Emergency Response Plan

Prepared for

Aston Bay Holdings Ltd.

Storm Project, Somerset Island, Nunavut, Canada

Date Created: June 8, 2022

Date Revised: May 16, 2025

Acknowledgment

This Emergency Response Plan (ERP) has been compiled by APEX Geoscience Ltd. (APEX) at the request of Aston Bay Holdings Ltd. (Aston Bay) for use at the Storm Project, Somerset Island, Nunavut. The ERP relies on information sources that include:

- PDAC E3 PLUS Excellence in Health & Safety E-toolkit 2009.
- *NWT and NU Mine Health and Safety Act and Regulations*, *Territorial Land Use Regulations of Canada,* and the *Nunavut Safety Act Occupational Health and Safety Regulations.*
- Health, Safety and Reclamation Code for Mines in British Columbia, 2021 (BC HSRC).
- British Columbia Occupational Health and Safety Regulation, 2020 (BC OHSR).
- Alberta Occupational Health and Safety Code, 2020 (AB OHSC).

The ERP is consistent with the level of involvement by APEX at any given project and has been produced from the noted information sources. Any other use of, or reliance on, this ERP by any third party is at that party's sole risk.

APEX is committed to providing a workplace in which all individuals are treated with respect and dignity, in an atmosphere that promotes equal opportunities and prohibits workplace harassment, bullying and violence.

With respect to APEX's ERP protocol, it is the obligation of:

- **Employers** to ensure all workers are adequately trained in matters necessary to protect their health and safety before the worker is moved to another worksite or before preforming a new work activity and to ensure workers are supervised by a competent person.

- **All Supervisors (Project Leaders)** to ensure that every worker under the Project Leader's supervision works in accordance with regulations, act, and code, to advise every worker of all known or foreseeable hazards, and to make available this ERP to workers.

- **All Workers** to properly use Personal Protective Equipment (PPE) and to report to the employer or Project Leader any concerns about unsafe or harmful worksite, to comply with regulations, act, and code and to follow procedures laid out in this ERP.

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PRINT AND POST APPENDIX 1
AT ALL CENTRALLY LOCATED, ACCESSIBLE PLACES.

1 Project Description

1.1 Company Information

Client Company Name:	**Aston Bay Holdings Ltd.**
Client Company Address:	8 King Street East, Suite 1800, Toronto
Client Company Contact Person:	Thomas Ullrich
Client Company Contact Telephone **(Office)**:	416-456-3516
Client Company Contact Telephone **(Mobile)**:	416-456-3516
Client Company Contact E-Mail:	thomas.ullrich@astonbayholdings.com

1.2 Project Leader (Supervisor) Information

APEX Project Code:	**NU.CU.00205**
APEX Project Leader:	Christopher Livingstone
APEX Project Leader Contact Telephone:	778-847-7450
APEX Project Leader:	Edward Parker
APEX Project Leader Contact Telephone:	780-934-8003
Aston Bay Project Leader:	Thomas Ullrich
Aston Bay Project Leader Contact Telephone:	416-456-3516

1.3 Project Name and Location

Project Name:	**Storm Project**
Property Name: **(if different from Project Name)**	Aston Bay Property
Project Location: **(Province, Territory, State or Country)**	Nunavut
Project Location: **(Coordinates)**	73° 39’ 23” N 94° 27’ 07” W
Project Location: **(General spatial description)**	Somerset Island, 112 km south of Resolute Bay, NU

1.4 Grassroots Exploration-Based Project

Main Mineral Deposit-Occurrence Name: (if different from Property Name)	**Storm Copper and Seal Zinc**
Project Location **(Coordinates)**:	73° 39’ 23” N 94° 27’ 07” W
Exploration Permit Number:	N2021C0004; 2BE-STO2025

2 First Aid Requirement

To the best of the Company's ability, APEX's objective is to adhere to jurisdictional First Aid safety requirements including first aid equipment, supplies and facilities.

2.1 Equipment Assessment

The following drop-down question boxes are used to assess the first aid service requirements.

- Jurisdiction **Nunavut**
- Hazard level **High Hazard Work (e.g., drilling, mining and quarrying operations)**
- Maximum number of workers at site per shift **40**
- Distance from a hospital by air travel with consideration for weather conditions **> 40 minutes**

2.2 First Aid Requirements

Using the Equipment and Attendant Assessment information from above, APEX has documented the level of first aid service required for this project.

Table 2.1 First Aid Service Requirements Table

First Aid Service	**Requirements (based on Equipment and Attendant Assessment)**
Type and number of First Aid Kit(s) required (e.g., personal kit, Level 1, Level 2, Level 3, etc.)	One fully stocked Level 3 First Aid kit Each drill and field crew will have a Level 1 First Aid kit
Number and certificate level of First Aiders required (e.g., Standard First Aid level, Level 3 Certificate, etc.)	One OFA Level 3 Certification All project supervisors and drillers will have Standard First Aid with CPR-C
List other first aid equipment requirements (e.g., splints, stretcher, ETV, etc.)	Burn kit, stretcher, spine board, oxygen, AED
Is a dressing station required?	Yes
Is a First Aid Room required?	Yes
Is industrial ambulance equipment required?	No
Is an emergency transportation vehicle or industrial ambulance required?	Yes

2.3 Emergency Equipment

Emergency equipment available on site to address the identified potential emergencies and hazards.

Table 2.2 Emergency Equipment Required

Emergency Equipment	Location of Emergency Equipment	Operational Procedures for Equipment
Fire Extinguisher	Dry chemical fire extinguishers located in each tent, building, or separate room. Dry chemical fire extinguisher at each fuel cache.	Pull the pin Aim nozzle at base of fire Squeeze trigger Sweep side to side
Level 3 First Aid Kit (1)	First Aid Tent	Designated First Aid attendant is certified to use this kit. Fill out an APEX incident report form every use of First Aid Kit and update the Bag Inventory Sheet within each kit
Level 1 First Aid Kit (many)	Field crews, Drill sites	Fill out an APEX incident report form when necessary and update the Bag Inventory Sheet within each kit
VOIP and/or Satellite Phone	At camp office	Follow First Response Protocol
InReach	Field crews	Follow APEX InReach Protocol
VHF Radios	Field crews, at the camp and at drill sites	Call “Medic Medic Medic” on Radio
Burn kit, stretcher, spine board, AED, and oxygen	First Aid Tent	Designated First Aid attendant will use these resources as necessary
Bear Deterrents (horns and spray)	Field crews, at the camp and at drill sites	All personnel will be trained in how to operate deterrents 3 evenly spaced airhorn blasts signify an emergency
Survival Bag	Field crews	To be used in Survival Conditions
Firearm	Field crews, at the camp and at drill sites	Authorized personnel in possession of a valid Canadian firearms license (PAL) are permitted to handle, transport or store firearms

Emergency Equipment	Location of Emergency Equipment	Operational Procedures for Equipment
Survival Shelters	At drill and with field crews	Shelter contains survival bag, propane heat source, and firearm

3 Checklist of the Most Common Hazards Applicable to This Project

Every employee has the right to be informed about the risks and hazards present in the place they work. For field crews this includes the risks, hazards, and potential dangers in the area they work, while travelling to and from the work site, while in camp, while on traverses, while on a drill, etc.

Table 3.1 Common hazard checklist table

CHECK ALL HAZARDS APPLICABLE TO THE PROJECT			
4.0 Personal Safety	☒ 4.2 Hazard Control and Personal Protective Equipment (PPE)	☒ 4.3 Lifting and Back Protection	☒ 4.4 Skin Protection
5.0 Field Equipment Safety	☒ 5.2 Rock Hammers and Chisels	☐ 5.3 Axes, Swedish Brush Hooks, Knives and Machetes (Pangas)	☒ 5.4 Augers
	☒ 5.5 Power Tools	☒ 5.6 Chainsaws	☐ 5.7 Brush Cutters
	☒ 5.8 Water Pumps	☒ 5.9 Small Generators	☒ 5.10 Rock and Core Handling and Cutting Equipment
	☒ 5.11 Portable Handheld XRF Analyzers		
6.0 Safe Traversing Practices	☒ 6.3 General Traversing Guidelines	☒ 6.4 Traversing in Specific Terrain	
7.0 Knowing Your Location	☒ 7.2 Topographic Maps and Map Grids	☒ 7.3 Air Photographs and Satellite Images	☒ 7.4 Compasses
	☒ 7.5 Global Positioning Systems (GPS)	☒ 7.6 Emergency Locator Devices (ELTs, PLBs)	☒ 7.7 Batteries
8.0 Survival	☒ 8.3 Prevention and Preparation for Survival Situations	☒ 8.4 Survival Equipment Lists	☒ 8.5 General Advice for Survival Situations
	☒ 8.6 Priorities for Survival Situations	☒ 8.7 Search and Rescue (SAR)	
9.0 Weather and Environmental Risks	☒ 9.1 Weather Hazards	☐ 9.2 Lightning	☒ 9.3 Whiteouts
	☐ 9.4 Avalanches	☐ 9.5 Floods	☐ 9.6 Mudflows and Landslides
	☒ 9.7 High Winds	☒ 9.8 Environmental Risks	☒ 9.9 Cold Injuries

