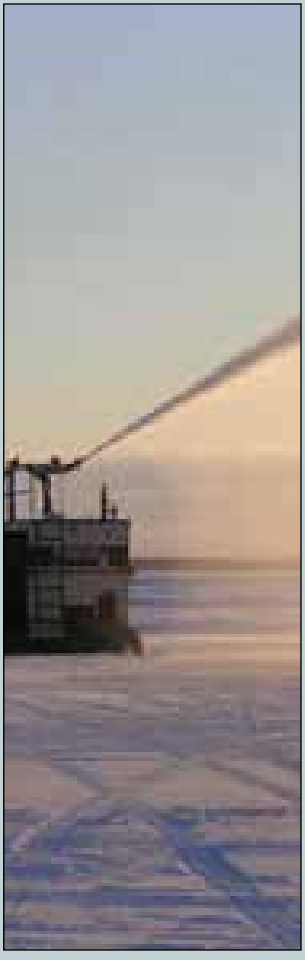
A FIELD GUIDE TO ICE CONSTRUCTION SAFETY



Northwest Territories Transportation

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A FIELD GUIDE
TO ICE CONSTRUCTION SAFETY

Department of Transportation
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This document is produced by the Department of Transportation of the Government of the Northwest Territories.

It is published in booklet form to provide a convenient and easy to carry reference for Department of Transportation staff and contractors involved in the construction and maintenance of winter roads, ice roads and ice bridges. It outlines work practices and procedures which are intended to increase the safety of those working or travelling on ice or under winter conditions. It is intended to be read in conjunction with the department's Highway Maintenance Manual that amplifies the details on the procedures.

Table of Contents

1.0 INTRODUCTION

Working on and around ice is inherently dangerous. Ice conditions, whether on a lake, slow moving river, creek or fast moving river, can be unpredictable and must be respected at all times. Workers and especially supervisors must be vigilant and extremely aware of the situation, the need for care and attention, and the critical need to fully communicate all plans, procedures, conditions and regulations.

The Department of Transportation's highest priority is safety. Consequently, the department is committed to:

- Encouraging the joint efforts of management and the employees to establish and maintain safe and healthy working conditions for all employees;
- Providing employees with safe and proper equipment and materials;
- Providing training in safe work practices;and
- Encouraging employee participation in the development and support of safety programs.

Employees, in turn, have a responsibility to perform their work in a safe and responsible manner, to follow guidelines established to ensure their safety, to advise their supervisor of unsafe practices or conditions and to promote safety amongst their co-workers.

It is impossible to anticipate all situations that may arise in the field or all of the factors that might affect one's response. This information should be treated as guidelines rather than strict rules and regulations. Common sense and good judgment are most important. The department has introduced the "VITAL" logo to assist all those who work on or around ice to take that extra time to ensure they are fully prepared for the work

All GNWT and contractors' employees involved in ice/winter road construction will be given a copy of "A Field Guide to Ice Construction Safety". Read this guide and if you require clarification or have any questions, talk to your supervisor immediately or at any of the regular safety meetings.

SAFETY IS EVERYONE'S RESPONSIBILITY.

2.0 GUIDELINES FOR WORKING IN A COLD ENVIRONMENT

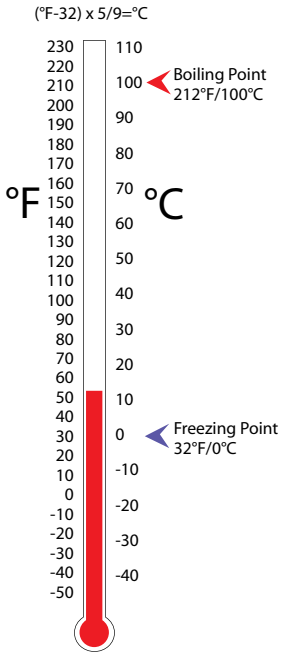
2.1 INTRODUCTION

These guidelines provide information for working in a "cold environment". They apply when working out of doors or when travelling on winter roads, when handling extremely cold materials and when involved in an accident or stranded in a vehicle. The intent is to prevent injuries caused by severe cold, particularly frostbite and hypothermia.

2.2 HAZARDS OF EXPOSURE TO COLD WEATHER

Frostbite is the freezing of body tissue resulting from exposure to the cold. Hypothermia is a lowering of the core body temperature as a result of prolonged exposure to cold temperature. Both conditions are extremely serious.

The following factors contribute to cold injury:



Air Temperature – As temperatures drop, the risk of injury increases.

0°C to -20°C: In this temperature range, the risk of frostbite or hypothermia exists but can be avoided. Work can continue as long as the individual is wearing proper clothing, is in good health and the equipment used is in proper working order.

-20°C to -45°C: In this temperature range, outdoor travel can be dangerous and equipment failure is serious.

-45°C and Below: This temperature range is a serious threat to personal health and safety. Normally, all outdoor work will cease. In the event of an emergency such as natural disasters, rescue operations and situations that threaten public safety, work must proceed with extreme caution.

Windchill – Air temperature is not the only measure of how cold it is. Wind velocity combines with air temperature to create a windchill that magnifies the cooling effect on exposed human skin. For example, a calm-air temperature of -20° Celsius poses little danger, but the same temperature in a 50-kilometre per hour wind will chill as quickly as a calm air temperature of -30° Celsius. Wind, therefore, adds to the effect of low temperature and causes the body to cool more rapidly or hastens the freezing of tissue. Figure 1 shows the relationship between air temperature and wind chill. These equivalent chill temperatures are applicable if your clothes and skin are dry. When you are wet, cold injury can result at much warmer temperatures.

FIGURE 1

Wind Chill Calculation Chart

		Air Temperature (°C)											
		5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
Wind Speed (kph)	5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53	-58
	10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51	-57	-63
	15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54	-60	-66
	20	1	-5	-12	-18	-24	-30	-37	-43	-49	-56	-62	-68
	25	1	-6	-12	-19	-25	-32	-38	-44	-51	-57	-64	-68
	30	0	-6	-13	-20	-26	-33	-39	-46	-52	-59	-65	-70
	35	0	-7	-14	-20	-27	-33	-40	-47	-53	-60	-66	-72
	40	-1	-7	-14	-21	-27	-34	-41	-48	-54	-61	-68	-73
	45	-1	-8	-15	-21	-28	-35	-42	-48	-55	-62	-69	-74
	50	-1	-8	-15	-22	-29	-35	-42	-49	-56	-63	-69	-75
	55	-2	-8	-15	-22	-29	-36	-43	-50	-57	-63	-70	-76
	60	-2	-9	-16	-23	-30	-36	-43	-50	-57	-64	-71	-77
	65	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79
	70	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-80

Frostbite Guide

Low risk of frostbite for most people
Increasing risk of frostbite for most people in 10 to 30 minutes of exposure
High risk for most people in 5 to 10 minutes of exposure
High risk for most people in 2 to 5 minutes of exposure
High risk for most people in 2 mnutes of exposure or less

2.0 GUIDELINES FOR WORKING IN A COLD ENVIRONMENT

Wind speed doesn't only occur when it's windy. Driving in an open vehicle will mechanically generate brisk air movement similar to high wind speeds.

The following is a useful guide to guess the wind speed:

- 10 kph – Wind felt on face; leaves rustle; moves a light flag.
- 20 kph – Leaves and small twigs constantly moving; fully extends a light flag.
- 30 kph – Raises dust, leaves and loose paper; large flags flap; small tree branches move.
- 40 kph – Small trees begin to sway; blowing and drifting snow.
- 50 kph – Larger tree branches moving; whistling heard in power lines; large flags waving wildly.
- 60 kph – Whole trees moving; resistance felt in walking.

