshoe or ski rather than lifting it out.
- If the snowmobile has stopped heading uphill, it will have to be turned downhill.
- Pack down the snow in front of the snowmobile to create a riding trail.
- If the machine is bogged down in slush, try not to become so fatigued and wet that you develop hypothermia and/or frostbite. Freeing a machine from slush usually means removing slush from the tracks, moving ahead a short way (until it bogs again) and repeating this procedure until you reach good ground.

If the snowmobile is bogged down in slush and you cannot retrieve it until the next day, follow this procedure:

- The track *must* be elevated enough to prevent it from freezing solidly into the slush. To do this, cut trees on shore to build a crib under the track. A snowmobile weighing 130 kg (350 lbs) will almost double its weight when submerged in slush.
- Use a lever to elevate the snowmobile in order to get the crib under the track.
- Once the crib is placed under the track, pack down a path in front of the snowmobile with snowshoes so the path freezes overnight.
- The next day, carefully use an axe to chop the ice away from the skis if they are frozen in.

15.9.3 Hazards on Land

Hazards may be hidden by deep snow along trails and around work sites.

- Watch out for rocks, logs and tree stumps etc. Keep away from fence posts and telephone poles. Barbed wire and hidden wires are hazardous (e.g. guy wires, cables that support poles).
- Watch out for diamond drill casings buried in snow when riding through drill sites.
- Watch out for depressions hidden by deep snow as it may be difficult to retrieve the snowmobile, especially if there is a stream in the depression.
- Place flagging tape on wires in camps or near regularly used trails. Check frequently that flagging remains in place, as wind or animals may remove it.
- If grasses, brush, or shrubs protrude through the snow cover, remove any buildup of organic material from the track and engine compartment, especially around the exhaust. Try to avoid contact with shrubs and bare ground.

15.10 Working on Ice

Before beginning work on ice, it is advisable to develop an ice safety plan as outlined in section 15.10.5.

Detailed information on ice thickness and quality is not normally available and it is necessary to obtain this information when a company plans to conduct a winter drill program. After initial testing of ice thickness on foot, snowmobiles are often the first equipment to go onto the ice in advance of drilling operations to further determine ice thickness for safe crossing routes and drill pad locations. To protect their own safety, it is essential for snowmobile operators to accurately assess ice conditions and follow SOPs when they work on ice.

To prepare ice roads and drill pads for heavy equipment, an accurate assessment of the safe load bearing capacity of ice is required. Although drilling holes with an ice auger is the most common method to determine the ice thickness, companies should consider hiring specialists that use ground penetrating radar (GPR) ice profiling equipment, especially when building an ice road that will be used frequently by heavy equipment or trucks. Ice profiling equipment that uses ground penetrating radar can determine the most accurate “picture” of ice thickness and variations, the location of hidden cracks and other features that make working on ice hazardous. Only when the ice is thick enough and has reached adequate load bearing capacity, should heavy equipment be used on, transported over, or set up for drilling operations on ice. Refer to chapter 21 Advanced Exploration Sites, Trenches and Access Routes for information regarding heavy equipment and ice roads.

Temperature fluctuations cause ice thickness to change rapidly and unpredictably. Ice is only as safe as the thinnest measurement. Therefore ice thickness measurements on ice roads, around a drill site or along designated ice crossings should be made on a continuous basis. Thickness of ice is dependent on many factors in addition to temperature. Do not become complacent just because the temperature is well below freezing.

Information in section 15.10 is compiled primarily from the following sources:

Best Practices for Building and Working on Ice Covers in Alberta
http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

A Field Guide to Ice Construction Safety (November 2007)
http://www.dot.gov.nt.ca/_live/documents/documentManagerUpload/Ice%20Construction%20Field%20Guide%20web.pdf

Policy Subject: Working on Ice
www.uoguelph.ca/~wrs/OMNR.working.on.ice.policy.doc

15.10.1 Risks and Hazards

In addition to general risks and hazards associated with snowmobiles, specific risks and hazards of working on ice include:

- Death from drowning or cold water immersion hypothermia caused by breaking through ice
- Breaking through ice caused by:
    - Thin ice due to underwater currents or bottom topography, temperature fluctuations
    - Lack of knowledge regarding local hazards, lack of training, unrecognized variable thickness of ice, undetected cracks (covered by snow), crossing pressure ridges, not following SOPs, risky attitude
    - Inaccurate measurement of ice thickness, inaccurate measurement of the total load
- Injuries caused by:
    - Cuts from using ice augers, ice chisels, axes, inadequate PPE
    - Slips trips and falls on icy, slippery surfaces

15.10.2 Ice Terminology and Features

Ice develops various characteristics that are determined by conditions when it forms and whether it is lake ice, river ice or sea ice. The colour of ice indicates its strength and quality. It is necessary to recognize the colour and type of ice to accurately determine the safe load bearing capacity of ice.