CHECK ALL HAZARDS APPLICABLE TO THE PROJECT			
	☐ 9.10 Heat Illnesses and Solar Injuries	☐ 9.11 Altitude Illness	
10.0 Wildlife	☒ 10.3 Bears	☒ 10.4. Other Large Mammals	☐ 10.5 Dogs, Cats and Monkeys
	☐ 10.6 Reptiles	☐ 10.7 Insects, Arthropods and Leeches	
11.0 Surveying Safety: Geophysical, Geochemical and Line Cutting	☒ 11.1 General Risks and Hazards Associated with All Surveys	☒ 11.2 Geophysical Survey Safety	☒ 11.3 Geochemical Survey Safety
	☐ 11.4 Line Cutting Safety		
12.0 Travel, Safety and Security	☐ 12.3 International Travel Preparations	☐ 12.4 Personal and Travel Security	☐ 12.5 Hotel Safety
	☐ 12.6 Hotel Fire Safety	☐ 12.7 Kidnap and Ransom	☐ 12.8 Travel Health
13.0 Vehicles	☐ 13.3 Safe Driving Guidelines for All Vehicles	☐ 13.4 Equipment Lists for Vehicles	☐ 13.5 Vehicle Maintenance and Inspections
	☐ 13.6 Training	☐ 13.7 Handling and Driving Skills	☐ 13.8 Defensive Driving Skills and Attitudes
	☐ 13.9 Four-Wheel Drive Vehicle Operation Guidelines		
14.0 All-Terrain Vehicles (ATVs and Quads)	☒ 14.3 Safe Operating Guidelines for ATVs	☒ 14.4 Equipment Lists for ATVs	☒ 14.5 Inspection, Maintenance and Fuelling Guidelines
	☒ 14.6 Training for ATV Operators	☒ 14.7 Safety Precautions	☒ 14.8 Basic Safe Riding Skills
	☒ 14.9 Safe Riding Strategies	☒ 14.10 Utility Vehicles	
15.0 Snowmobiles	☒ 15.3 Safe Operating Guidelines for Snowmobiles	☒ 15.4 Equipment Lists for Snowmobiles	☒ 15.5 Inspections, Maintenance and Fueling Guidelines
	☒ 15.6 Training for Snowmobile Operators	☒ 15.7 Safety Precautions for Snowmobiles	☒ 15.8 Safe Riding Skills
	☒ 15.9 Safe Riding Strategies	☐ 15.10 Working on Ice	☐ 15.11 Cold Water Immersion Hypothermia – Falling Through Ice
16.0 Aircraft	☒ 16.3 Aircraft Charters	☒ 16.4 Safe Operating Guidelines for All Aircraft	☒ 16.5 Pilot Fatigue

CHECK ALL HAZARDS APPLICABLE TO THE PROJECT			
	☐ 16.6 Float Planes	☒ 16.7 Helicopters	☒ 16.8 Safe Loading Guidelines for All Aircraft
	☐ 16.9 Transportation of Dangerous Goods	☐ 16.10 Training	☒ 16.11 Responsibilities Regarding Aircraft
	☒ 16.12 Slinging	☒ 16.13 Temporary Landing Sites	☒ 16.14 Commonly Accepted and Known Hand Signals
	☒ 16.15 Emergency Procedures		
17.0 Boats, Canoes, and Inflatables	☐ 17.3 Safe Operating Guidelines for Boats, Canoes, and Inflatables	☐ 17.4 Safe Loading Guidelines	☐ 17.5 Equipment – Required and Recommended
	☐ 17.6 Communications Guidelines for Boats, Canoes, and Inflatables	☐ 17.7 Guidelines for Motors and Fuel Handling	☐ 17.8 Maintenance and Inspection Guidelines
	☐ 17.9 Training	☐ 17.10 Safe Boat Handling Guidelines and Techniques	☐ 17.11 Recognition of Boating Risks and Hazards
	☐ 17.12 Water Survival		
18.0 Camp Set Up and Management	☒ 18.2 Jurisdictional Regulations and Company Policies	☒ 18.4 Camp Management Guidelines	☒ 18.5 First Aid
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19.0 Communications	☒ 19.3 Equipment Selection	☐ 19.4 Training	☒ 19.5 Communications Routines, Schedules, and Protocols
	☒ 19.6 Emergency Communications	☐ 19.7 Communications Tips Regarding Transportation	
20.0 Drilling Sites	☒ 20.3 Drill Site Location, Planning and Preparation	☒ 20.4 General Safety Guidelines for Drill Sites	☒ 20.5 Guidelines for Safe Work Practices
	☒ 20.6 General Hazards Associated with Drills and Specific Equipment	☒ 20.7 Health Hazards	☒ 20.8 Guidelines for Safe Drill Moves

CHECK ALL HAZARDS APPLICABLE TO THE PROJECT			
	☒ 20.9 Core Facilities and Sample Preparation	☐ 20.10 Selecting a Drill Contractor – Evaluation Criteria	
21.0 Advanced Exploration Sites, Trenches and Access Routes	☐ 21.3 Heavy Equipment	☐ 21.4 Access Routes to Advanced Sites	☐ 21.5 Trenches and Pits
	☐ 21.6 Explosives		
22.0 Abandoned and Old Sites	☐ 22.3 Guidelines and Preparations for Exploring Old or Abandoned Sites	☐ 22.4 Surface Hazards at Old Workings	☐ 22.5 Preparation Requirements to Enter Old Workings
	☐ 22.6 Ventilation	☐ 22.7 Gases	☐ 22.8 Shafts, Adits, Tunnels and Declines
	☐ 22.9 Common Hazards in Old Underground Workings	☐ 22.10 Sampling on Abandoned Mine Sites – Surface and Underground	☐ 22.11 Confined Spaces

4 Emergency Response

Emergencies and Evacuations:

- Describe what constitutes an 'emergency' on this project:

Due to the remote nature of the Storm Project, most instances resulting in severe injury, severe illness, lack of transportation or communication is considered an emergency. Emergencies on this project include:

  - **Medical emergencies**: Trauma (transportation accidents, wildlife encounters, any severe or life-threatening bodily harm), substance abuse or medical conditions (asthma, COPD, CKD, cystic fibrosis, diabetes, heart disease, etc) that could result in death/permanent damage.
  - **Environmental emergencies**: Gas leaks, weather, natural disasters that could result in large scale disruptions.
  - **Situational emergencies**: Missing persons, violence, or threats.

At the Storm Project, a 'First Aid Incident' is not considered an emergency. A 'First Aid Incident' is considered to be a situation where first aid can be administered to 100% treat an injury/condition, and the First Response Protocol does NOT need to be initiated. The worker(s) involved in this non-emergency First Aid situation must only report to the project leader with an incident report. No further action is required.

- Describe the point where an emergency would escalate to an evacuation on this project:

A medical emergency will escalate to an evacuation (medivac) if the first aid attendant / medic deems the patient to need immediate professional medical attention or if there are multiple patients with severe or life-threatening conditions.

An environmental emergency will escalate to an evacuation (local, regional, group evacuation or rescue evacuation) if there are uncontrolled wildfires; uncontrolled floods; collapsing benches, cave-ins, rockslides or crevice openings; avalanches; uncontrolled large-scale rock or ice falls; or deterioration of air quality into dangerous levels.

A situational emergency will escalate to an evacuation (rescue evacuation or group evacuation) if there are credible threats to a person/group and the worker(s) are in immediate danger.

- Describe what constitutes an 'evacuation' on this project:

There are two types of evacuations on this project: medivac or rescue evacuation.

A medivac is the transport of the worker(s) to the hospital in a helicopter or plane. A rescue evacuation is the removal and relocation of the worker(s) from a dangerous situation using any mode of transportation.

- Describe the circumstances where the First Response Protocol must be used:

When an emergency (as defined above) occurs, the First Response Protocol must be initiated. The First Response Protocol can be initiated by anyone who is aware of the instances where an emergency is occurring.

The First Response Protocol should not be initiated in the event of a non-emergency 'First Aid Incident'.

Chain of Command:

- Describe how workers are alerted during an emergency:

Workers and drivers/pilot will hear "MEDIC MEDIC MEDIC" over the radio, and/or will be verbally informed by their project leaders and/or be alerted by an InReach message.

- Name of person(s) that has the authority to declare an evacuation:

First Aid Attendant: Paramedic – TBD

or Project Leader: Christopher Livingstone, Edward Parker, or Thomas Ullrich

- Describe how workers are alerted during an evacuation:

All radio communication must STOP except between the Project Supervisor/First Aid Attendant and the emergency scene. All work must stop in the event of an emergency, and workers should monitor their communication devices while an evacuation is being performed. While workers not involved in the evacuation may not be directly contacted in the event of an evacuation, the relevant parties (evacuees, driver/pilot, first aid attendant/medic and project leader) will be in contact. Radio, InReach or verbal communication will be used to alert relevant parties during an evacuation.

- Name of the first aid attendant(s)/ medic(s) on each shift:

First Aid Attendant: Paramedic – TBD

- The chain of command during an emergency and/or evacuation is:
  1) Worker(s) initiate First Response Protocol
  2) Project Leader and/or first aid attendant/medic is alerted
  3) Project Leader and/or first aid attendant/medic decide whether a medical center, RCMP/police, or fire station is contacted and delegates that task
  4) First aid attendant/medic and/or Nurse/Doctor on call decide whether a Medivac is required and initiate a Medivac if required
  5) If the emergency requires a local, regional or group evacuation (camp evacuation), the Project Leader will make the decision to initiate the complete evacuation

- The protocols around communication during an emergency and/or evacuation are:

All radio communication must STOP except between the Project Supervisor/First Aid Attendant and the emergency scene.

No worker shall contact media or family members of the patient during or after an emergency – the project leader and/or first aid attendant/medic will inform media and/or family if needed.

- Name of person(s) that has the authority to declare an emergency and/or evacuation over:

Project Leader: Christopher Livingstone, Edward Parker, or Thomas Ullrich

- Name of person(s) in charge of reporting the emergency and/or evacuation to relevant authorities (if necessary):

Project Leader: Christopher Livingstone, Edward Parker, or Thomas Ullrich

Emergency and Evacuation Personnel:

- Name of the first aid attendant(s)/ medic(s) on each shift:

First Aid Attendant: Paramedic - TBD

- Describe the specific roles of each worker during an emergency and/or evacuation:

General worker(s): know when to initiate the First Response Protocol. Be prepared to follow any direction from the First Aid Attendant/ medic and/or Project Leader and/or Nurse/Doctor on call.