(Environment Canada)

Factors affecting individuals' ability to tolerate cold:

- **Physical Condition** – Individuals vary greatly in their ability to tolerate cold. For example, an individual who is short and stout is less susceptible to the effects of cold than one who is tall and slim. Fatigue can also render an individual vulnerable to cold.
- **Physical Activity** – Physical activity will generate body heat and counteract the effects of cold temperatures. On the other hand, workers who are sedentary or who do light work may not produce adequate heat to maintain body temperature.
- **Adequate Protective Clothing** – This is the most important factor in preventing cold injuries. Warm head cover and face protection is essential. Hands and feet must be kept dry.
- **Use of Tobacco and Drugs** – Nicotine in any form decreases blood flow while alcohol and some drugs stop the liver from releasing fuel that muscles need to make heat. In addition, alcohol increases blood circulation to the skin and the body becomes cold faster. The use of alcohol, tobacco and drugs greatly increases the risk of cold injury.

2.3 Prevention of Injury

Prevention of cold injuries is largely a matter of common sense. By recognizing the dangers, planning effectively to reduce them, paying attention to the work at hand and staying calm if a problem occurs, most injuries can be avoided.

Food, Rest and General Health – Overall physical well-being is an important factor in the prevention of cold injury. When you are exhausted, hungry, ill or injured, your chances of frostbite or hypothermia are increased. Learn to recognize your physical limits and don't exceed them. When doing physical work ensure that you are well rested before heading out onto the job and pace yourself to avoid exhaustion and perspiration.

Eat plenty of the right sorts of food for producing body heat. Most important are fats, followed by carbohydrates, with protein being the least important.

The following list indicates the composition of various foods:

Bacon Fp	Chicken Pf	Macaroni Cp
Beans (dried) CPf	Chocolate FC	Meats (average fat content) Pf
Beef (chipped) Pf	Eggs (whole) Pf	Milk (whole) PFc
Biscuits (Pilot) Cp	Fish PF	Milk (non-fat, dried) Pc
Bread (white) Cp	Fish (in oil) FP	Nuts FPc
Butter F	Flour (white) Cp	Dried meat FP
Dates Cp	Fruits Cp	Potatoes (dried) C
Candies (hard) C	Ham FP	Soups (dried, thick) C
Cereal (oatmeal) Cp	Honey C	
Cereal (oatmeal) Cp	Jams and Jellies C	
Cheese FP		

(F)ats (C)arbohydrates (P)roteins
Lowercase letters indicate a minor component of the food item.

2.0 GUIDELINES FOR WORKING IN A COLD ENVIRONMENT

Personal Clothing – Workers are responsible for providing or obtaining and carrying cold weather clothing and footwear that is appropriate for the outdoor temperature range and type of activity, including sunglasses, when travelling and working in cold temperatures and isolated areas. It is important to consider what weather conditions **might** be encountered rather than what they currently are. Plan for the worst case. In cold windy weather, protect your face, head and neck. Enormous amounts of body heat can be lost from these areas even when other parts of the body are adequately clothed.

Avoid tight fitting clothing, which might restrict circulation, particularly on the hands and feet. Wear multiple layers of light, loose-fitting clothes. Air between the layers provides warmth. Outer wear should be water-resistant.

Avoid sweating. Sweat dampened clothes lose their insulating value. The following sequence is a guide when removing clothing to avoid sweating:

- Remove gloves/mitts, unless protection from cold materials, snow and ice is needed.
- Remove headgear and neck wrapping.
- Open jackets at the waist and sleeves.
- Remove outer layers of clothing.

Replace clothing in the reverse sequence as soon as work is done. Don't wait until you start feeling cold.

Don't use old matted boot insoles that have lost their insulating ability. Keep your hands and feet dry by changing socks and/or liners that have become wet from perspiration or water.

Communications – Working alone must be avoided when cold weather is potentially a danger. However, this is not always possible on winter road construction (which is over land). In this case, a "buddy" system must be used. This means that a person working on a winter road must be able to contact another person by radio or telephone on an open channel at all times. Reporting schedules are shown in Figure 2. Workers who work on an ice crossing or on lake ice are never to work alone. Supervisors are to clearly lay out the communications plan prior to starting work so everyone is clear on the work and what happens during an emergency.

FIGURE 2

Warm-up and Reporting Schedule for Outdoor Activities

Windchill (°C) (Refer to Figure 1)	**Outside Worker**	**Equipment Operator**
-15 to -30	Warm-up breaks every hour.	Where warm shelter is provided by heated cab, breaks are every 2 hours, otherwise, same as outside worker.
	Persons working should be contacted every hour by visit or radio communication.	Same as outside worker.
-30 to -45	Warm-up breaks every ½ hour.	Where warm shelter is provided by heated cab, breaks are every 2 hours, otherwise, same as outside worker.
	Persons working should be contacted every ½ hour by visit or radio communication.	Same as outside worker.
	NON-EMERGENCY WORK SHOULD CEASE. Where work must proceed, warm-up breaks should be taken every ½ hour.	NON-EMERGENCY WORK SHOULD CEASE. Where work must proceed and where warm shelter is provided by heated cab, breaks are every hour, otherwise, same as outside worker.
Greater than -45	NON-EMERGENCY WORK SHOULD CEASE. Where work must proceed, persons working alone should be contacted every ½ hour by visit or radio communication.	NON-EMERGENCY WORK SHOULD CEASE. Where work must proceed, same as outside worker.

Important: This is a guide only. Common sense should over-ride the strict application of this table.

2.0 GUIDELINES FOR WORKING IN A COLD ENVIRONMENT

Warm-up Breaks – Figure 2 shows warm-up break schedules for outdoor work in cold conditions. It assumes that under normal warm weather working conditions, breaks are scheduled at two-hour intervals. The schedule provides for additional breaks as the wind velocity at the work site increases and/or the temperature decreases. If effective protection from the wind can be achieved by shields or screens or by modifying or relocating work, then temperature alone can be considered. Where the work itself generates wind (i.e. driving or riding on an unshielded vehicle), this should be taken into account.

The tolerance of individuals to cold varies widely. In all cases, common sense should be taken into consideration to determine individual limitations.

Awareness – A major defence against serous cold injury is awareness of the danger. When working with others watch for potential danger or signs of injury. In turn, make sure that your co-workers are looking out for you. Periodic checks of face and ears can identify a potential frostbite problem before it becomes serious. Look for disorientation or clumsiness in yourself or others, which could be a sign of hypothermia.

Equipment – Equipment is prone to mechanical breakdown during cold temperatures. In extreme weather conditions such a breakdown can be life threatening. It is, therefore, prudent to take care to ensure that equipment is in good working order. As the temperature decreases, more stringent standards of safety will apply:

- **Air Temperatures from 0°C to -20°C:** To avoid accidents and breakdowns, all equipment must be checked at the start of each working day and every eight hours thereafter.
- **Air Temperatures from -20°C to -45°C:** All equipment must be checked at the start of each working day and every four hours thereafter.
- **Air Temperatures -45°C and Below:** Normally, all outdoor work will cease. In the event of an emergency such as natural disasters, rescue operations and situations that threaten public safety, work must proceed with extreme caution. Equipment checks must be carried out hourly.

Use caution when handling gasoline. With a freezing point of -56°C (-70°F) and a high evaporation rate, contact with the skin can be very dangerous. Similarly, caution should be exercised when handling metal objects. Always wear gloves or mitts rather than touch the object directly.