- Clear blue ice is strongest. It forms when water freezes over a long period when the air temperature is below freezing. It is chunky – not flakey – when tested.
- White opaque ice (snow ice) is generally rated as half as strong as clear blue ice. This ice contains air which weakens the ice. It forms when wet snow freezes or when snow on ice freezes.
- Frazil ice (newly formed): While clear in colour, it is composed of loosely amalgamated crystals that make it weak and porous. It is flakey – not chunky – when tested.
- Candled ice or gray ice is least strong: The gray colour indicates that water is present in the ice. As ice melts, lines of weakness containing water and impurities effectively separate individual ice crystals and weaken an ice sheet so it will disintegrate easily. Ice prisms form perpendicular to the surface of the sheet – hence the term candling. Even before it “candles”, the strength of gray ice is much diminished and it will not support the weight of people or snowmobiles. Never go out on candled or gray ice.

- Slush: Overflow conditions or melting are the usual causes of slush. Overflow results when a layer of snow depresses ice causing it to crack so water rises up and over the ice but remains under the snow. The overlying snow insulates the water so the water does not freeze, which forms a slush layer despite cold temperatures.
- Cracks: Dry and wet cracks form when ice moves and when it contracts. Cracks may or may not indicate weakening of the ice. It is necessary to locate cracks and recognize the different types to determine the safe load bearing capacity of ice.
    - Dry cracks develop when ice expands at the top of ice layers as it builds up and thickens from the bottom. Dry cracks can be repaired with water or slush.
    - Wet cracks are dangerous as they indicate the ice has fractured completely through to the water below. The load the ice bears must be reduced; the amount depends on the size, location and configuration of the cracks. Wet cracks will often refreeze and heal. After healing, the ice may be as strong as before, but it must be tested by drilling a core sample to tell how deep the crack has healed.
    - Radial cracks form when ice is overloaded. The cracks radiate outwards from the load.
    - Circumferential cracks form when ice is overloaded. They form surrounding the load and when circumferential cracks join radial cracks, ice failure is imminent.
    - Hinge cracks form along river or stream banks or lake shores where water levels fluctuate.
    - Tidal cracks form near the shoreline on sea ice due to tidal action.
- Pressure ridges may be due to ice movement, wind or currents. They contain piles of broken ice, cracks and perhaps hidden open water. Ice pressure ridges are very unstable. See the photos below for visual examples.
- To learn more about types of ice, ice features and descriptive terms, refer to the photographs and diagrams in the Glossary and Section 2. Ice Cover Hazards and Factors to Consider in: *Best Practices for Building and Working on Ice Covers in Alberta*. Website: http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

15.10.3 Hazards Related to Ice

Be informed about local hazards and be able to recognize general hazards and potentially dangerous conditions when working on ice.

- Ice thickness is never uniform even though it appears as a smooth even surface. The underside of any ice sheet is rough and uneven due to water currents, unseen obstacles, springs, outlets and inlets to the body of water. Unless the ice is tested frequently, it may not be evident that the ice is too thin to support a specific load.
- Ice must be floating on water to be safe. Ice that slopes steeply on banks of lakes or rivers indicates fluctuations in water level and there may be air under the ice. Keep off ice that sounds hollow.
- Beware of fog. On cold days local fog may be an indication of open water. Slow down.
- A rapid large drop in the air temperature will cause ice to become brittle and less safe due to internal stresses that develop. It may require 24 hours or more to be safe again.
- If the temperature goes above freezing for 24 hours the ice may not be safe.

Figure 15.4: Pressure ridge, snow covered ice on Great Slave Lake, Northwest Territories © Jens Pedersen

Lake Ice

Ride slowly, use caution and watch out for the following typical hazards:

- Shoreline hazards: Sloping ice, docks, protruding rocks, submerged logs, broken ice and/or hinge cracks where there are fluctuations in the water level
- Inflows and outflows of rivers, streams, creeks and springs
- Open water and air holes
- Pressure ridges: If it is necessary to cross a pressure ridge, use a probe to determine the ice thickness and whether there is open water present. It is advisable to walk a snowmobile across perpendicular to the ridge (90°).
- Shoals: Ice may be thinner over shallow areas of lakes. Bottom topography impacts the formation of ice by determining the presence of currents, schools of fish etc.
- Underwater currents may change and cause ice to thin unpredictably. This may be a high risk factor depending on the size and shape of the lake.
- For additional information, refer to section 2.8.3 Route Selection Over Lakes, Ponds and Muskeg Terrain in *Best Practices for Building and Working on Ice Covers in Alberta*. Website: http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

Figure 15.5: Pressure ridges may hide thin ice and open water. © Jens Pedersen

River Ice

River ice thickness is extremely variable so try to avoid travelling on it. Use an ice profiling machine, if possible, to measure the thickness and determine the safest route and safe load limits. Study maps, air photos and satellite photos to locate potential areas of thin ice.