Driver/pilot(s): Be prepared to mobilize the first aid attendant/medic or transport the injured or in-danger worker(s).

First aid attendant/medic: Be prepared to be mobilized to the injured worker(s) or receive the injured worker(s). Understand the point where additional services need to be called/alerted and make the call when a medivac needs to be initiated. Be prepared to be transported to the medical center with the patient(s).

Project leader: Understand the point where additional services need to be called/alerted and make the call when a medivac needs to be initiated. Understand the point where a local, regional or group evacuation needs to be made. Notify all workers during an emergency or evacuation. Notify all workers when an emergency or evacuation is over. Notify relevant authorities if needed. Notify family members or emergency contacts of the injured worker(s). Notify media if needed.

Emergency and Evacuation Procedures:

- Describe both muster stations, reference the map if needed:

There are 2 muster stations at the Storm Camp:

1) One muster station will be located at the camp kitchen.
2) Another muster station will be located at the west side of camp toward the ocean and/or the airstrip.

- Describe the evacuation route, use evacuation route map as a reference:

Assemble at the mustering point. Head 500 meters due west to the airstrip to fly out.

- Name of person(s) in charge of clean-up and remediation after an emergency and/or evacuation:

Project Leader: Christopher Livingstone, Edward Parker, or Thomas Ullrich

Emergency and Evacuation Responses:

Describe the Emergency Response for each emergency or evacuation situation identified in Section 3.

A medical emergency at the Storm Project is defined as: trauma (transportation accidents, wildlife encounters, any severe or life-threatening bodily harm), substance abuse or medical conditions (asthma, COPD, CKD, cystic fibrosis, diabetes, heart disease, etc) that could result in death/permanent damage.

Medical Emergency Response:

- Assess the situation. Assure your own personal safety and the safety of others.
- Initiate the First Response Protocol.
- Stop or contain the emergency, if possible, without placing yourself or anyone at further risk.
  - Administer first aid using the primary survey "ABC". The primary survey checks the airway, breathing, circulation and for bleeding and shock.
    - A – Airway: Check the airway and clear it, if necessary
    - B – Breathing: Check for breathing; if there is none, start rescue breathing
    - C – Circulation: Establish the presence or absence of a pulse. Start CPR if there is no pulse. Control bleeding.
    - Treat for shock. Protect from cold and dampness. Elevate the feet. Administer oxygen if possible.
- If required, immediately contact an ambulance or Medevac aircraft as per the First Response Protocol.
  - If the victim is unconscious, try to list all obvious injuries.
  - If the victim is conscious, establish the extent of injuries.
  - Contact the hospital and advise them of the incoming patient(s).
- Report the accident to the supervisor as soon as possible (contractor foreman, project geologist, senior geologist etc.).
- If the accident is serious, notify the jurisdictional Workers' Compensation Board or authority and the local police etc. within the required time in addition to the company contacts.
- Take notes to document the accident. Include: what happened, names of witnesses, sketches and photos if possible. Complete and submit an accident report form to the appropriate company personnel.

Medical Emergency Response Involving a Vehicle Accident or Incident:

- Assess the situation. Assure your personal safety and the safety of others.
- Initiate the First Response Protocol.
- Administer first aid, if practical.
- If there are injuries or the damage is in a public area and more than $1,000.00 (in Canada), call the police, request a police report and call your company contact. Know the laws and limits that apply in the country where you work.
- Report the accident or incident to the supervisor as soon as possible.
- Take notes to document the accident. Include: what happened, names of witnesses, sketches and photos if possible. Complete and submit an accident report form to the appropriate company personnel.
- File and incident report

Medical Emergency Response Involving an Aircraft Accident:

At the site of the aircraft accident:

- Assure your own personal safety and the safety of others.
- Initiate the First Response Protocol.
- Administer first aid, as needed.
- Remove and set up the ELT if it did not automatically begin operation.
- Build a shelter (and fire) near the accident scene and make everyone comfortable. Remain near the scene.
- Make signals that are visible from the air to aid in the search (e.g., fires, signal mirror, large symbols). Refer to sections 8.6 Search and Rescue Guidelines and 16.15.2 Ground to Air Emergency Signals.

At the project site or base:

- Attempt to contact the aircraft by normal means when it is 15 minutes overdue. Use local resources when possible. Use (1) the base radio, (2) a radio in another aircraft on site, and (3) a cell phone to reach the satellite phone on the aircraft if it is so equipped.
- Relay contact attempts through other aircraft in the area.
- After 30 minutes or if an accident is confirmed, contact the nearest aircraft home base and advise them, as appropriate, that the aircraft is overdue or that there has been an accident. Contact the operations base manager of the aircraft charter company.
  - Report an accident or incident to the supervisor (foreman, project geologist, senior geologist etc.), to the air charter company concerned and to the relevant government authority (Transportation Safety Board of Canada investigation office) as soon as possible.
- After 60 minutes overdue: Contact the nearest operations base manager. Brief the manager on the action taken and the following information:

- Name of the pilot
- Type of aircraft, registration and colour
- Number of crew/passengers
- Planned flight route
- Departure time, estimated time of arrival
- Last known position
- Hours of fuel on board.
- Emergency equipment on board

- Notify appropriate company contacts.
- Record all actions taken.
- Share information ONLY with the aircraft/helicopter company and the rescue coordination centre. Do not speak to media.
- If necessary, contact an ambulance or Medevac aircraft or equivalent as soon as possible.
- Provide first aid, as required, upon arrival at the site.
- It the accident is serious, notify the jurisdictional Workers' Compensation Board authority and the local police etc., within the required time in addition to the company contacts.
- Complete and submit an accident report forms to the appropriate company personnel
- File an incident report.

An environmental emergency at the Storm Project is defined as: Wildfires, gas leaks, air quality changes, weather, natural disasters that could result in large scale disruptions.

Environmental Emergency Response:

- Assess the situation. Assure your own personal safety and the safety of others.
- Initiate the First Response Protocol.
- Do not attempt to remedy any environmental emergency, do not place yourself at risk if attempting to rescue other workers.

Environmental Emergency Response Involving Forest Fires:

- Assure your own personal safety and the safety of others.
- Initiate the First Response Protocol.
- If safe, return to camp as soon as possible.
- Arrange for camp evacuation, if necessary as per the First Response Protocol.
- If required, immediately contact an ambulance or Medevac aircraft as per the First Response Protocol.
- Provide first aid, as required.
- Call the 24 hour local forest fire number.
- Report the fire to a supervisor (foreman, project geologist, senior geologist etc.) and to the forestry company in the area as soon as possible.

- If a serious accident is associated with the fire, notify the relevant authorities within the specified time (e.g., Workers' Compensation Board in Canada or the jurisdictional equivalent).
- Complete and submit the appropriate accident investigation forms to the appropriate company personnel.
- File an incident report.

A situational emergency at the Storm Project is defined as: Missing persons, violence or threats.

Missing Persons Emergency Response:

- Confirm that the person has failed to check in at the predetermined time.
- Contact the person's supervisor and provide details such as where the person was working, how late they are, if he/she is alone.
- Do not endanger yourself during a rescue.
- If you plan to start a search, inform a supervisor of your plans before heading out. Always go with a second person or a team if possible.
- Every search team must carry a first aid kit, communication equipment and appropriate provisions.
- Go to where the person is most likely to be found (i.e., where his/her truck is parked).
- If the missing person is not found right away, the appropriate SAR authority and/or local police should be notified within the appropriate length of time as specified in the ERP.
- Notify all authorities when the missing person is found so all search and rescue participants are informed and can cease their efforts.
- File an incident report.

Violent or Threatening Individuals Emergency Response:

- Remove yourself from danger.
- Contact your supervisor and provide details/document items such as what the threatening or violent person did, at what time, who was present, has this happened before, etc.
- If the danger increases, notify law enforcement.
- File an incident report.

Emergency and Evacuation Responses:

Describe the Emergency Response for each emergency or evacuation situation identified in Section 3.

The following dropdown lists are from the PDAC Guidelines for Preparing Emergency Responses (PDAC H&S Toolkit, Chapter 3.5).

PDAC 3.5.1 Medical Emergency

- Assess the situation. Assure your own personal safety and the safety of others.
- Summon help if necessary.
- Stop or contain the emergency, if possible, without placing yourself or anyone at further risk.
  - Administer first aid using the primary survey “ABC”. The primary survey checks the airway, breathing, circulation and for bleeding and shock.
    - A – Airway: Check the airway and clear it, if necessary
    - B – Breathing: Check for breathing; if there is none, start rescue breathing
    - C – Circulation: Establish the presence or absence of a pulse. Start CPR if there is no pulse. Control bleeding.
    - Treat for shock. Protect from cold and dampness. Elevate the feet. Administer oxygen if possible.
- If required, immediately contact the Medivac aircraft.
  - If the victim is unconscious, try to list all obvious injuries.
  - If the victim is conscious, establish the extent of injuries.
  - Contact the hospital and advise them of the incoming patient(s). Give the following information as a minimum:
    - Name of patient(s)
    - Age and sex
    - Nature of injury
    - State of consciousness
    - Estimated time of arrival
    - Request an ambulance to meet the aircraft/boat/vehicle at the designated location.
    - Have the pilot notify the hospital 10 minutes before landing of the revised time of arrival and again request an ambulance to meet the aircraft or boat at the designated location.
- Report the accident to the supervisor as soon as possible (contractor foreman, project geologist, senior geologist etc.).
- If the accident is serious, notify the jurisdictional Workers’ Compensation Board or authority and the local police etc. within the required time in addition to the company contacts.
- Take notes to document the accident. Include: what happened, names of witnesses, sketches and photos if possible. Complete and submit an accident report form to the appropriate company personnel.