Emergency Kit – All vehicles should be outfitted with emergency gear as a precaution against vehicle breakdown or sudden changes in weather or road conditions. Drivers should routinely check to see that their vehicles are equipped with:

- Reflectors or flares
- Shovel
- Hatchet, axe or saw
- Tow strap or rope
- Basic tool kit
- Jumper cables
- Flashlight, candle
- First aid kit
- Personal survival kit
- Food (rations)
- Maps
- Mirror
- Newspaper
- Toilet paper, paper towels
- Small metal can, jug
- Matches (strike anywhere)
- Knife
- Rope, wire
- Sleeping bag or blankets

2.4 First Aid Treatment

It is important to recognize the early symptoms of cold injury. As the body cools, discomfort is first felt at the extremities such as fingers and toes. Shivering follows this discomfort. This is a warning that the body must be warmed, either in a warm shelter or, in some circumstances, by more vigorous activity. The activity should not be so great as to cause sweating. If the warning is ignored then the result can be serious injury such as frostbite or hypothermia.

Hypothermia – Hypothermia is a condition that results from the cooling of the body at a rate that exceeds the body's ability to generate warmth. This can occur slowly, as in the case of a person who has put in a full day of work under cold conditions and is in need of food and rest to allow the body to restore normal body core temperature. It can also occur quickly, as in the case of a person who has fallen through ice into frigid water.

Typical signs and symptoms include:

- Increasing slowness of physical and mental response;
- Stumbling, cramps and shivering;
- Slurring of speech;
- Impaired vision;
- Unreasonable behaviour or irritability; and
- Increased pulse and respiration as long as the body can still respond by shivering.

2.0 GUIDELINES FOR WORKING IN A COLD ENVIRONMENT

As the body's normal heat regulating processes are overcome, the body core temperature will drop. At a body core temperature of 35°C (95°F) body functions become depressed, and below 30°C (86°F) the body functions are critically reduced.

The first step in treatment is to remove the victim from the cold by providing shelter, removing any wet clothes and wrapping the victim in a blanket or sleeping bag. Hot liquids can be administered if the victim is awake. Avoid cigarettes and alcohol **completely**, which will only worsen the condition.

Placing the victim in a sleeping bag may not be enough since the victim's body is not generating sufficient heat on its own. An external heat source such as a fire or body heat from others may be required. Care must be taken not to provide too much heat too quickly since this may result in the sudden dilation of surface blood vessels, which will rob the essential internal organs of blood and may trigger a fatal collapse of essential organ(s) functions.

Frostbite – A condition in which skin tissue, exposed to extreme cold, freezes. Hands and feet are most susceptible because of their distance from the body core and the tendency of protective clothing to be compressed or restrict blood circulation. Ears, nose and cheeks are also highly susceptible because they are frequently left unprotected.

Frost nip is the only type of frostbite that can be effectively treated in the field. If sudden blanching of the skin is noticed promptly, it can usually be treated effectively by firm steady pressure of a warm hand (no rubbing!) or by blowing warm breath on the spot until it returns to normal colour or, in the case of fingers, by holding them under a warm armpit or against the skin in the crook of the neck. In the case of toes it is necessary to remove footgear and re-warm them by applying heat at or near body temperature. Placing the frozen toes against the bare stomach of a companion is an effective means of re-warming.

Superficial frostbite involves only the skin or tissue immediately beneath it. The area appears white or waxy. After re-warming, the area will first become numb, mottled blue or purple and then swell, sting and burn. In more severe cases blisters will occur beneath the outer layer of skin in 24 to 36 hours.

Deep frostbite is more serious, extending into deeper tissue. It is usually accompanied by huge blisters, which may take from three days to a week to develop. General swelling of the area will occur and may last for a month or more. In both cases, blisters will dry up, blacken and slough off, leaving a thin layer of new skin that is red in colour and extremely sensitive to cold. In some cases the sensitivity is permanent. If not treated properly, major tissue damage may occur which may be aggravated by infection.

In all cases of true frostbite every effort should be made to remove the injured person to a hospital where re-warming of the injured area can take place under controlled conditions. Inadequate re-warming followed by re-freezing can result in considerable damage to the affected area. If it is not possible to speedily evacuate the injured person to an hospital, then it is generally preferable to leave the injured part frozen until hospital conditions can be achieved and maintained. Under no conditions should an injured person with re-warmed feet be permitted to walk since this will result in serious tissue damage. In fact, less damage will be done walking on frozen feet than by walking on thawed feet.

If the casualty is unable to reach a hospital and a doctor is not available, it may be advisable to consider re-warming. This should only be attempted in a warm, secure location such as a maintenance camp. The frozen part can be thawed by immersing it in the largest possible vessel of water, warmed to a temperature between 10°C and 15°C (50°F and 59°F), which is then warmed by 5°C (9°F) every five minutes to a maximum of 40°C (104°F). The temperature is critical and great care must be taken to ensure that the water never exceeds this range. The vessel should be large enough to allow water to be added without having to pour it directly on the injured part and to ensure that the part itself does not cool the water. Following re-warming the injured part must be protected from further injury either from exposure to cold or from rubbing or rough treatment.

If pain becomes a problem then acetaminophen such as Tylenol in normal doses can be administered to the injured person. Other painkillers should be avoided in order to ensure that the healing process is not adversely affected.

Clean the injured part thoroughly as soon as re-warming has been completed, using a mild, non-alcoholic antiseptic or very mild soap – administered with thoroughly boiled and cooled water. Don't rub or scrub, rather dab off dirt gently with sterile absorbent cotton, facial tissue or the softest available cloth (also boiled). Be sure not to use antiseptics involving alcohol, as they may be very painful but are also liable to do further damage to delicate tissues.

Ultimate success in the treatment of frostbite largely depends on two factors: First, the exercise of extreme care during and after re-warming so that the delicate injured part is not further damage in any way; and, second, the prevention of infection, which becomes the paramount issue from the time of re-warming to the conclusion of treatment.

3.0 ICE CAPACITY AND TESTING

3.1 Introduction

Construction of ice bridges and ice roads has unique safety hazards because of the ever-present danger of an ice failure. To reduce this risk for those working on the road as well as for the travelling public, strict attention must be paid to testing of the ice to ensure that it is capable of supporting the loads to which it is subjected. The following section provides guidelines for testing of ice thickness and for determining the capacity of the ice to carry loads.

3.2 Safety Procedures

Each year before the winter or ice road construction season begins, your supervisor must organize a meeting with all ice/winter road construction employees to review and discuss safety procedures for ice road construction contained in this guide.

The GNWT supervisor must attend the contractor's information meeting to ensure that an appropriate review is done.

The GNWT supervisor or contractor's supervisor must have regular safety meetings with all respective ice/winter road employees during the construction phase. Minutes of the meeting must be produced and a copy provided to the GNWT Regional Superintendent within five working days following the meeting.

All ice/winter road workers are responsible for understanding and following the guidelines contained in this guide. The GNWT supervisor shall ensure that GNWT employees follow the procedures and practices of this guide through periodic work site inspections.

The GNWT supervisor shall ensure that contractors follow the guidelines contained in this guide through periodic inspections and the review of the contractor's minutes of safety meetings.

3.3 Ice Testing

The work crew supervisor is responsible for supervising/measuring the ice thickness.

Test crewmembers must wear an approved flotation suit, as described in Section 4.5 of this guide, when measuring initial ice thicknesses and until the ice thickness is more than 18 centimetres thick throughout the entire work area.

Do not work alone when taking initial ice thickness measurements or during the ice/winter road construction stages. Always use the "buddy system".

The lead tester must wear a safety harness, as described in Section 4.5 of this guide, attached to a ten (10) millimetre thick polypropylene rescue rope approximately 30 metres long that is held by trailing crewmembers.

Workers on foot are not to proceed onto ice that is less than 10 centimetres thick for any reason. Snowmobiles must have a minimum of 15 centimetres of ice and cars or light trucks less than 1,600 kilograms in weight must have at least 20 centimetres of ice before proceeding. The use of extremely light tracked or even floating vehicles are highly recommended for use in the early stages of ice road construction. Vehicles such as the "Badger" have a low bearing pressure, protect the operator from the elements and will float if ice breaks under them. All efforts to add safety and security should be pursued by the supervisor.