- If you fall through river ice, you risk being swept under the ice by the current.
- Erosion: The underside of river ice is constantly eroded by currents and changing water levels.
- Thin ice: Avoid areas where ice is always thinner (e.g., narrows, rapids, bars, springs, entering streams, channel bends and estuaries).
- Fast-flowing water: Avoid ice near narrows and manmade objects (e.g., bridge abutments, docks).
- Travel only at the coldest times of the season. Travel on rivers only after carefully checking the ice conditions and determining them to be safe.
- Ride on the banks rather than on the river ice whenever possible. Remember, ice conditions can change rapidly. Wear a floater suit, ride with a buddy, ride slowly and use extreme caution. Hinge cracks along river banks may form and be difficult to cross.
- For additional information, refer to section 2.8.4 River and Stream Cover in *Best Practices for Building and Working on Ice Covers in Alberta*. Website: http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

Figure 15.6: A stream flowing underneath a cover of fractured ice and snow presents a risk of falling through and being swept away despite the shallow depth near the bank. © Bill Mitchell

Sea Ice

Seek local knowledge regarding hazards associated with sea ice; hazards vary greatly due to shoreline configurations, subsurface features, currents, prevailing wind direction, and tides etc. It may be advisable to hire knowledgeable locals, as their experience and knowledge of local conditions and risks contribute an additional safety factor. The following are some of the factors affecting safety on sea ice:

- Thickness: Sea ice must be thicker than clear lake ice to support the same load. Find a reliable sea ice thickness chart and seek local knowledge.
- Weather: Poor visibility due to fog or blowing snow etc., will obscure features such as cracks and pressure ridges. It may be difficult to determine your location without a GPS.
- Wind, waves and swells all affect the stability of sea ice. They affect the formation of ice sheets and how quickly the ice becomes stable enough to travel on. A certain thickness of sea ice formed under calm conditions may be safe to travel on while the same thickness formed under rough conditions may not be stable due to hazardous cracks etc.
- Wind: Strong winds may blow sea ice away from shore in a very short time and leave open water. Cracks in sea ice provide planes of weakness that wind can utilize to move sea ice around. Continuously monitor wind and weather conditions so you do not become stranded.
- Tidal cracks develop parallel to the shoreline up to more than 100 metres off shore. They result from tidal action that raises and lowers ice along the shoreline. When travelling through areas of tidal cracks, it is safest to travel on bare ice rather than on snow covered ice in order to avoid hidden wide cracks. Use a probe to detect gaps and cracks under snow, as required.
- Pressure ridges and cracks develop due to actions of wind, tides, swells and heating and cooling air temperatures. Cross them with great care in the direction perpendicular to the ridge or crack. Probe ahead to test the ice and for open water.

- Colour of sea ice: Due to varying conditions during formation, the color of ice may change over distance. Learn from locals how to recognize what is safe and what is not safe.
- Sea ice forms pockets of brine as it freezes, which cause the ice strength to vary across the ice sheet. This variation in strength is especially important to consider when temperatures rise late in the season.
- Ice that forms in estuaries is often hazardous to ride on due to variation in water depth, salinity, currents etc.
- The information regarding sea ice is from the following website: http://www.usap.gov/travelanddeployment/documents/FieldManual-Chapt17SeaIce.pdf

Snow Cover on Ice

The amount of snow on ice affects safety.

- Insulation: Snow prevents ice from freezing quickly as it insulates ice from cold air temperatures. The ice will be thinner and weaker than ice without snow cover.
- Visibility: Cracks in the ice are covered.
- Overflow conditions may develop when snow weighs down the ice and water flows up through a crack.
- Load bearing capacity: Snow adds weight to the ice. Where snow is piled up in windrows from clearing an ice road or landing strip etc., the extra snow load causes ice to sag and it may eventually fracture. Dangerous cracks may be hidden by the snow load under the windrows.
- Ice may thaw below the snow cover and be thinner or weaker than expected.
- These risks are increased when deep snow falls early in the winter season.