PDAC 3.5.3 Missing Persons

- Confirm that the person has failed to check in at the predetermined time.
- Contact the person's supervisor and provide details such as where the person was working, how late they are, if he/she is alone.
- Do not endanger yourself during a rescue.
- If you plan to start a search, inform a supervisor of your plans before heading out. Always go with a second person or a team if possible.
- Every search team must carry a first aid kit, communication equipment and appropriate provisions.
- Go to where the person is most likely to be found (i.e., where his/her truck is parked).
- If the missing person is not found right away, the appropriate SAR authority and/or local police should be notified within the appropriate length of time as specified in the ERP.
- Notify all authorities when the missing person is found so all search and rescue participants are informed and can cease their efforts.

PDAC 3.5.4 Survival – Stranded Crew

Field crew on traverse

- Assemble the field party at the site where the survival cache is located, which is usually at the end of the traverse (air drop or vehicle).
- Contact the camp office by radio and inform them of your position and conditions.
- Determine whether it is possible to safely return to the project site by foot. This can only be done if:
  - The site is reasonably close – this distance should be determined before the traverse starts.
  - Weather conditions are good.
  - The GPS equipment is functioning and there are spare batteries.
  - Emergency food and shelter are available to carry.
  - Everyone is in good physical shape and capable of completing the trip.
- When it is not feasible to return to camp, the survival cache and personal survival kits should provide temporary shelter and supplies.
- Remain at the site until transportation arrives.
- Maintain communication abilities; do not waste battery power.

Drill crew at a remote site

- A survival situation may occur due to bad weather, whiteout conditions, flooding, bear activity, unavailable aircraft, vehicle breakdown etc.
- Assemble the drill crew and keep everyone together at the survival cache location.
- Contact the camp/office and inform them of the conditions.

- Determine whether it is possible to safely return to the project site by foot. This can only be carried out if the same conditions are met as in #3 above in "Field crew on traverse".
- When it is not feasible to return to camp, the survival cache and personal survival kits should provide extra temporary supplies at the drill site shelter.
- Remain at the site until transportation arrives.
- Maintain communication abilities; do not waste battery power.

PDAC 3.5.7 Fires

Fire in camp is one of the most serious risks.

- Try to put out the fire only if it is safe to do so.
- Sound the fire alarm
- Assure your own personal safety and the safety of others.
- Evacuate all persons to the muster point and hold a roll call.
- Locate any missing or injured persons and organize a rescue, as required.
- Arrange for camp evacuation, if necessary.
- If required, contact an ambulance or Medevac aircraft immediately.
- Provide first aid, as required.
- Call the 24 hour local forest fire telephone number.
- Report the fire to a supervisor as soon as possible (foreman, project geologist, senior geologist etc.).
- Arrange for temporary shelter once all persons are accounted for, as required.
- An emergency shelter should be separate from the rest of the camp and be equipped with emergency food, blankets, means of heating the shelter, sufficient seating for everyone and emergency communication equipment.
- If injuries resulting from the fire are serious, notify the relevant authorities within the specified time (i.e., jurisdictional Workers' Compensation Board authority in Canada, or equivalent).
- Complete and submit an accident/incident investigation forms to the appropriate company personnel.

Forest Fire

- Assure your own personal safety and the safety of others.
- If safe, return to camp as soon as possible.
- Arrange for camp evacuation, if necessary.
- If required, immediately contact an ambulance or Medevac aircraft.
- Provide first aid, as required.
- Call the 24 hour local forest fire number.
- Report the fire to a supervisor (foreman, project geologist, senior geologist etc.) and to the forestry company in the area as soon as possible.

- If a serious accident is associated with the fire, notify the relevant authorities within the specified time (e.g., Workers' Compensation Board in Canada or the jurisdictional equivalent).
- Complete and submit the appropriate accident investigation forms to the appropriate company personnel.

PDAC 3.5.8 Whiteouts and Extreme Cold

- Everyone should remain within the camp accommodations until the emergency has passed. Cease travel and work that could result in injury.
- Cease work with equipment or cutting tools, as an injured employee may not be able to reach a first aid station and evacuation may not be possible until conditions improve.
- Equip all remote work sites, such as drill rigs, with heat and emergency supplies including food and water. Regularly check emergency stores to be sure they are complete and food items are replaced when they reach their expiry date. Depending on location, 3 days of supplies should be made available.
- All work crews and individuals working away from the immediate project or camp should be supplied with and carry fully functioning communication equipment and have access to survival equipment and/or caches. This includes anyone travelling by any type of vehicle or aircraft.

PDAC 3.5.9 Wild Animals

Develop emergency response procedures appropriate for the specific dangerous species at the project location.

- Identify the local dangerous animals and train employees to take appropriate precautions. Make sure that everyone understands their responsibility to prevent animals from becoming human habituated and food conditioned. Do not leave food where it will attract large animals, rodents, reptiles etc.
- Situate projects and camps to avoid locations where animals may live or feed and arrange structures so that large animals have escape routes.
- Emergency procedures must conform to wildlife regulations of the AHJs. Post contact information for the area wildlife officer in order to request assistance, as required.
- Attempt to scare animals away with noise or other appropriate means.

Bears

- The ERP should include emergency procedures when bears approach and/or enter camps. Refer to section 10.3 Bears for recommendations.
  - Employees should be trained to recognize bear behaviour and correctly respond to bear encounters. Refer to section 10.3.10 Guidelines for Bear Encounters.
  - An ERP should include plans for a designated person to shoot the bear if the situation demands this action. All employees permitted to handle firearms must follow the laws and regulations of the AHJs. In Canada, this means that anyone in

camp who has permission to handle firearms must be trained and hold a Possession and Acquisition License (PAL). Refer to section 18.2.2 Firearms Regulations and Policies.

- Attempt to scare a bear away by making noise and using appropriate deterrents (refer to section 10.3.9 Bear Deterrents).
- Inform the appropriate wildlife officials if a bear persistently returns and arrange for them to remove it.
- Where relevant, address the possibility of killing a polar bear with the local indigenous landowners, including compensation costs if a bear must be killed in self-defense.

Emergency procedures when an animal enters camp

- Verify that a threatening animal (e.g., bear) is sighted approaching or within the camp boundaries.
- Sound the alarm. The alarm for an animal in camp must sound very distinct and different from the fire alarm so people react appropriately. (People assemble in one place in response to a fire, whereas they stay inside or go to the nearest shelter in response to an animal in camp.) The animal alarm might be three short blasts of a siren.
- People in shelters should shout or use radios to confirm their location. Do not go to a muster point. Maintain a low position. Locate a canister of pepper spray in the shelter.
- Designated people should attempt to isolate the animal from the areas where people are sheltering and drive it away using appropriate deterrents. If present in camp, trained bear guards should respond to face the bear rather than employees from out of the region (territory/province/country).
- Notify appropriate wildlife officials to capture and relocate the animal, if required.
- Develop plans and tactics that address (1) an animal entering a tent, the kitchen or dining structure, (2) if someone is attacked, (3) handling the invasion during the day and during the night, (4) if it is necessary to kill the animal.

PDAC 3.5.10 Spills

- Assure your own personal safety and the safety of others.
- Assess the situation without risking employee safety. Determine the substance of the spill, if possible.
- Safely stop the spill/leak, if possible.
- Take immediate action to minimize the effects of the spill (containment) if it is safe to do so.
- Report the spill to a supervisor as soon as possible. If the supervisor is unavailable, work through the phone list; if nobody is available, call the appropriate government environmental authority.
- Record detailed notes:
  - Time of occurrence
  - Who was contacted and when

  - Actions taken to contain spill
- What to report:
  - When and where the spill occurred
  - When the spill was discovered and by whom
  - What was spilled, how much was spilled, and where could it go
  - Whether the spill has been stopped and contained
  - What, if any, remediation measures have been started
  - Your name and telephone number
- Complete and submit an environmental spill report or appropriate investigation form to the company and government authorities within the specified time.

Refer to sections 10. Hazardous Material and 11.0 Spill Management in the e3 Plus Environmental Stewardship Toolkit for information regarding specific hazardous substances and spill containment procedures. Website: http://www.pdac.ca/e3plus/

Appendix 1A - Emergency Contacts (Print and Post)

ON SITE PROJECT CONTACTS	
Primary Contact Name	Christopher Livingstone
Primary Contact Number	1-778-847-7450
Storm Camp Office Number	TBD
Secondary/SAT Phone Number	TBD
Secondary Contact Name	Edward Parker
Secondary Contact Number	1-780-934-8003
Tertiary Contact Name	Thomas Ullrich
Tertiary Contact Number	1-416-456-3516
Arctic Watch Lodge	Tourist camp with airstrip – 50 km north of Storm Camp
Arctic Watch Lodge Number	TBD
Aziz Kheraj	Logistics & Operations – Resolute Bay, NU
Aziz Kheraj Number	867-252-3838 (office) 613-618-3838 (cell)
MEDICAL EMERGENCY CONTACTS	
HOSPITAL	
Closest Medical Centre or Hospital Phone Number	1-867-252-3844
Name and general location of the closest Medical Centre or Hospital	Resolute Bay Health Centre – 112 km north of Storm Camp
1st Alternate Hospital	1-867-439-8816
Name and general location of 1st Alternate Hospital	Arctic Bay – 300 km east of Storm Camp
2nd Alternate Hospital	1-867-561-5111
Name and general location of 2nd Alternate Hospital	Taloyoak – 450 km south of Storm Camp
3rd Alternate Hospital	1-867-360-7441
Name and general location of 3rd Alternate Hospital	Gjoa Haven – 500 km south of Storm Camp
4th Alternate Hospital	1-867-983-4500
Name and general location of 4th Alternate Hospital	Cambridge Bay – 600 km southwest of Storm Camp
Baffin Regional Hospital – Qikiqtani General - Iqaluit	1-867-975-8600