An ice chisel or needle bar may be used to test ice up to 30 centimetres thick. An auger should be used for ice more than 30 centimetres thick. Ice thickness must be tested before any workers or vehicles are allowed on the surface. If ice thickness is less than 10 centimetres test crewmembers should vacate the area immediately.

Measurements should be taken using an ice thickness measuring stick, which has a foot to hook onto the underside of the ice. This eliminates visibility problems caused by poor light or loose ice obstructing the view of the hole.

The GNWT supervisor or contractor's supervisor shall ensure that the gross vehicle weights of all vehicles used for working on ice are posted in clear view on both the outside and inside of the vehicle for the operator's reference. Workers must be aware of the weight of the equipment they are using and shall not proceed if the ice is not thick enough to support the operator and equipment, including all attachments and extra gear.

If, during testing, the measured ice thickness is less than that required to support the worker(s) and the equipment being used, back off slowly and suspend further testing. Report to the work crew supervisor.

3.0 ICE CAPACITY AND TESTING

The boundaries of the corridor where ice bearing capacity has been established, as provided in this guide, shall be clearly marked, and all workers shall ensure that working equipment stays within that corridor. Examples of types of markers include trees, poles, cones or any item that clearly delineates the boundaries. No one is to proceed beyond the boundary without the proper safety precautions.

During shift changes, workers shall report ice conditions noted during their shift to the work crew supervisor and to the crew coming on shift. The use of a thickness diagram regularly updated is recommended.

The contractor's supervisor or workers shall report any hazardous situation immediately to the GNWT supervisor for proper assessment.

The GNWT supervisor shall perform a risk assessment on any hazardous situation reported by employees or the contractor to ensure that safe working conditions are maintained.

If an area of thin ice is found but conditions are still safe, drill additional holes to determine the extent of the weak area. The thinnest ice measurement will govern the allowable loading. For example, if nine test holes read 25 centimetres and one reads 12 centimetres, the critical ice thickness will be 12 centimetres. Subsequent testing will start at the 12 centimetre test hole location.

Flooding or spray ice can increase ice thickness. Alternatively, construction activities can be postponed until the ice thickens naturally.

In general, the most frequent and intensive testing will take place early in the construction season. As ice thickness increases and crews become more confident that all thin areas have been identified, testing may be reduced. Typically, the frequency and distribution of test holes is as described in Figure 3.

FIGURE 3

Test Hole Spacing of Ice Roads and Bridges

	Preconstruction	Construction	Operation and Maintenanace	
	Initial test run	**From start of construction until road is opened to traffic**	**This may overlap with construction activities at lower load levels**	
Rivers (crossing with a flowing current)	30 metres between test holes along centre line	30 metres between test holes along alternate edges	30 metres between test holes along alternate edges If SIR is used, test holes are only required for calibration and for mapping of thin areas	Look for thin areas caused by river current
Lakes	If within 250 metres of shore: 30 metres between test holes along centre line	If within 250 metres of shore: 30 metres between test holes along alternate edges	250 metres between test holes along alternate edges	Beware of shallow or shoal areas that could affect the ice strength due to the underwater wave caused by vehicles passing over the ice
	If more than 250 metres from shore: 250 metres between test holes along centre line	If more than 250 metres from shore: 250 metres between test holes along alternate edges	If SIR is used, test holes are only required for calibration and for mapping of thin areas	
Slow moving rivers (Mackenzie Delta)	If within 250 metres of shore: 30 metres between test holes along centre line If more than 250 metres of shore: 250 metres between test holes along centre line	If within 250 metres of shore: 30 metres between test holes along centre line If more than 250 metres of shore: 250 metres between test holes along centre line	250 metres between test holes along alternate edges	If SIR is used, test holes are only required for calibration and for mapping of thin areas
	Frequency – repeat as required until sufficient ice has formed to allow the start of construction	Frequency – continue testing in areas where construction is underway	Frequency – test entire route prior to raising load limits of spot test known thin areas as directed by the work supervisor	

Note: The above table indicates normal test frequency and hole spacing. Good judgement based on field experience must be used when varying from this table. In thin areas the suggested spacing must be reduced to determine their extent and severity.

If available, Subsurface Interface Radar (SIR) may be used in conjunction with test holes. This is particularly useful in identifying air bubbles, cracks and other anomalies that might be missed by the test holes. The SIR unit must be calibrated to ensure its accuracy at the start of each day, after four hours of use and whenever erratic or questionable readings are obtained.

SIR tapes are to be annotated as they are produced, indicating location and type of anomalies as well as significant thickness readings. The notes are to be initialled by the operator and submitted to the GNWT supervisor no later than the following day. These tapes will be retained until the end of the ice/winter road season.

All distances, test hole locations and SIR results must be recorded in the "Ice Thickness" log book (bound book). The records will be filed as part of the permanent record and will be made available to senior department officials. It is very important that the log book is filled out accurately and in a professional manner. In addition to the distances and thicknesses, the following information must also be recorded:

- Date of test;
- Time of start and finish;
- Names of testing crew;
- Air temperature during testing;
- The presence of wide, wet cracks and other significant cracking;
- Details of load reductions and/or traffic detours;
- Location, i.e. Peel, Mackenzie at Arctic Red, Tsiighetchic Branch at Mackenzie, Liard River, Mackenzie River at Fort Providence, Aklavik, Tuktoyaktuk, etc.; and
- Printed name and signature.

3.4 Ice Capacity

The ability of ice to support a load is dependent on a number of factors, including ice thickness, the pressure of the water below the ice as deflection develops, the way the ice formed initially, snow cover, vehicle speed and the kinds of load placed on the ice cover. The strength is different for sea and freshwater ice and is affected by the presence of cracks and sudden or extreme temperature changes. It should also be remembered that ice thickness can vary considerably from place to place and until a margin of safety is achieved, extreme caution must be exercised. Although ice can be described as BLUE, WHITE, GREY, fresh water or salt water, this guide will treat all ice the same when applying the bearing capacity formula and the safety precautions required.

Figure 4 is a graphical representation of the Gold's Formula, which is used as a guide for establishing the thickness of ice necessary to support a given load. The Gold's Formula provides an estimate of the load limit for a particular thickness of ice, below which the failure of an ice sheet is unlikely. It is not an infallible measure of the bearing capacity of an ice sheet and must be combined with field observations of other factors affecting ice strength when actual load limits are determined.

Only the formula that is found in this guide shall be used to determine ice-bearing capacity. No other formula, graphs or charts shall be used.

FIGURE 4

Ice Bearing Capacity Chart

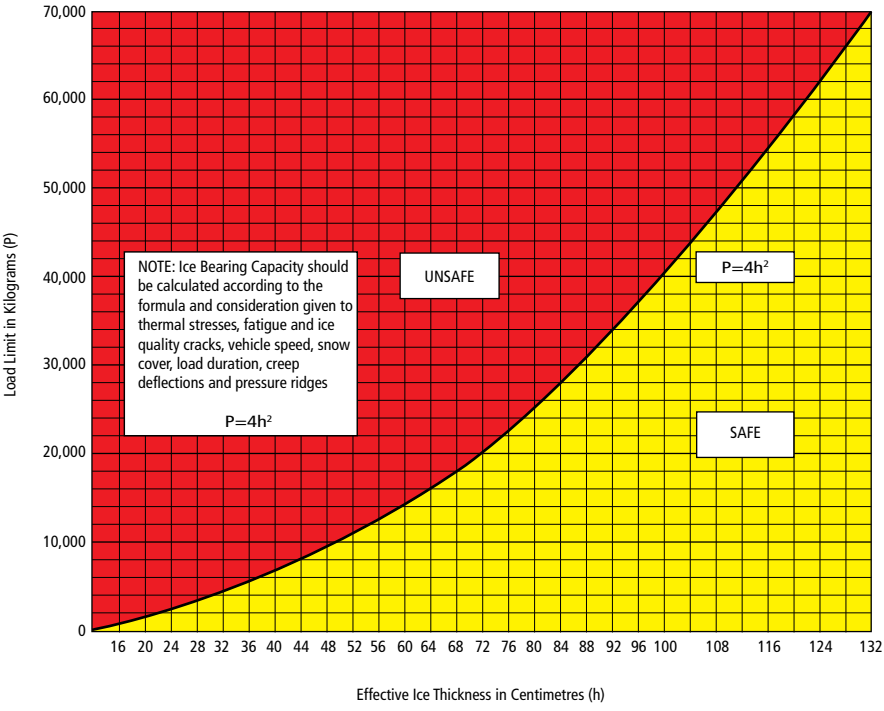


Figure 5

Ice Bearing Capacity Chart
Golds Formula (Capacity = 4 x h^2) (Height in centimetres – Capacity in kilograms)