Slush

If you drive a snowmobile through slush and stop, slush can embed in tracks and bog the machine down. It can be very difficult to free it. If you get wet or fatigued while dislodging the machine, you increase the risk of developing frostbite and/or hypothermia. See sections 15.9.2 Retrieving a Snowmobile and refer to section 9.9.3 Hypothermia.

- Overflow conditions: These show up as dark patches or areas. Look back and check the trail occasionally for dark areas to make sure you are not riding through slush.
- Avoid dark clear round patches, which are usually upwelling springs or air holes made by animals.
- Wet areas on ice or on snow covering ice may indicate melting under the snow cover, overflow conditions or springs. Avoid dark patches.
- If you encounter slush or overflow, accelerate until you are out of it. Do not slow down. If you are following a snowmobile that encounters slush, steer off the path of the leading snowmobile and create your own path through the area.

Figure 15.7: Overflow on a trail crossing a swamp © Jens Pedersen

Thawed and Refrozen Ice

- Once ice starts melting and refreezing, charts and tables to determine the safe load bearing capacity of ice *no longer apply*.
- Avoid working on ice early and late in the season – it is especially hazardous. Although ice may appear solid and safe, it may actually be melting upwards from the underwater surface.
- Gray or candled ice is very dangerous.
- Ice near shore melts sooner and will be weaker than ice farther out in a lake.
- Meltwater runoff affects the ice thickness and strength.
- Objects embedded in ice (logs, stumps, rocks) and docks absorb heat from the sun, which promotes rapid melting of the ice surrounding them.

Figure 15.8: Crack with open water in a pressure ridge © Jens Pedersen

15.10.4 Ice Testing Equipment

Ice profiling machines that use ground penetrating radar are considered the best method to assess ice thickness. If an ice profiling machine is not available or the work cannot be contracted out, then the ice thickness must be tested by hand using an ice chisel, hand and/or power auger.

Equipment for testing ice thickness

A minimum of two people plus the following equipment should be required when testing ice on foot:

- Flotation snowmobile suit or a personal flotation device (PFD) worn over a snowmobile suit (1 per person)
- Waterproof boots, insulated waterproof gloves
- Full body harness – to attach to the rescue rope
- 20 to 30 metres certified polypropylene floating rescue rope, 1 cm (3/8th inch) thick
- Axe or ice chisel – may be used for ice up to 30 cm
- Power ice auger – drills up to about 125 cm and more with extension bits, as required
- Measuring stick with a hook on the bottom
- 2-way radios and/or cell phone or satellite phone (preferably 1 per person)
- GPS, as required
- Whistle

- Sunglasses
- Hypothermia kit – see section 15.4 Equipment Lists

Tips for using a power auger

Once the ice is thick enough, it may be advisable for two people to handle a power auger. It can be easy to lose control when only one person operates the machine. This means ice must be thick enough to support the weight of two people plus all their equipment.

- Refer to the manufacturer's owner manual and follow the safe operating, sharpening and maintenance instructions.
- Wear gloves to protect your hands from sharp edges on the cutter heads.
- Check that the clutch works properly before use.
- Ice augers with a "safety arm" are preferable, as the rotation will stop if control of the auger is lost.
- Always stand on ice when operating the auger. Place your feet away from the hole but still maintain stability. Never stand on an oil drum etc., to gain height.
- Start slowly when starting the auger. Do not fully open the throttle when you start drilling.
- Periodically pull the auger up and down to help clear the hole of ice shavings.
- If the ice is thicker than one length of the auger shaft, drill to the maximum depth of the auger and shut it off before adding the extension. Do not join an extension to the auger before starting to drill the hole.
- Join each length of auger with the correct cotter pin. Do not use substitutes.
- If you lose control of the auger while drilling, release the throttle immediately to stop the machine. Let go of the auger rather than be thrown by the torque of the machine.
- Do not wear loose clothing that might get caught in the rotating auger shaft or blade (e.g. scarf).
- For additional information, refer to the following Appendices in *Best Practices for Building and Working on Ice Covers in Alberta.* Website: http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

  Appendix A Using an Auger to Measure Ice Thickness While on Foot

  Appendix B Guide for GPR Ice Profiling

  Appendix C Safety Equipment for Ice Safety Plan

Figure 15.9: Ice auger with extension © Iain Mitchell

15.10.5 Planning and Preparation for Working on Ice

Ice safety plan for working on ice

Before commencing any work on ice it is advisable to develop an ice safety plan based on risk assessments, hazard mitigation, and site specific safe operating procedures and emergency response procedures. The SOPs and ERP for working on ice should incorporate observations and conclusions of the risk assessments (refer to chapter 2, section 2.1.5 Risk Assessments and chapter 3 Emergency Response). As a minimum, a written emergency response plan (ERP) should include (1) self-rescue procedures, (2) procedures to rescue a crew member who has fallen through ice, (3) escape procedures when a vehicle breaks through ice, and (4) procedures to treat cold water immersion hypothermia.