Stanton Territorial Hospital – Yellowknife	1-867-767-9300
RCMP	
Closest RCMP Detachment Office	#230, Resolute Bay
	Emergency: 1-867-252-1111 Non-Emergency: 1-867-252-0123
SEARCH & RESCUE	
Search and Rescue Nunavut Emergency Line	#230, Resolute Bay
POISON CONTROL	
General Emergency Number	1-800-332-1414
General Emergency Number – Rural/SAT Phone	1-800-332-1414
ENVIRONMENTAL	
Forest Fire / Wildfire Reporting	N/A
Government of Nunavut – General Inquires	1-877-212-6438
Ministry of Environment	1-867-975-7700
Weather – Environment Canada	https://weather.gc.ca/
Spills and Environmental Emergencies	1-867-920-8130
Conservation Officer	Resolute 1-867-252-3879
MENTAL HEALTH	
Health Link	811
Mental Health Line – Location Specific	Iqaluit, NU 1-867-979-3333
Crisis Helpline	1-800-661-0844
TRANSPORTATION	
Custom Helicopters (Headquarters)	1-204-338-7953
Custom Helicopters (Rankin Inlet Base)	1-867-645-3939
Kenn Borek Air (Resolute)	1-867-252-3845
Kenn Borek Air (Head Office)	1-403-291-3300
Summit Air (Yellowknife)	1-867-873-4464
Air Tindi (Yellowknife)	1-867-669-8200
WSCC EMERGENCY REPORTING AND SUPPORT	

Yellowknife Switchboard	1-867-920-3888
Iqaluit Switchboard	1-867-979-8500
Cary Ingram, Chief Inspector of Mines	1-867-920-3805
Mark Kelly, Mines Inspector Supervisor	1-867-669-8366
Viktor Mubili, Mines Inspector	1-867-960-3852
24 Hour Hotline for Serious Accidents	**1-800-661-0792**
COMPANY CONTACT	
APEX Geoscience Ltd. **Edmonton, Canada** #110, 11450-160 ST. NW Edmonton, AB T5M 3Y7 Canada **Vancouver, Canada** 410-800 W. Pender St. Vancouver, BC V6C 2V6 Canada	 Tel: 1-780-467-3532 Tel: 1-604-290-3753
CLIENT COMPANY CONTACT	
Aston Bay Holdings Ltd.	Thomas Ullrich
8 King Street East, Suite 1800, Toronto	1-416-456-3516

Appendix 1B - First Response Protocol (Print and Post)

Print this and post by all camp phones, and inside every SAT phone case.
in First Aid Tent and Office/Project Manager Tent,

Aston Bay Holdings Ltd.

Storm Project, Somerset Island, Nunavut, Canada

In the event of an **EMERGENCY**, contact the First Aid Attendant and/or Project Supervisor immediately:

OVER THE RADIO: Call "**MEDIC MEDIC MEDIC**"

All radio communications must STOP except between the Project Supervisor/First Aid Attendant and the emergency scene.

ON THE PHONE:

Primary Contact Name	**Christopher Livingstone**
	Edward Parker
	Thomas Ullrich
Primary Contact Number	1-778-847-7450
Secondary/SAT Phone Number	TBD

ALL WORK MUST STOP IN

THE EVENT OF AN EMERGENCY

If instructed by the First Aid Attendant or Project Supervisor:

 # 1 Call the relevant service:

MEDICAL	**Emergency Health Services (911)** **Closest Hospital/Medical Centre**	**1-867-252-3844**
RCMP	**Closest RCMP Detachment**	**#230, Resolute Bay** Emergency: 1-867-252-1111 Non-Emergency: 1-867-252-0123

#2 - Be Prepared to Provide:

1) **Your Name and location**
2) **Camp/Worksite/Hotel Lat/Long:** 73° 39' 23" N 94° 27' 07" W
3) **Patient location (if not in camp)**
4) **Number of injured persons**
5) **Patient information for each injured person**
   a) **Condition**
      - Conscious / Unconscious
      - Nature of Injury
   b) **Age / Sex of Patient**
   c) **History**
      - What happened?
      - When did it happen?
      - What remedial action has been taken so far?
   d) **Any other relevant information that you know:**
      - Medical History (i.e., is diabetic, etc.)

REPORT BACK to First Aid Attendant

Obtain instructions from the First Aid Attendant as to the need for a **MEDIVAC**.

If Medivac is Required:

1) **From the Field:**
   a) The First Aid Attendant will be mobilized by helicopter to the emergency scene with the first aid jump kit, stretcher, spine board, and AED.
   b) The patient will be examined, stabilized, and packaged for transport to Storm Camp.
   c) If necessary, the Nursing Station will be consulted for further instructions prior to moving the patient.
   d) The patient will be transported with the First Aid Attendant to Storm Camp by helicopter.

e) If instructed by the Nurse, the patient will be transferred directly to Resolute (or alternate) by Twin Otter. If not, the patient will be transferred to the First Aid Tent at Storm Camp until further instructions are received.

2) From Storm Camp:

a) The Nursing Station will be consulted for Medivac instructions.

b) Unless otherwise directed by the Nurse or First Aid Attendant, the patient will be transported with the First Aid Attendant to Resolute (or alternate) by Twin Otter.

c) If the Storm Camp Twin Otter is NOT readily available, contact Kenn Borek Air to send a Twin Otter from Resolute Bay (or alternate).

Kenn Borek, Resolute Bay – 1-867-252-3845

d) Further Medivac decisions will be made by the Nursing Station.

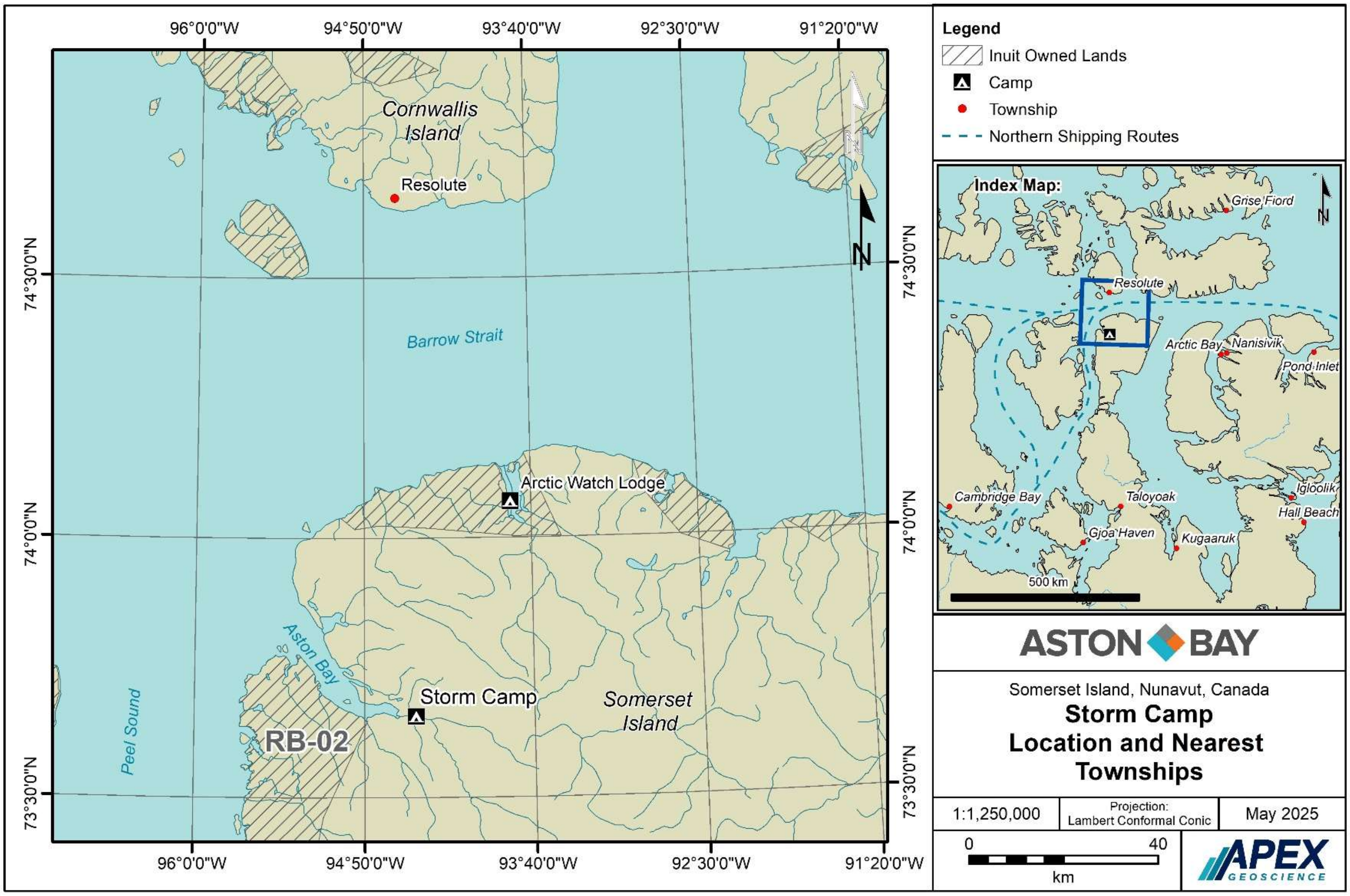
Primary Medivac Vehicle	On-Site Helicopter Storm Camp Twin Otter
Secondary Medivac Vehicle	Resolute Bay Twin Otter