cm (h)	Capacity	cm (h)	Capacity	cm (h)	Capacity	cm (h)	Capacity
2.5	25	37.5	5625	75	22500	112.5	50625
3.5	49	40	6400	77.5	24025	115	52900
5.0	100	42.5	7225	80	25600	120	57600
7.5	225	45	8100	82.5	27225	125	62500
10	400	47.5	9025	85	28900	130	67600
12.5	625	50	10000	87.5	30625	135	72900
15	900	52.5	11025	90	32400	140	78400
17.5	1225	55	12100	92.5	34225	145	84100
20	1600	57.5	13225	95	36100	150	90000
22.5	2025	60	14400	97.5	38025	155	96100
25	2500	62.5	15625	100	40000	160	102400
27.5	3025	65	16900	102.5	42025	165	108900
30	3600	67.5	18225	105	44100	170	115600
32.5	4225	70	19600	107.5	46225	175	122500
35	4900	72.5	21025	110	48400	180	129600

Every condition will be different - in the next few pages a number of observations will be made to assist the supervisor to make informed judgements when determining the ice bearing capacity. The presence of cracks, climatic conditions, load spacing, vehicle speeds, recent damage and presence of shoals could all affect the ultimate bearing capacity of the ice in question.

Sudden and Extreme Temperature Changes – A temperature drop of more than 20° Celsius over a 24 hour period will produce severe thermal stressing and cracking of the ice. If this occurs the road should be checked for cracks which may compromise the load capacity.

The Presence of Cracks – Any ice cover will have cracks caused by thermal contraction or movements in the ice cover. Except during spring thaw or in areas subject to fatigue, cracks do not necessarily indicate a loss in the load-bearing capacity of the ice.

Where there is an indication that a wet crack penetrates right through the ice cover, a reduction in the allowable load limit is advisable. Once a wet crack refreezes, the new ice is as strong as the original. A healed wet crack should be tested with an ice chisel, auger or a chain saw to gauge the depth of healing.

Where a dry crack over 10 centimetres wide is observed, a reduction in the maximum load limit should be considered. The decision to reduce the load limit will be based on the frequency, width, depth and intersection of the cracks (see Figure 6). Dry cracks can be repaired by filling them with water or slush.

FIGURE 6

Modification of the Ice Loading and Remedial Action for Various Types of Cracks

Type of Crack	Modification of Ice Loads	Remedial Action
Hairline Cracks	None	None
Refrozen Cracks	None	None
Non-intersecting and Intersecting Dry Cracks	Weight reduction to **90%** of allowable should be considered based on frequency, width and intersection of cracks.	Fill cracks, and/or Detour around affected area, and/or Spray/flood affected area, and/or Abandon existing alignment.
Non-intersecting Wet Cracks	Weight reduction to **75%** of allowable should be considered based on frequency, width and intersection of cracks.	
Intersecting Wet Cracks	Weight reduction to **50%** of allowable should be considered based on frequency, width and intersection of cracks.	

As a result of normal thermal contraction, cracks sometimes form in the middle of a road perpendicular or parallel to the direction of travel. If they remain dry they do not seriously reduce the bearing capacity of the ice. Cracks at the sides of the road and running parallel to the direction of travel indicate over-stressing (perhaps by the weight of snow deposits from clearing operations) or possible fatigue from excessive traffic. If such cracks develop, particularly if they are wet, traffic should be diverted away from the crack and, in more extreme cases, road use should be suspended until the cracks have healed.

Fluctuating water levels may produce cracks near and generally parallel to the shoreline, which can create hanging ice or pressure ridges. These cracks are often accompanied by a difference in the levels of the floating and the grounded ice. If these cracks are wet, loads should be reduced accordingly. With extreme differences in the level, bridging repair or flooding may be necessary.

Moving Loads – Deflection of ice by a moving vehicle creates stresses, which fatigue the ice when frequently repeated and in extreme cases may result in a sudden failure. The speed of the vehicle is a key factor. An empty truck travelling between 25 and 35 kilometres per hour will often cause more audible cracking in the ice cover than a fully loaded truck travelling at 10 kilometres per hour or less. Restricting the speed of heavy trucks may be necessary to protect the integrity of the ice and load capacity.

Moving loads deflect the ice sheet and create a wave in the water beneath the ice. The speed of the wave is dependent on the depth of the water, underwater obstacles such as rock outcroppings, the thickness of the ice cover and the strength of the ice. The greatest deflection and the most severe stresses occur when the vehicle on top of the ice and the wave below it are travelling at the same speed.

The moving deflection effect is critical when the water depth is less than 50 times the thickness of the ice. The critical velocity increases with water depth. Consequently, over very deep water, the deflection wave travels through the ice at a much higher velocity than a vehicle would normally achieve. Although the speed of a vehicle is not significant over deep water it becomes critical near the shore.

When a vehicle is travelling parallel to a shoreline, resonant waves reflect back through the ice. The wave pattern is critical when the vehicle weight is close to the load-bearing limit of the ice. Reflected waves are greatest when a vehicle approaches a shoreline at a right angle. If possible, roads and vehicles should meet the shoreline at a 45° angle. It is important that drivers obey the posted speed limit at all times and especially when a road meets the shoreline at a 90° angle and when a vehicle's weight is close to a maximum load limit for the ice.

Multiple Loads – Two or more moving vehicles increase deflection and stress as they approach or travel close together. Therefore, drivers should decrease speed when approaching another vehicle and should not follow other vehicles too closely. Heavy and/or tracked equipment such as a tracked dozer can also cause vibrations in the ice that add to the deflection effect.

Frequently Repeated Loads – Frequently repeated loadings will cause rutting, holes, and dry and wet cracks to form in the ice. The weakened condition of the ice may be a reason to reduce the allowable load limit. If cracks or potholes appear in the ice, the travel route may be detoured, loads reduced, the area flooded or the road closed temporarily to allow for the recovery of the damaged areas.

Long-term Loads – Long-term loads are those imposed by vehicles parked for more than a few minutes. Over a period of time the ice begins to show signs of plastic or creep failure. This mechanism for failure is significantly different, therefore, the standard load calculations do not apply. Parking of vehicles or equipment on ice that is at or near its load limits must be avoided. Also, avoid parking vehicles close together or near the edges of the ice road/bridge corridor where the snow banks are located as this area is much weaker due to the insulation provided by the snow and the constant weight applied by the snow banks.

4.0 WORKER SAFETY

4.1 Introduction

Working on ice is inherently dangerous. Failure can occur so quickly that rescue can be very difficult, dangerous or even impossible. It is, therefore, imperative that all workers are aware of the potential danger and take the necessary steps to protect themselves and others. Workers should observe all Occupational Health and Safety Regulations as well as other standards, procedures and practices relating to their work.