Before starting any work on ice, it is advisable to inquire about potential hazards from locals or co-workers familiar with the history of the area and water body; this information will assist in developing parts of the ice safety plan such as SOPs.

An ice safety plan requires written procedures and documentation. Provide appropriate training and communication of the plan to employees. Guidance for developing an ice safety plan can be found in *Best Practices for Building and Working on Ice Covers in Alberta*: website: http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf. This document contains extensive information about working safely on ice and reference to it is made throughout this section. It includes the following sections specifically directed toward developing an ice safety plan and emergency response procedures:

Section 3. Ice Cover Hazard Controls

Section 4.1 Design Controls

Section 4.2 Ice Monitoring Controls

15.10.5.1 Guidelines for Testing and Assessing Safe Ice Thickness

When assessing ice thickness, it is preferable to use an ice profiling machine because it detects the presence of hidden hazards and it produces the most accurate data to calculate the load bearing capacity of ice. Because using one is not always possible, guidelines are presented in section 15.10.5.2 for measuring ice thickness on foot using hand tools. No matter which method is used, when a range of ice thicknesses are established, only the thinnest measurement can be used to calculate the safe load bearing capacity of the ice.

For many reasons, the load bearing characteristics of ice may change rapidly. Changes result from fluctuations in some or all of the following: air temperature, wind speed, precipitation, solar radiation, water depth and/or currents under the ice, ice movement that creates cracks and pressure ridges, impurities, and obstacles in the ice etc. Changes in ice characteristics may occur from day to day and sometimes throughout the day. It is essential to continuously monitor ice conditions for changes. Remember that the safe load bearing capacity of ice is different for moving loads and for stationary loads and use the appropriate ice bearing capacity charts and allowable load tables. Refer to the following sections in *Best Practices for Building and Working on Ice Covers in Alberta*: Website: http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

Section 2.5 Load Duration

Section 4.1 Design Controls

Section 4.2 Ice Monitoring Controls

Section 4.1.5 Stationary Loads

Restrict travelling on ice to areas where the ice thickness has been measured and is proven to be safe. This may require travelling by a circuitous route, rather than a direct route to stay on safe ice.

Preparation for Ice Testing Procedures

It is essential for everyone to be prepared when testing ice thickness and working on ice:

- Be familiar with the hazards.
- Be trained to work safely.
- Work in teams with appropriate equipment.
- Carry dependable communications equipment (2-way radio, satellite phone, or cell phone) and strictly adhere to a check-in schedule throughout the testing process.
- Know self-rescue techniques and those for rescuing a co-worker who falls through ice.
- Know how to treat cold water immersion hypothermia.

Testing ice is dangerous work because there is always the possibility of breaking through. The greatest risk of falling through ice is faced by crews at the start of the season when there is minimal information about the condition of the ice.

1. Do not begin testing ice if there is any doubt about its safety. Never attempt ice crossings during freeze up and breakup. Newly formed ice (frazil ice) is not strong, even when it looks solid. It requires an extended period of below freezing temperatures to produce strong safe ice cover. When the weather warms and snow starts to melt, thick ice is not necessarily safe. It may be candled in places, contain pockets or layers of water or brine and disintegrate easily.
2. Make sure the ice is thick enough to bear the total load (people + equipment + fuel + snowmobiles, as required) to cross safely. Test it first if there is any question at any time about the safe thickness. Drill a hole and measure it.
3. Check the ice thickness on foot using a hand or power auger before allowing snowmobiles or light equipment to travel on ice.
4. Test the ice thickness at regular intervals.
    - Where thinner ice is detected or if the thickness is highly variable, adjust the position of the auger holes to closer intervals to determine the size of the abnormal area.
    - Repeat testing when significant temperature changes occur even when temperatures do not go above freezing.
    - For guidelines, refer to the following tables in *Best Practices for Building and Working on Ice Covers in Alberta*: Website: http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

        Appendix A Table A1: Recommended Maximum Spacing of Auger Test Holes for Measuring Ice

        Appendix A Table A2: Recommended Minimum Frequency of Auger Test Hole Measurements
5. Record measurements in a log book. Record the location with a GPS unit and/or on a map, temperature, the “effective ice thickness” and other information required by AHJs. Store the log book in a secure place.
    - “Effective ice thickness”: When ice is composed of continuous layers of white snow ice and clear blue ice, calculate the “effective ice thickness” by measuring the thickness of each type of ice. White ice is rated as half the value of its measured thickness. Add this sum to the measurement of clear ice. Report the effective ice thickness in terms of clear blue ice. See Figure 15.10 below.
    - Take into account the presence and types of cracks and adjust the safe load bearing capacity accordingly. Exercise additional caution by leaving a comfortable margin of error.
    - For information regarding measuring and recording ice, refer to:

        Best Practices for Building and Working on Ice Covers in Alberta: Website: http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

        Section 4.2.1 Measuring and Recording Ice Thickness

        Section 4.2.2 Monitoring Ice Cracks

        Appendix A Table A3: Ice Cover Profile Template

A Field Guide to Ice Construction Safety
http://www.dot.gov.nt.ca/_live/documents/documentManagerUpload/Ice%20Construction%20Field%20Guide%20web.pdf

Section 3. Ice Capacity and Testing

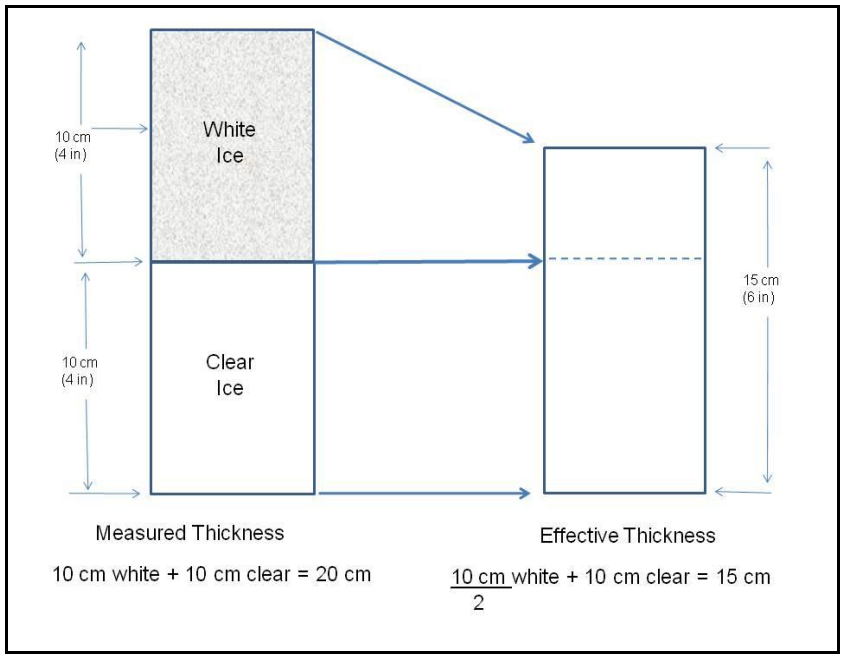

Figure 15.10: Computing the "effective ice thickness"

Compute the "effective ice thickness" from continuous layers of clear ice and white ice:

Measure the thickness of each layer. Divide the thickness of the white ice layer by 2 and add the result to the thickness of the clear ice layer to obtain the effective ice thickness.

6. What is the "safe ice thickness"? Numerous tables are available that contain conflicting information regarding the safe ice thickness for various activities. To protect personal and employee safety, the PDAC Health and Safety Toolkit recommends using the most stringent standards.

SAFE ICE THICKNESS FOR LIGHT LOADS ON CLEAR BLUE ICE (Measurements do not apply to stationary loads)		
Minimum Ice Thickness (centimetres)	**Minimum Ice Thickness** (inches)	**Maximum Load** (Clear blue ice)
10 cm	4 inches	1 Person on foot
18 cm	7 inches	Snowmobiles: 1 rider total load less than 500 kg single file, well-spaced
38 cm	15 inches	**¾ ton 4x4 vehicles (maximum GVW 5,000 kg)**
REDUCE LOAD BY AT LEAST 15% FOR CLEAR BLUE RIVER ICE **REDUCE LOAD BY AT LEAST 50% FOR SLUSH ICE**		

Table 15.1: Safe ice thicknesses for slow moving light loads on clear blue ice.

Source of ice thickness recommendations: *Best Practice for Building and Working Safely on Ice Covers in Alberta:* http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

15.10.5.2 Guidelines for Testing Ice Thickness on Foot

The PDAC advises that ice be *at least* 10 cm thick before crossing on foot (15 cm is safer).