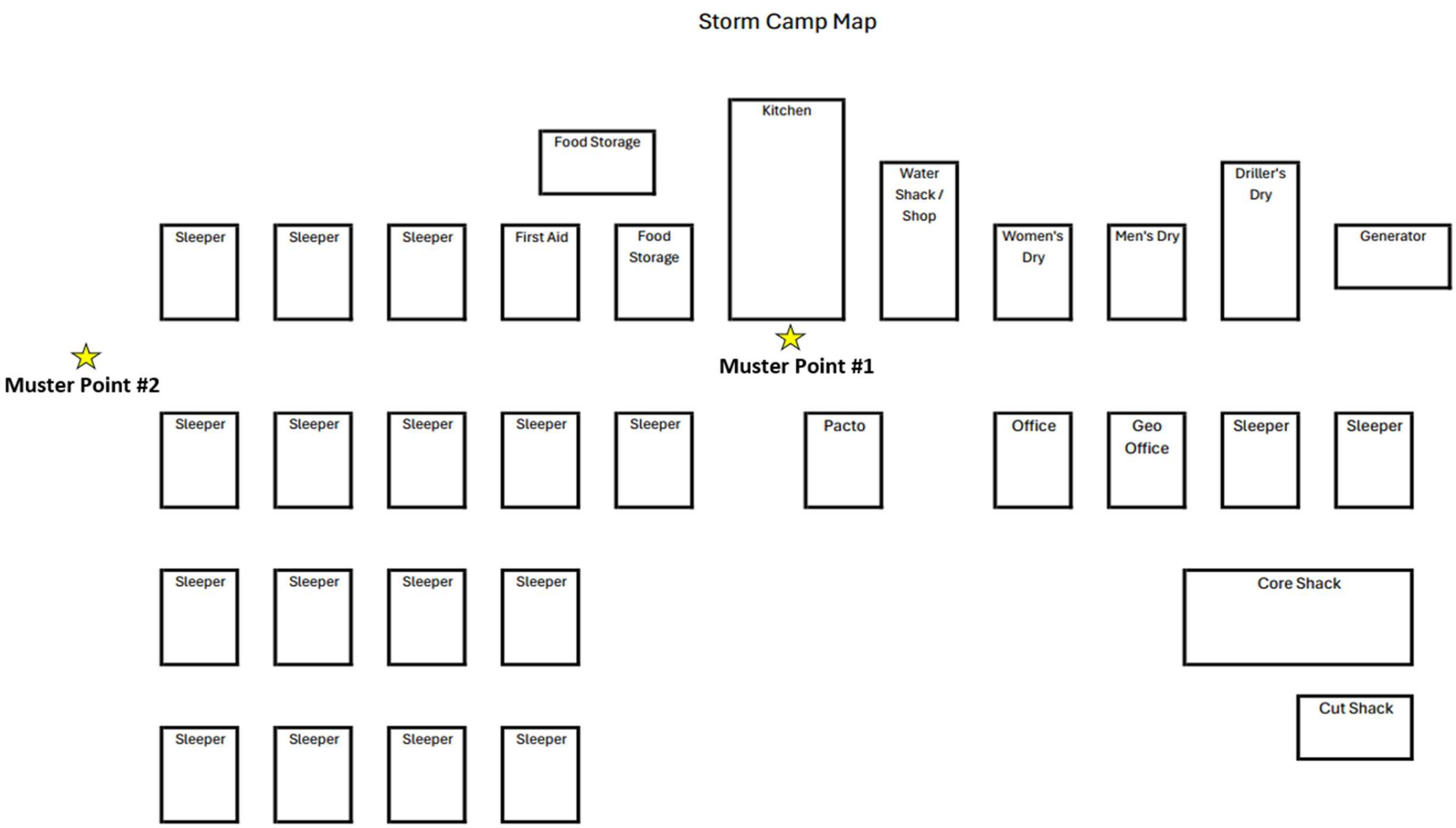
Camp Evacuation Procedure

Where it becomes necessary to evacuate the camp, the Project Supervisor shall make the decision to initiate a complete evacuation in accordance with the following procedure:

1. The decision to initiate a general evacuation of all personnel shall be accepted as a general stop work order, requiring all personnel to cease work immediately.
2. Communicate with and advise all field personnel to return to camp and prepare to evacuate. The time of communication and name of each field crew communications operator must be recorded.
3. Should there be any personnel with whom contact cannot be made this must be noted and efforts made to locate and communicate with said personnel.
4. Notify Kenn Borek of the requirement for full evacuation with provision of the number of personnel involved.
5. Have all personnel congregate at a predetermined Mustering Point 2. Depending upon the reason for evacuation and weather conditions, this may either be in the field, near the helipad or at the lodge.
6. Notify the appropriate authorities (RCMP [1-867-252-1111] and Health Centre [1-867-252-3844]) in Resolute Bay or wherever the evacuation destination is.
7. Should the evacuation require multiple flights ensure each group of personnel has a designated supervisor with a satellite phone, a firearm and sufficient survival gear. As the situation would not be considered a typical demobilization, personnel should not attempt to remove personal articles from camp, in consideration of evacuating the maximum number of people at the earliest opportunity.
8. All personnel should have clothing appropriate to the weather conditions.
9. Where possible, and if practical, all generators, stoves and gas cylinders should be shut off prior to departure.

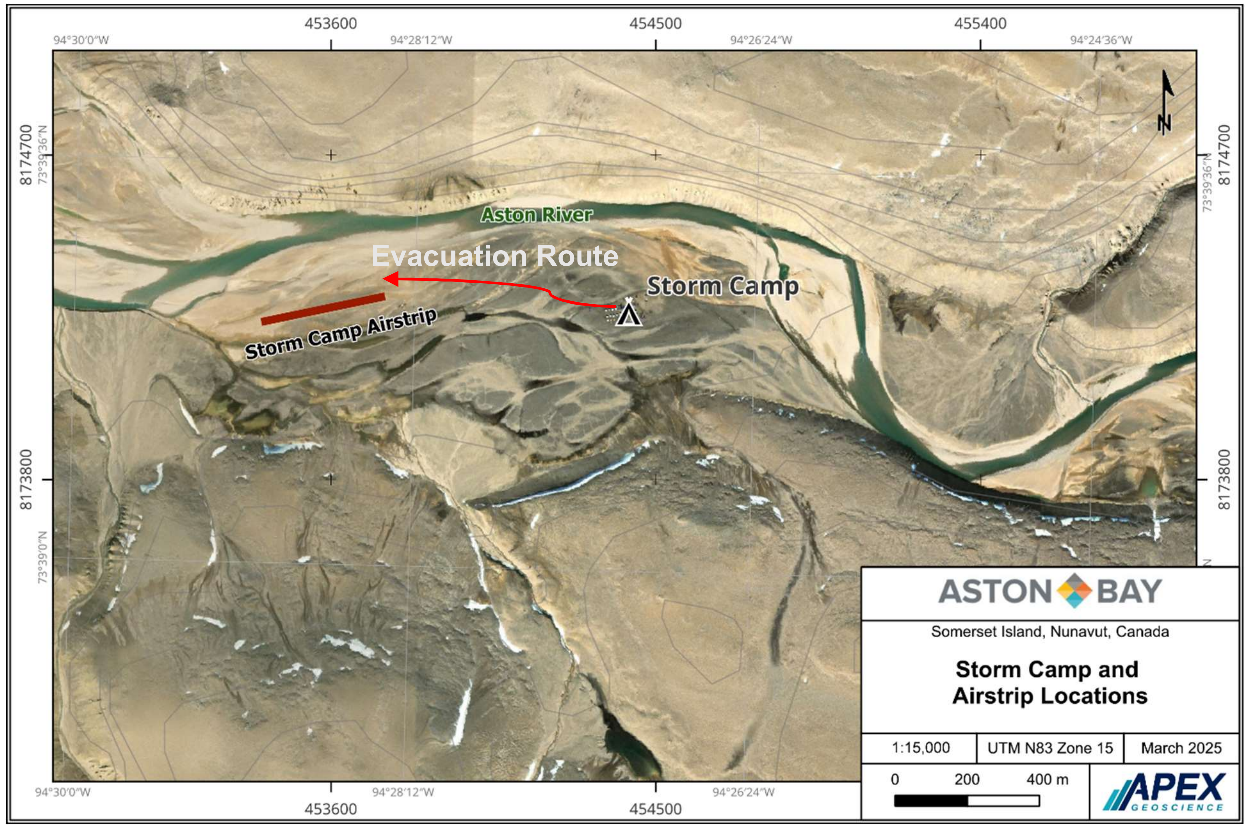
Appendix 1C - Camp Location, Project Location, General Access Routes (Print and Post)





rm Camp Layout

Appendix 1D - Emergency Evacuation Route (Print and Post)



Evacuation Instructions:

- Assemble at marshalling point and proceed along evacuation route to the Storm Camp Airstrip

Appendix 2 Expanded Summary of Common Hazards

Source: PDAC E3 PLUS Excellence in Health & Safety E-toolkit 2009.

The following dropdown lists represent hazards identified by the 2009 Excellence in Health & Safety (EHS) toolkit developed by the PDAC; their content is directly related to Chapters 4.0 to 22.0 (see Resource 2). A Table of Content list of the PDAC Hazards is presented in Resource 2 and can help the Project Leader (and team) select – in advance of using these dropdown menus – any PDAC Hazards that pertain to the project.

PDAC 4.0 Personal Safety

Introduction

This chapter addresses ways of protecting your body from the risks and hazards of working in the mineral exploration industry with emphasis on the need for and use of personal protective equipment (PPE). It is in the best interest of each employee to become as knowledgeable and self-reliant as possible regarding their personal safety. Therefore, employees should be trained and certified in the correct selection, use, care and maintenance of PPE, as required. Although PPE provides a personal means of defense against hazards, employees need to understand that they should not develop a false sense of security and rely on PPE to the exclusion of other safety measures. The resources section lists many government websites to enable the reader to seek out additional information regarding PPE and safety protection for employees.