4.2 Ice Conditions

- Seek approval from the work crew supervisor before going on any winter road or ice road.
- Every effort must be taken to know and understand the local conditions.
- Every operator must be aware of the required ice thickness for his/her vehicle.
- The ice must be a minimum of 15 centimetres thick before a snowmobile or 20 centimetres thick before a car or light truck may travel on the ice.

4.3 Weather Conditions

- Evaluate weather and ice conditions prior to venturing onto the winter road and follow Chapter 2 – Guidelines for Working in a Cold Environment. Dress and be prepared for the worse case scenario. You can always take a layer off.
- Cancel or postpone travel on a winter road if the weather is unsuitable or if deterioration of the ice is apparent.

4.4 Procedures

- On winter road construction (over land), a "buddy" system can be used. This means that a person working on winter roads will be able to contact another person by radio or telephone on an open channel at all times. Wherever possible, workers should not be left to work alone. Workers on ice are not allowed to work alone.
- If machine operators are working alone, they will radio the work crew supervisor at the beginning of each shift and give their location and direction of travel. During the shift, they are required to call in as shown in the guidelines presented in Figure 2.
- Observe and report hazardous conditions.

4.5 Protective Clothing and Safety Equipment

- A lifeline (i.e. 10 millimetre thick polypropylene rope) must be used by workers who are doing the initial testing of an area or suspect that they may be near the load limits given the equipment they are using (i.e. snowmobile or pickup with trailer mounted auger). The lifeline should be at least 30 metres in length and should be held by another worker rather than attached to a piece of equipment. The line must be inspected for damage before and after each use. The lead worker during testing must wear a CSA approved harness to which the lifeline is secured.
- **All** GNWT Department of Transportation workers on the ice during initial ice road construction must wear a Canadian Coast Guard (CCG) approved flotation suit. The department has specified the Mustang Survival, Anti-Exposure Coverall and Worksuit model MS2176 and Mustang Survival Coverall model MS-185 as an acceptable flotation suit for their workers. All contractors and/or other workers on the ice during initial ice road construction are strongly encouraged to adopt the same Canadian Coast Guard (CCG) approved flotation suits as the GNWT Department of Transportation.
- All workers on the ice during the initial ice road construction shall also carry a set of ice rescue picks on them while on the ice.
- Inspect all personal safety equipment daily.
- If operating a vehicle, obtain an emergency kit as described in Section 2.3 of this guide. Store it securely in the vehicle to protect it from damage, theft and direct sunlight. If items from the kit are used, they should be replaced or the kit exchanged for a fully serviced one at the end of the shift.
- Fire extinguishers, first aid kits and warning devices such as flares, reflectors and flags are mandatory on all vehicles used on winter road construction and maintenance.
- Wear warm clothing and footwear appropriate for the conditions encountered or anticipated.

4.6 Vehicles and Equipment

- Each piece of equipment will be weighed and the minimum ice thickness necessary to support it will be calculated according to the formula presented on the Ice Bearing Capacity chart (Figure 4) in Section 3.4 of this guide. In communities without access to a weigh scale, equipment will be weighed with portable scales. If neither permanent nor portable scales are available, weight information given by the manufacturer can be obtained from the Central Repair Facility in Hay River. The gross vehicle weight (GVW) of all motor vehicles used for working on ice will be posted in clear view on the outside and inside of the vehicle for the operator's reference. Workers must be aware of the operating weight of the equipment they are using and shall not proceed if the ice is not thick enough to support the weight of the equipment and operator plus any additional gear or attachments.
- Equipment operators will decide whether the doors and/or hatches on equipment working on ice will be removed or lashed open during the construction phase. Wherever practical, canopies will be removed and panic bars or hatches will be installed on equipment doors so that operators can quickly exit in case of breakthrough. At the first sign of breakthrough the operator is to abandon the vehicle immediately.
- Use of seat belts is optional when travelling on ice during the construction phase.
- Tools, equipment and materials must be stowed neatly in the vehicle.
- Visibility from the vehicle should be unobstructed (i.e. clean windshield).
- No equipment will be used on winter roads if it is not in proper running order.
- Vehicles operating close to the load-bearing capacity of the ice during construction must not exceed 20 kilometres per hour.
- If required, materials and equipment will be repaired, replaced or modified. This may include the installation of snowploughs and wings.
- Operators will be responsible for the care of their equipment and for reporting any equipment problem to their work crew supervisor. The work crew supervisor will arrange for repairs.
- An operational check of all equipment will be done and proper training for all personnel carried out.

4.7 Summary of the Key Dos and Don'ts:

Do:

- Ensure sufficient ice capacity for the heaviest unit to be used on the delineated ice road corridor.
- Open up and clear a specific section to full width in one shift to avoid the refreezing of windrowed snow. (Compacted snow and disturbed snow freezes very hard and requires increased effort to move again.)
- Keep the windrow height low (i.e. less than one metre) and spread out to reduce the overloading of the ice by the windrow and its ability to catch a lot of drifted snow.
- Plow snow berms off the main ice road to catch drifting snow in areas where drifting is a problem. (Remember the snow catchment area behind a berm is approximately 30 times as long as the height of the berm – so get them back far enough from the main road.)
- To promote rapid ice growth, remove all loose or fresh snow that insulates the ice sheet or compact the snow to remove air and insulating value from the snow cover.
- If flooding, use multiple "lifts" of water that will freeze solidly in 12 to 24 hours. (This reduces "shell" ice from forming.) Keep traffic off flooded areas.

Don't:

- Do not park heavy equipment on the ice or near the snowbanks overnight or for extended periods – the ice will "creep" and failure can occur.
- Do not make multiple passes over the same area of ice within a short period of time (i.e. one hour). This can cause ice fatigue and ice failure.
- Avoid opening new road when temperatures are very cold (-40). This causes extreme internal stress in the ice sheet. (Ice needs some time to normalize the internal stress.) This is not that critical if there is a lot of over capacity with the ice thickness.
- Avoid loading the ice to its limits when temperatures are very cold or when there has been a sudden decline in air temperature.

4.0 WORKER SAFETY

The Department of Transportation has introduced the VITAL program to act as a safety message for all personnel who work on or are responsible for working on and around ice road and ice bridge construction.

VITAL stands for:

V	**VEHICLE**	All operators and supervisors must be aware of the vehicle weight, ice required to support it, the characteristics and capabilities of the vehicle, ensuring it is in good repair and the most effective escape plan.
I	**ICE**	Everyone working on or near the ice needs to know the ice thickness, the bearing capacity, the conditions and any special observations or notes. An ICE LOG is to be kept.
T	**TASK**	All workers are to know exactly what is expected of them while they are working or operating equipment on the ice.
A	**ASSEMBLE the proper equipment**	Everyone working on or near ice is to have the proper personal protective gear and tools to accomplish their task. Radios, ice chisels/augers, ice profilers, vehicles, ropes, floater suits, etc. are to be in good working order and tested prior to deploying on the task. If in doubt, ask.
L	**LEARN**	Successfully working on ice takes experience, knowledge, training and skill. Learn the techniques and procedures and keep you and your team alive.

5.0 PUBLIC SAFETY

5.1 Introduction

All GNWT Department of Transportation employees involved in ice road construction, in addition to their regular duties, are responsible for monitoring road conditions. If an employee sees a situation that is a danger to the public, they have the authority and responsibility to take immediate action to correct the problem. For example, if wet cracks and overflow conditions are observed at a stream crossing, an employee has the authority to detour traffic or temporarily close the road.

Winter roads in the north are somewhat unique in that even minor accidents or delays have the potential to create a life-threatening situation. Anything, therefore, that interferes with the steady flow of traffic is a public safety concern.

5.2 Construction Techniques

Hazards created by drifting snow can be reduced by blading out snow guards approximately 30 metres from each side of the road surface. The guards will trap blowing snow before it reaches the road surface. This will keep the road open longer during drifting conditions and also reduce maintenance costs. Care must be taken to ensure that the ice beyond the edge of the cleared road surface is sufficient to support the equipment being used.