1. Testing crews should follow all company SOPs, ERPs and use required safety equipment.
2. Never test ice thickness alone. Always work in pairs. It is advisable to have a third person as a spotter on shore to call for help if a crew member falls through ice.
3. Check ice thickness at the entry point with an axe or ice chisel to determine if the ice will support the total weight of the crew member plus equipment. The ice should be chunky when hacked. Do not proceed if the ice thickness is less than 10 cm; wait until the ice is thicker.
4. If the ice is thick enough to test:
    - The lead crew member should wear a full body harness and attached safety line. The lead should walk a predetermined distance and chip or drill the first hole while the second crew member remains on shore holding the safety line taut.
    - Check for water at 10 cm. If there is none, drill to water and measure the ice thickness.
    - If the ice is a safe thickness at the first test hole, the lead crew member may advance the predetermined distance and drill a second hole to the water. The second crew member should follow in the same path and remain behind the first test hole on safe ice.

- If the ice thickness is safe at the second hole, both crew members may advance the predetermined distance and continue the procedure.
- The second crew member should:
    - Hold the safety line taut. Stay on shore until the first hole is safely drilled.
    - Follow in the same path as the lead crew member where ice is proven safe. Remain at least 15 metres behind the lead crew member and behind a successful test hole.
    - Carry the 2-way radio or sat phone and stay in regular contact with the supervisor.
- Record the ice thickness, temperature, observations regarding cracks, presence of snow load and other details required by AHJs. Report the effective ice thickness in terms of clear blue ice.
- If at any time the ice thickness is less than 10 cm thick, remove equipment and retreat to shore. Wait until ice is thicker to test again.

15.10.5.3 Guidelines for Safe Snowmobile Ice Crossings

The PDAC advises that ice be at least 18 cm thick before crossing with a snowmobile.

1. Follow company SOPs, ERPs and use required equipment.
2. Test the ice thickness before the initial crossing of the season and any time there is *any* doubt about the safe load bearing capacity of the ice. Carry out the initial test for safe ice thickness on foot.
3. Carry out initial ice crossings and trail breaking with two snowmobiles spaced at least 150 metres apart.
4. For initial crossings, both snowmobile riders should wear flotation snowmobile suits, a floater jacket, or an approved PFD over the snowmobile suit. Each rider should carry a readily available set of ice rescue picks on their person.
5. Each snowmobile should carry appropriate equipment including an axe, waterproof matches and a hypothermia kit that includes a throw rope with a float attached in case one snowmobile breaks through ice. The rope itself must float. See section 15.4 Equipment Lists.
6. Test the ice at predetermined intervals.
7. Record the ice thickness, temperature, observations regarding cracks, presence of snow load and other details required by AHJs. Report the effective ice thickness in terms of clear blue ice.
8. Once a safe crossing is established, mark the route every 15 metres so the safe route is obvious. Use 1”x2”x4’ lath pickets flagged or painted with fluorescent paint. Tree branches or large orange garbage bags filled with snow may work.

15.11 Cold Water Immersion Hypothermia – Falling Through Ice

Falling through ice into cold water is a serious emergency. Should it happen to you, react as soon as possible and attempt self-rescue. Many popular beliefs about how the body reacts when we fall into cold water are inaccurate and out of date. Dr. Gordon Giesbrecht, a Canadian authority

on human response to cold environments, has written books, articles and made videos on the subject. Dr. Giesbrecht has generously provided information and photographs to illustrate the correct method of self-rescue if you fall though ice. Information in this section is compiled primarily from the following sources, which contain important, updated information about cold water immersion and the value of a flotation snowmobile suit if you fall through ice.

Hypothermia Frostbite and other Cold Injuries: Prevention, Survival, Rescue, and Treatment, by Dr. Gordon G. Giesbrecht and James A. Wilkerson, M.D.

Thin Ice, by Dr. Gordon G. Giesbrecht: available on the following website: http://www.umanitoba.ca/faculties/physed/research/people/giesbrecht/Thin_Ice.pdf

Survival in Cold Waters, by Dr. C. J. Brooks: available on this Transport Canada website: http://www.tc.gc.ca/marinesafety/TP/Tp13822/menu.htm

Cold Water Boot Camp. www.coldwaterbootcamp.com

Videos made by Discovery Channel Canada and Dr. Gordon Giesbrecht: available on the following website: http://www.umanitoba.ca/faculties/physed/research/people/giesbrecht.shtml

How your body reacts when you fall into cold water

First stage: *Cold Shock:* You will immediately suffer cold shock and be unable to breathe properly. The gasping and hyperventilation will last about one minute. It is possible to drown almost immediately if you gulp in water and/or cannot keep your head above water.

Second stage: *Cold Incapacitation* develops during the next 10 to 30 minutes. Extremities cool quickly and your limbs and hands become numb so you lose the ability to grasp anything. You have about 10 minutes to perform life saving tasks. Victims cannot maintain a horizontal posture to swim, which is known as “swim failure”, so they often drown during this stage.