Acronyms

AHJ – Authority Having Jurisdiction

ANSI – American National Standards Institute

ATV – All-Terrain Vehicle

COPD – Chronic Obstructive Pulmonary Disease

CSA – Canadian Standards Association

dB – Decibel

EES – Excellence in Environmental Stewardship

EHS – Environment Health and Safety

ERP – Emergency Response Plan

JSA – Job Safety Analysis

MSDS – Material Safety Data Sheet

OHS – Occupational Health and Safety

PFD – Personal Flotation Device

PPE – Personal Protective Equipment

RPP – Radiation Protection Program

SOP – Safe Operating Procedures

UV – Ultraviolet

UVA – Ultraviolet A (wavelength range between 400-320 nanometres)

UVB – Ultraviolet B (wavelength range between 320-280 nanometres)

WHMIS – Workplace Hazardous Materials Information System

XRF – X-ray fluorescence

PDAC 4.1 Risks and Hazards

Accident statistics collected by the Association for Mineral Exploration British Columbia (AME BC) and the Prospectors & Developers Association of Canada (PDAC) are presented each year in the Canadian Mineral Exploration Health and Safety Annual Report. Statistics consistently indicate that over 60% of exploration work related injuries are due to: (1) slips, trips, and falls, (2) the misuse of tools and camp equipment, and (3) injuries due to improper lifting. In addition, ATVs are a frequent cause of injuries, as it is easy to travel too fast for the surface conditions and overturn them. Fatalities are most frequently related to transportation accidents (especially helicopters and ATVs) and breaking through ice. All exploration employees should work in a manner to prevent injury to themselves and their co-workers.

Some consequences of injuring various body parts:

- Back – strains, lifting injuries, chronic back pain, paralysis
- Extremities – cuts, crush and pinch injuries, burns, broken bones, loss of fingers and toes
- Skin – cuts and abrasions, burns, sunburn, frostbite, rashes, insect bites, diseases
- Eyes – vision damage, blindness, retinal burns, punctures, snow blindness
- Hearing – hearing loss, deafness, infections
- Head – impact injuries, cuts, concussion, brain injuries, death
- Lungs – asphyxiation, suffocation, drowning, lung diseases (including asbestosis, asthma, cancers, chronic obstructive pulmonary disease)

PDAC 4.2 Hazard Control and Personal Protective Equipment (PPE)

Risk assessments, job safety analyses (JSAs) and hazard controls are parts of due diligence with respect to safety and should be carried out to protect employee health and safety. The following preferred order for risk management techniques is well accepted in the manufacturing and construction industries: (1) eliminate the hazard, (2) apply engineering controls, (3) apply administrative controls, and finally (4) provide personal protective equipment (PPE) for employee protection. It is much more difficult to follow this management order in the mineral exploration industry where many of the significant hazards are related to terrain, weather and transportation in remote locations. For these reasons PPE plays a very important role for employees working outdoors where hazards are usually uncontrolled. Refer to sections 1.2 Due Diligence with Respect to Safety, 2.1.4 Job Safety Analyses and 2.1.5 Risk Assessments.

General recommendations regarding personal protective equipment (PPE)

- In Canada, Occupational Health and Safety (OHS) legislation mandates the use of PPE when working conditions require an employee to place a part of his or her body at risk. Where the use of PPE is not legislated, companies should develop their own requirements and enforce them.
- The correct use of PPE is an important part of safety and demonstrates due diligence with respect to safety.
- PPE must be compatible. One type of PPE should not interfere with the intended use of another or create a new hazard, i.e., safety glasses should not prevent earmuffs from fitting correctly.
- Choose PPE equipment that is suitable for the size of the person who wears it. Consider the size, fit, weight and comfort of the equipment. A person is more likely to wear PPE if it feels comfortable.
- Some projects may require specific PPE procedures where there are particular risks (e.g., uranium or asbestiform mineralization).

Responsibilities Regarding PPE

Exploration Companies

- Develop and implement safe operating procedures (SOPs) regarding the use of PPE.
- Employers should make PPE available and take all reasonable steps to make sure employees use appropriate PPE for the jobs they perform. Employers may be required to supply PPE, depending on jurisdictional regulations.
- Employers should provide adequate training in the correct use and maintenance of PPE. Document the training in accordance with jurisdictional requirements.
- It is advisable to develop a policy regarding the required use of PPE with consequences when an employee refuses to wear it (e.g., a “no PPE – no work” policy).

Project Supervisors

- Make sure risk assessments and job safety analyses (JSAs) are completed to determine the required PPE for the location and jobs.
- Provide a list of required PPE for various tasks. Provide written instructions for future reference regarding the correct methods to use PPE.
- Provide training in the proper use, fit and care of the PPE. Training should include demonstrating the correct way to wear and adjust PPE, especially for items such as earplugs and respirators, as their incorrect use greatly diminishes the protection they provide.
- Periodically assess the condition of required PPE to be sure it is still doing its job.

Employees

- Use all mandatory PPE and follow company SOPs and training regarding PPE and protective clothing.
- Know how to wear and adjust PPE so it functions correctly.
- Maintain and care for PPE and replace it when it is worn or damaged. Know the limitations of the PPE you use.

PDAC 4.2.1 Physical Conditioning

Field work is physically demanding. Employees who lack adequate physical conditioning are more susceptible to the following injuries. Some injuries may result in long term disability or even death.

Potential injuries

- Musculoskeletal disorders (strains, sprains, tendonitis, repetitive strain injuries etc.)
- Joint injuries
- Back injuries
- Bone fractures

Prevention and Preparation

To avoid strains and injuries that result from physical challenges, it is advisable to follow these general procedures before you begin fieldwork:

- Have a general medical checkup if it has been a year or more since the last one. This may be a mandatory procedure depending on company policy. Immunizations should be up-to-date.
- Have a dental checkup if you will be working in a remote area.
- Employees should give consent and inform the project medic about personal background health information in case it is needed in an emergency. Supervisors and first aid workers must exercise confidentiality and can only disclose personal health information with the permission of the employee or as required by law. While health forms filled out by employees should be kept in strict confidence, employees with health issues that might cause them to become incapacitated should inform their supervisor and co-workers about all allergies, required medications or adverse reactions and special dietary requirements. Occasionally, allergies to certain foods, insect bites or medications can cause fatal reactions. If you have a special medical condition or allergy, teach co-workers to recognize symptoms of an impending attack. They need to know how to administer medication (e.g., insulin, epinephrine) because you may be unable to administer medication to yourself. A stressful situation can trigger symptoms of some disorders such as diabetes or asthma. If you require such a medical kit, keep it with you at all times.
- Make sure to take more than an adequate supply of any required medication to the field.
- Learn to swim; wear a personal flotation device (PFD) when you are working on water or near deep water. Refer to Chapter 17. Boats, Canoes and Inflatables.
- Do some physical training to strengthen weak muscles. Different jobs require various degrees of physical fitness. Know your limitations and work with the “buddy system” for lifting heavy loads. Only take on work that is within your physical abilities.
- Plan traversing schedules so that the most challenging traverses are done when field crews are in the best physical condition or there is extra support (e.g., mountaineering specialists or helicopters).
- To prevent injuries at the end of the day when you are tired:
  - Pace yourself during the day while on traverse.

- Pay extra attention to your footing when your pack is heaviest such as at the end of the day.
- Control your speed and pay extra attention to road or trail conditions when driving back to the project or camp.

PDAC 4.2.2 Head Protection

Head injuries are serious and may result in headaches, concussion, brain damage and even death. Hard hats and helmets for specialized activities are designed to minimize head injuries.

Risks and Hazards to the Head

- Impact injuries due to contact with sharp edges, low overhead hazards, sharp puncturing objects, flying debris, or falling on tools or sharp rocks
- Slips, trips and falls due to rough or slippery ground, working at height without fall protection
- Electrocution due to contacting overhead electrical sources

Prevention and Preparation

Helmets

The required or suggested use of helmets may depend on jurisdictional OHS legislation and company SOPs.

- Regional legislation may require riders and passengers to wear government approved helmets when riding ATVs, snowmobiles or a 2-wheel motor bike. Helmets worn with a face shield provide the most protection. Refer to Chapters 14. All-Terrain Vehicles and 15. Snowmobiles for additional information.
- Where legislation does not require the use of helmets, employees should use common sense and wear a helmet when conditions are hazardous.

PDAC 4.2.3 Eye Protection

Eye injuries may result in eye infections, retinal or corneal burns, diminished eyesight or blindness.

Risks and Hazards to Eyes

- Blindness or other injuries may be caused by flying rock or metal chips when using a rock hammer or a chisel, or when sharp objects or tools impact the eyes.
- Eye injuries may result when dust or debris gets into eyes, or when branches whip into eyes while traversing or riding an ATVs or snowmobiles etc.
- Burns or eye damage may result from contact with chemicals or from broken hoses that eject hydraulic fluids.

Prevention and Preparation

Protect your eyes and sight by wearing appropriate safety glasses, goggles, or a face shield when exposed to hazards.

- In Canada, safety eyewear should meet the CAN/CSA-Z94.3 Industrial Eye and Face Protectors standard for impact resistance.
- Lenses should be appropriate for the job and work location.

- Clear lenses are appropriate for most work and should offer almost 100% ultraviolet (UV) protection.
- Tinted or dark lenses with UV protection are essential when working where there is high sun exposure (e.g., snowfields, glaciers, on water, in deserts and at high altitude). Tinted lenses in safety glasses are available that offer full UV protection.
- Coloured lenses: Grey and green lenses are best for drivers in order to see traffic lights. Amber lenses are best for seeing contrast, such as when working on ice, snow and water. Lenses should not be so dark that they diminish your vision. Transitional or "photochromatic" lenses that change colour in response to the level of light are often acceptable for work in areas where the light levels vary, but they may not be dark enough for protection when working on snow and water.
- Polarized lenses are important for work locations where glare is a factor such as on snowfields, glaciers and on water.