When constructing the road, a narrow lane may be initially compacted to allow the movement of equipment to locations within the limits of the project. Wherever possible, however, the full width of the road should be cleared in order to reduce the possibility of thermal cracks and the development of pressure ridges.

5.3 Road Inspections

While all personnel have a responsibility to identify potential hazards, this is a major part of the activities of supervisors, foreman and superintendents. Regular road patrols are carried out during both the construction and maintenance phases of the winter road season. Once identified, problems must be either corrected or isolated from the traffic. The travelling public must also be promptly advised of changes to road conditions that might affect their ability to complete a trip.

When conducting road inspections:

- Look for snow drifting, overflow, wet or dry cracks and icing. If a hazard is discovered, place warning devices such as flags, delineators or flares. If possible, remedial action should begin at once. Warning signs must be set if the repair will take some time to complete.

- Check for missing or damaged traffic signs and make immediate repairs or replacements.
- Check for and remove debris or dead animals from the roadway.
- Report the unauthorized erection of signs or the construction of accesses to the Regional Highway Superintendent.
- Help stranded motorists.
- Report abandoned vehicles to the RCMP or the Traffic Enforcement Officer.
- Check for and report spills of oil or dangerous goods.
- Inspections should be done once a week on snow roads, twice a week on ice roads and daily on ice bridges.

5.4 Highway Patrols

Traffic Enforcement Officers are responsible for ensuring that vehicles comply with the Motor Vehicles Act and its regulations. Inspections of transport trucks are especially important when the load limits on the ice roads are not yet up to those set for the all-weather highway system. A truck that is legally loaded for the primary highway system may exceed the load limit for an ice road or crossing and cause an ice failure.

If construction/maintenance personnel believe that trucks are operating in excess of an ice crossing load limit, they should notify Department of Transportation personnel of the need for spot inspections. The Officer assigned to enforcement duty on a winter road will be equipped with portable scales to weigh the truck traffic.

5.5 Signs and Barricades

Winter road traffic signs are used to declare the road open or closed, to direct traffic to destinations along the road, to post load limits and to warn motorists of potential hazards. The standards of signing are somewhat different from those on permanent all-weather roads because conditions on seasonal roads are more subject to change. Traffic signs must be adjusted to meet these changing road conditions.

During Construction – While the winter road is under construction and not yet open to the public, barricades and signs will be posted at the entrance to the winter road stating that it is closed. Regular checks and patrols will be conducted to ensure that all barricades are in place at all times. If barricades have been moved or vandalized, the RCMP having jurisdiction in the area should be notified.

At the end of the season the signs and barricades should be reinstalled and the closure monitored and enforced.

Entry Signs – Signs must be posted at each major river crossing and at the entrance to all winter roads on the NWT Highway System, which clearly indicates whether the road or crossing is open or closed, the maximum allowable weight and the phone number to call for road information.

At the entrance to the winter roads, signs must also be posted that advise motorists to carry chains and survival gear and indicate that there are no services available. On the Mackenzie Delta ice roads, in the Inuvik/Tuktoyaktuk area, additional signs will be posted to caution motorists to remember that they are driving on ice.

At the entrance to the major ice bridges, motorists will be advised to maintain a distance of 400 metres from other vehicles and a maximum speed of 20 kilometres per hour.

Roadway Markers – Markers such as flagging and trees will be installed to delineate the edge of the roadway. Additional traffic control devices such as drums and barricades can be used to direct the flow of traffic.

Regulatory and Advisory Signs – Speed limit signs should be posted as required, taking into account the type of road surface. For example, the upper limit for the Tuktoyaktuk/Aklavik/Inuvik ice road is 70 kilometres per hour because the surface is entirely of ice.

Signs should also be posted to indicate the distance from the next community. These signs and the speed limit signs should be posted at 50 kilometre intervals, near communities and at intersecting roads.

Standard warning signs should be posted where required. For example:
- WA-1 90° Curve (left or right)
- WA-8 Checkerboard (left, right or both directions)
- WD-A43 Diversion
- WD-A44 Detour
- WD-103 Detour Next __ kilometres
- WD-106 One Lane Traffic

On short detours, traffic cones or drums may be sufficient.

Barricade lights may be installed in an emergency to attract attention to a sign message or to identify a particular hazard or obstruction. Lighting devices should be positioned so as not to blind traffic with their glare. Flashing devices do not provide good illumination and should not be used by themselves to channel traffic.

5.6 Temporary Road Closure

Section 23 of the Public Highways Act authorizes the closure of portions of a highway for the purpose of construction or maintenance. The department routinely closes sections of highway if snowstorms or drifting snow reduce visibility to the extent that travel is hazardous.

When a road is closed, proper signs must be installed to inform the public. The same standards apply to temporary and permanent road closures. In addition, it is important to notify the local radio stations so that public service announcements advising of the closure can be made.

5.7 Public Information and Communications

The department makes regular public announcements on current road conditions through public service announcements on local radio stations, messages on a toll-free telephone line, on the GNWT web site and communication with major transportation companies. Any changes in road conditions must be promptly communicated to the department's Regional Superintendent and/or Highway Superintendent to ensure that information provided to the public is up to date and accurate.

6.0 ACCIDENT RESPONSE

6.1 Introduction

In spite of taking all reasonable safety precautions, accidents can happen. Whether such accidents involve the public or government employees or private contractors, it is likely that those involved with highway construction and maintenance will be among the first on site and will be required to respond.

Similarly, regardless of who is involved in the accident or its severity, it is important to report it to the correct individuals so that follow-up action can be taken and so that information and statistics are available to those with responsibility for establishing design/construction standards and operational guidelines. It is thorough this process that ongoing problems are identified and corrected.

6.2 Initial Response

In the event of an accident:

- The first priority after aiding the accident victim(s) is to secure the site to ensure that no one, including yourself, is in danger from further accidents. For example, in the case of an ice failure, warning signs, flares or barriers must be used to warn others away from the failure (hole). In an area where visibility is poor and traffic is likely, warnings must again be provided to ensure that approaching vehicles do not endanger the people and equipment that are providing assistance at the accident scene.
- In the case of an ice failure, approach with extreme caution. No attempt at rescue must be made if it puts the rescuer at risk.

THINK BEFORE YOU ACT.

- Determine if anyone is in immediate danger. A rescue effort may be required if a person is trapped in a vehicle and the vehicle is in an unstable position. Similarly, an injured person may be in need of immediate medical attention. Deal with life threatening situations or injuries immediately.
- At the first opportunity, radio/telephone (Sat phone) for assistance. Provide the following information:
  i. Location;
  ii. Brief description of the accident;
  iii. Description of injuries;
  iv. Assistance required such as air evacuation, ambulance, road closure, additional personnel or equipment;
  v. Request that the RCMP be notified; and
  vi. Request that the Regional Superintendent and/or District Highway Superintendent be notified.

- Stabilize casualties, being sure to provide as much warmth and shelter as possible.
- Maintain security of the site and stability of victim(s) until assistance arrives, or transport victim(s) to the nearest facility where medical assistance or transportation is available.

Important – There is always a danger in moving an accident victim. This danger must be weighed against the danger associated with the delay in receiving professional medical treatment and the lack of adequate warmth and shelter. Whenever possible use your radio or telephone (Sat phone) to seek professional medical advice before making the decision to move the casualty.