Third stage: *Hypothermia:* It takes about 30 minutes for your core body temperature to drop so that true hypothermia sets in. Your body loses heat 25 times faster in cold water than when exposed to cold air. Shivering intensifies and you lose good judgment quickly although you probably will not lose consciousness for one hour. Hypothermia advances at a faster rate as the water temperature decreases.

Fourth stage: *Circumrescue Collapse*: Death due to post rescue collapse may occur during or within hours of rescue.

Dr. Gordon Giesbrecht promotes the following slogan to help remember what to do if you fall through ice:

“One Minute — Ten Minutes — One Hour”

One Minute:

Do not panic. You will suffer “cold shock” and be unable to breathe properly. Work to regain control of your breathing with slow deep breaths, which will take about one minute (**photo 1**). This is very important – if you inhale water while gasping for air or hyperventilating, you may drown almost immediately.

1. Control your breathing.

2. Extend your arms onto the ice where you fell in.

Ten Minutes:

Once you can breathe more easily, work to get out of the water as fast as possible. As ten minutes pass, you will become progressively incapacitated from the cold and be able to accomplish less and less. Work at self-rescue immediately.

- Remove snowshoes, skis or snowmobile helmet before your hands become numb.
- Move to the edge of ice that last supported you – usually the direction you came from – and extend your arms onto the ice (**photo 2**).
- Get as much of your upper body onto the ice as possible. Kick your feet to the surface so they are horizontal on the water surface (**photo 3**). On your stomach with your face low, reach onto the ice and kick hard to heave or roll your body out of the water and up onto the ice (**photo 4**). Use ice rescue picks to jab the ice and pull your body up and out with a hand-over-hand motion. Keep your weight spread out over the ice.
- Once out of the water, roll to stronger ice and then crawl. Stand up only when you reach ice that is strong enough to bear your weight. If the ice is soft or thin, you may have to break your way to shore.

3. Kick hard; get horizontal.

4. Kick and pull your body onto the ice. Roll to stronger ice.

One Hour:

If you cannot get out of the water and onto the ice within 15 minutes, chances are you will not be able to do so. However, you will not lose consciousness from hypothermia for about an hour so you can increase your chances of rescue with the following actions.

- Keep your head above water to prevent drowning; stop struggling and preserve your energy.
- Extend your arms and as much of your body as possible onto the ice. Lay your head on your arms and remain still so your clothing has a chance to freeze to the ice. This action will help keep your head out of water and may prevent you from sliding back into it even when you become unconscious.
- You have a good chance of rescue if you follow a check-in schedule appropriate for your dangerous working conditions and have an appropriate site specific emergency response plan.

Once on shore:

- Summon help if you have functioning communication equipment.
- Remove water from your clothing. Roll in powdery snow, which will absorb water. Change into dry clothing if available. Otherwise, remove clothing one item at a time, wring it out to reduce the water content and put it back on.
- Find shelter to avoid hypothermia. If no shelter is available, build a fire immediately. Use the contents of your survival kit (distributed in your clothing) and your hypothermia kit from the waterproof bag, if available. Warm yourself concentrating on your head and trunk area. Eat available food (from your pockets) to combat hypothermia.

To rescue someone who has fallen through ice into cold water:

- Do not panic. Do not run out onto the ice or you may fall through as well.
- Summon help. Explain to the victim how to get out using the actions described above. Talk them through the steps.
- Toss a throw rope with a loop tied into it so the victim can put their arms or body through the loop; their hands may be too numb to hang on to the rope. Extend a stick, branch, snowshoe, jacket etc., if no rope is available.
- NOTE: It is important to treat all people rescued from cold water immersion as hypothermia or shock victims. Treat victims *very* gently and whenever possible, lift them from the water in a horizontal position rather than with a vertical lift. Transport them horizontally to a medical centre. To treat casualties, refer to section 9.9.3 Hypothermia.

15.12 Resources

The Prospectors and Developers Association of Canada (PDAC) thanks the following for granting permission to include material from their publications.

Bombardier Recreational Products Inc.

Dr. Gordon Giesbrecht

Their permission does not imply that they endorse the PDAC Health and Safety Guidelines. The PDAC is solely responsible for the content of these Health and Safety Guidelines.

Books

Giesbrecht, Gordon G. Ph.D. and James A. Wilkerson, M.D. (2006) *Hypothermia, Frostbite and Other Cold Injuries: Prevention, Survival, Rescue, and Treatment*. The Mountaineers Books.

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Products

ResQMe, a device to cut seat belts and break vehicle windows to escape: http://www.resqme.com/. Accessed December 16, 2009.

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