6.3 Follow-up and Reporting

In the event of death, serious injury or major equipment loss:

- Prevent the destruction or removal of evidence at the accident scene if possible. The site should remain secured until the Regional or Area Superintendent of Transportation or the Director, Highways and Marine Division, authorizes restoration of the site and recovery of the equipment.
- If there are witnesses to the accident, they should be interviewed while events are still fresh in their minds. Written statements should be obtained.
- Try to establish the cause of the accident.
- Take photos and make a sketch, complete with measurements of the accident site.
- Within 24 hours, report the accident to Workers' Compensation Board (WCB) and provide a written accident report to the Regional Superintendent, which includes:
  i. Date and time of accident;
  ii. Persons involved;
  iii. Vehicles or equipment involved;
  iv. Description of accident;
  v. Weather conditions at the time of the accident;
  vi. Road conditions at the time of the accident; and
  vii. Action taken.

Note: WCB also requires an accident report within 72 hours (three days).

In the event of minor injury or equipment damage:

- Minor injuries to department employees are to be reported to the appropriate Administrative Officer within 24 hours. The injured person and their supervisor are responsible for filing reports with the WCB within 72 hours (three days).
- Minor government or contracted equipment accidents are to be reported to the Central Repair Facility in Hay River within 24 hours.

6.4. Other Reporting Responsibilities

It is the responsibility of the GNWT Department of Transportation Regional Superintendent to immediately report accidents involving death and serious injury to:

- Assistant Deputy Minister or the Deputy Minister, Department of Transportation ((867) 920-3460)
- Supervisor – WCB Prevention Services within 24 hours, Workers' Compensation Board (1-800-661-0792)
- Manager, Insurance and Risk Management, Department of Finance ((867) 873-7307)
- Manager Public Affairs and Communications, Department of Transportation ((867) 873-7712)
- Workplace Safety Program Coordinator, Department of Transportation ((867) 920-8809)
- Director, Highways and Marine Division ((867) 873-7800) or Assistant Director, Highway Operations ((867) 874-5021), Department of Transportation

APPENDIX – A

Safety Act

The Northwest Territories Safety Act and Regulations are the legal requirements for governing safe work sites in the Northwest Territories. The following sections of the NWT Safety Regulations are especially relevant to the construction and maintenance of winter roads. (The reader should refer to the regulations for updates or changes.)

Section 3 – "Subject to Section 4, every employer shall:

a) Initiate an accident prevention program and direct effective ways and means of preventing work injuries, including the promotion of relations between management and the employees that will encourage attitudes and desires favourable to an accident-free operation;
b) Encourage the participation of his employees in the implementation of accident prevention measures;
c) Organize accident prevention committees;
d) Maintain a record of accidents and injuries, including the causes of the accidents and the action taken to prevent similar incidents;
e) Conduct regular inspections of all structures and places of employment and review work practices at intervals that will ensure that safe working conditions are maintained;
f) Correct any condition that constitutes a hazard to workers and ensure that no person other than those workers necessary to correct the condition could be exposed to the hazard;
g) Maintain records and statistics, including inspections and accident investigations sufficient to indicate the effectiveness of the accident prevention program; and
h) Initiate the prompt investigation of every accident to determine the action necessary to prevent a recurrence."

Section 4 – "An accident prevention program shall be initiated and maintained by every employer with 10 or more workers in any one area or settlement."

Section 9 – "An employer shall ensure the adequate instruction of each worker in the safe performance of his duties."

Section 10 – "A supervisor is responsible for the proper instruction of workers under his direction and control, and for ensuring that their work is performed without undue risk."

Section 51 – "(1) Where a worker is exposed to the risk of drowning he shall wear a device having a buoyant effect sufficient to maintain his head above water without any effort on his part.

(2) The devise referred to in subsection (1) shall not be dependent upon manual manipulation to produce the buoyant effect and shall be acceptable the Chief Safety Officer."

Section 57 – "(1) Every worker shall wear a lanyard, life-line and safety-belt or body-harness where that worker is working:

a) at an elevation 3 metres or more above grade or floor level;
b) over a pit, a shaft, or operating machinery; or
c) where a fall could result in drowning, and where it is impractical to provide adequate work platforms or guarding.

(2) An employer shall provide a separate lanyard, life-lie and safety-belt or body-harness to each worker to whom the conditions specified in subsection (1) apply…"

Section 211 – "(2) A safe means of access shall be provided to the operating platforms, cabs and bodies of mobile equipment."

Section 215 – "(3) Notwithstanding subsections (1) and (2), mobile equipment listed in Section 210 may be exempted from the requirements of these regulation in respect of ROPS (rollover protective structure) where it can be shown to the satisfaction of the Chief Safety Officer where the vehicle will be used under circumstances where no rollover hazard will exist."

APPENDIX – B

Emergency Preparedness

Emergencies, incidents and injuries can occur at any time and without warning. Being prepared to handle emergencies is an individual as well as an organizational responsibility. Supervisors are responsible to ensure that assessment of emergency preparedness of the workplace is carried out and that employees are aware of safety procedures and emergency protocols. Rehearsals and "walk through" exercises are recommended to ensure everyone knows their task during an emergency. When the real thing happens – it happens fast, without warning and usually at the worse possible time.

The first priority of employees involved in any emergency situation is the safety and welfare of themselves, their co-workers and the public. Emergency response services are generally obtained through the "local emergency service". It is critical that during an emergency, the lines of communication be kept clear. Other unnecessary communications must be avoided. Once the first priority has been looked after, secondary priorities include the protection of property and the environment, preservation of evidence and the identity of witnesses/participants. Employees involved in or witnessing an emergency incident should report the event to their supervisor/manager. They should refrain from discussing the incident with persons other than their supervisor, manager, Department OHS, Risk Management and Emergency Services Personnel (fire, ambulance, police, etc.). All other requests for information should be referred to the department's Manager of Public Affairs and Communications or departmental spokesperson.

QUICK REFERENCE CHARTS

Wind Chill Calculation Chart

		Air Temperature (° C)											
		5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
Wind Speed (kph)	5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53	-58
	10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51	-57	-63
	15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54	-60	-66
	20	1	-5	-12	-18	-24	-30	-37	-43	-49	-56	-62	-68
	25	1	-6	-12	-19	-25	-32	-38	-44	-51	-57	-64	-68
	30	0	-6	-13	-20	-26	-33	-39	-46	-52	-59	-65	-70
	35	0	-7	-14	-20	-27	-33	-40	-47	-53	-60	-66	-72
	40	-1	-7	-14	-21	-27	-34	-41	-48	-54	-61	-68	-73
	45	-1	-8	-15	-21	-28	-35	-42	-48	-55	-62	-69	-74
	50	-1	-8	-15	-22	-29	-35	-42	-49	-56	-63	-69	-75
	55	-2	-8	-15	-22	-29	-36	-43	-50	-57	-63	-70	-76
	60	-2	-9	-16	-23	-30	-36	-43	-50	-57	-64	-71	-77
	65	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79
	70	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-80

Ice Bearing Capacity Chart
Golds Formula (Capacity = 4 x h²) (Height in centimetres – Capacity in kilograms)

cm (h)	Capacity	cm (h)	Capacity	cm (h)	Capacity	cm (h)	Capacity
2.5	25	37.5	5625	75	22500	112.5	50625
3.5	49	40	6400	77.5	24025	115	52900
5.0	100	42.5	7225	80	25600	120	57600
7.5	225	45	8100	82.5	27225	125	62500
10	400	47.5	9025	85	28900	130	67600
12.5	625	50	10000	87.5	30625	135	72900
15	900	52.5	11025	90	32400	140	78400
17.5	1225	55	12100	92.5	34225	145	84100
20	1600	57.5	13225	95	36100	150	90000
22.5	2025	60	14400	97.5	38025	155	96100
25	2500	62.5	15625	100	40000	160	102400
27.5	3025	65	16900	102.5	42025	165	108900
30	3600	67.5	18225	105	44100	170	115600
32.5	4225	70	19600	107.5	46225	175	122500
35	4900	72.5	21025	110	48400	180	129600