- UV protection should protect against both UVA and UVB radiation. Most safety glasses offer very good UV protection and are available with tinted lenses.
- If safety glasses are not required, wear sunglasses when working where your eyes are exposed to extra sunlight as described above. One solution is to wear polarizing "clip-on" lenses that fit over sunglasses with UV protection.
- Cold weather – wear eye protection with frames made of nylon or rubber as they do not become brittle.
- Ask a supervisor if you are unsure of which type of equipment or lenses are appropriate.
- Tip: To remove goggles or safety glasses after working in dusty or gritty areas, tilt your head forward and downward. Close your eyes and release the straps holding the glasses from the back of your head. Pull them away and downward so any debris falls away from your eyes.
- Additional information to help make the correct selection for eye protection and safety lenses is available at the following websites:
  - http://www.ccohs.ca/oshanswers/prevention/ppe/glasses.html
  - http://www.rhdcc-hrsdc.gc.ca/eng/labour/publications/health_safety/eyes/page00.shtml

Safety Goggles

Wear safety glasses with side shields or goggles *at* the following work sites or when performing some jobs such as:

- During any and all exposure to broken or flying rock. This includes sampling rocks, splitting core or whenever you are near someone doing this work.
- Operating a chainsaw, core saw, rock saw, core splitter
- Sites where heavy machinery is present
- Traversing through wooded and brushy areas
- Working in dusty conditions
- Riding ATVs or snowmobiles on narrow, heavily wooded trails
- Working at or near helicopter landing sites

Goggles are a safer choice for the following jobs:

- Slinging overhead loads: Safety glasses can blow off if not firmly attached to your head.
- Working above eye level
- Handling hazardous or corrosive fluids or materials
- Boosting batteries
- Using ultraviolet (UV) lamps
- Using additional eye protection with a face shield

Wearing contact lenses creates additional safety issues

- Always wear safety glasses or other appropriate eye protection in addition to contact lenses, as the lenses do not protect your eyes from injury. In some circumstances their presence may increase the potential risk of eye injury.
- Always wear safety goggles with no side perforations if it is necessary to handle corrosive or hazardous fluids. They prevent them from getting into your eyes and under the lenses and potentially causing extensive eye damage.
- Practice wearing a respirator with your contact lenses before working for long periods.
- Information about the safety of wearing contact lenses in the workplace is available on the following website: http://www.ccohs.ca/oshanswers/prevention/contact_len.html

PDAC 4.2.4 Hearing Protection

Although permanent or temporary hearing loss can develop rapidly, it can also develop so gradually that one is unaware it is happening. Sustained noise levels can also cause increased blood pressure and levels of stress.

Risks and Hazards to Hearing

- Deafness may result from exposure to high noise levels when:
  - Flying in aircraft
  - Working around helicopter landing sites
  - During slinging operations
  - Working around heavy machinery and generators
  - Using machinery (e.g., chainsaws, rock saws, drills)
- Ear infections caused by using dirty earplugs.
- Serious injury or death may result if you are unable to hear alarms or warning sounds such as those on heavy equipment or fire alarms.

Prevention and Preparation

Helicopter engines, chainsaws and drilling equipment etc., frequently produce noise levels above 85 decibels (dB). The louder the noise, the shorter the duration needed to damage your hearing and result in permanent hearing loss. Even sustained noise levels in the moderate range can result in permanent hearing damage. Preserve your hearing by using hearing PPE and wearing it the entire time you are exposed to noise hazards.

A noisy work area should be monitored to determine the noise level. A company should try to reduce excessive noise by engineering it out, controlling or diminishing it through good maintenance, acquiring quieter equipment, and/or reducing the time that employees are exposure to the noise. Hearing PPE is essential, but additional efforts should be made to control noise.

Hearing protection should be worn when noise levels are high, such as when operating certain tools or equipment and during noisy activities. Some examples include:

- Helicopter and charter aircraft flights: Use disposable earplugs during all helicopter and charter aircraft flights. Some companies provide earmuffs for all passengers. Use these in addition to earplugs when appropriate.
- Chainsaws, rock saws
- Drilling sites
- Equipment such as rock crushers and pulverizers, air hammers, pluggers
- Riding muskeg tractors, snowmobiles
- Any activity where there is potential for exposure to excessive noise

Earmuffs and Earplugs

Employees should be trained to properly fit and maintain their earmuffs and earplugs. Make sure hair and glasses do not interfere with hearing protection. Earmuffs are available to accommodate specific noise levels and in different styles for use with hard hats and for people who wear glasses. Earmuffs are the preferred PPE for noise reduction as they generally provide superior protection and are safer to use than earplugs. Use earmuffs that fit correctly and are comfortable. Companies should consider providing an annual hearing test to detect changes in hearing when employees work where noise levels are a hazard.

Earmuffs

- They must fit tightly to be effective.
- Replace the outer foam cushions when they become worn or brittle.

Earplugs

- They must be worn correctly to be effective. Follow the manufacturer's instructions to insert them.
- Take proper care of reusable earplugs and replace them as necessary. Try not to insert them with dirty fingers as you may transfer bacteria to your ear canal.
- Do not share earplugs, as infections can be transmitted between people this way. Disposable earplugs are intended for single use only so discard them after use.
- Use earplugs in conjunction with earmuffs for additional protection, as appropriate.
- Tip: If you use helicopters frequently, consider attaching reusable earplugs on a cord to your jacket or field vest so they are always available.

Audio entertainment devices and headsets

In general, it is not good practice to allow employees to wear personal electronic music devices with headphones or earplugs (including iPods) when working, especially with or around machinery, when riding ATVs or when traversing. Many people have the music turned up loud and as a result:

- They may not hear instructions or shouted warnings from co-workers – either in person or by radio communication.
- They may not hear warning sounds from machinery that is not functioning properly. They may not hear the audible backup warning signals from moving equipment.
- They may not become aware of dangers such as bears.
- They will be generally distracted from the job at hand thus increasing the risk of accidents.

Music played in camp from a portable radio through loudspeakers may be acceptable as long as it is not too loud; external sounds (e.g., warnings) must still be apparent. The project or camp supervisor should make clear protocols with respect to this topic and make sure they are followed. Wearing headphones when working on a computer or relaxing in the camp may be acceptable as long as the music is not at unacceptably high levels and does not interfere with the work of others.

Additional information regarding hearing protection is available at the following websites:
http://www.ccohs.ca/oshanswers/prevention/ppe/ear_prot.html

http://www.rhdcc-hrsdc.gc.ca/eng/labour/publications/health_safety/ears/page00.shtml

PDAC 4.2.5 Hand Protection

Protect your hands from injuries such as cuts, abrasions, smashed or crushed fingers, broken bones and repetitive strain injuries.

Risks and Hazards to Hands

- Cuts, impact injuries, crushed fingers may result when:
  - Handling core boxes, using rock saws and core splitters
  - Tools break or are misused
  - Handling sharp rocks or objects
- Crushed and severed digits caused by getting caught in pinch points and rotating parts of machinery
- Cuts or dermatitis caused by contact with sharp and/or poisonous vegetation
- Burns caused by contact with hot stoves, lanterns, hot motorized equipment, chemicals or explosives
- Frostbite caused by exposure to cold due to inadequate gloves or clothing Skin cancers may develop after lengthy exposure to sun.
- Electrocution caused by contact with faulty electrical tools or extension cords, using improperly grounded tools or saws, or using electrical equipment in wet conditions
- Blisters caused by repetitive manual work
- Repetitive strain injuries may result from repeating the same task and/or using computers.
- Vibration injuries may result from using pluggers

Prevention and Preparation

- Wear gloves when performing work that requires hand protection. Choose the correct type of gloves for the job. Training is required for the correct use, inspection and maintenance of some types of gloves.
- Avoid wearing rings, watches, or jewellery and improperly fitting gloves when operating machinery, as they may become caught in the equipment and cause severe injury. Some jobs benefit from wearing properly fitting gloves to increase your grip (e.g., using chainsaws or when handling drilling equipment).
- Traversing: Wear appropriate gloves to protect your hands from the sun, the cold, from sharp or poisonous vegetation and from repeated handling of rough rocks.
- Hand care: Do not neglect cuts and burns. Get appropriate first aid or medical attention right away to prevent infections. Wounds that do not heal can become dangerously infected, especially in tropical climates. Look after your hands in dry and in cold climates by applying lotion or salve to prevent cracks that frequently develop and are slow to heal.
- Handwashing: Protect your hands by washing them with mild cleansing agents. Avoid using solvents to remove grease, as they may be absorbed through the skin or damage your skin.
- Apply sunscreen to protect your skin including on the back of the hands, as skin cancers frequently develop there after years of sun exposure.

Gloves

Choose the correct job-rated gloves for proper protection. Use and maintain them according to the manufacturer's instructions. Training may be required to use some types correctly.

- Leather gloves protect from cuts and scratches as well as from heat to a limited degree.
- Wear them when doing heavy manual labour.
- Cold protection: For cold weather work and snowmobiling, wear insulated gauntlets or gloves. Double layered gloves are more effective than a single layer style. Wear thin inner gloves if it is necessary to remove outer gloves to write notes or do delicate tasks.
- Use waterproof and fuel proof insulated gloves when handling fuel and salt in cold conditions. Neoprene gloves can protect your hands in cold, wet conditions.
- Electric shock: Wear leather lineman gloves to prevent static electric shock when slinging loads under helicopters.
- Corrosive materials: Use nitrile, neoprene or butyl rubber gloves, as appropriate, to handle corrosive materials. Choose gloves with the required permeation rate and breakthrough time, which is determined by the use of the gloves. Training is required when gloves are used as PPE for chemical hazards. Check the relevant Material Safety Data Sheet (MSDS) for PPE information.
- Explosives: Use nitrile rubber gloves to handle explosives, as this material is the least likely to cause a static spark of electricity. Only fully trained and certified employees may handle explosives and they should be trained in the use and maintenance of the correct type of gloves.

- Kitchen gloves: It may be advisable to wear disposable plastic gloves when handling food. Gloves need to be discarded each time they become contaminated. Wearing gloves does not reduce the need for good handwashing procedures. It is advisable to wear rubber gloves when washing dishes to protect hands from excess exposure to water.
- When using rubber and plastic gloves, keep your hands away from heat sources as the gloves can melt and cause burns.
- Latex gloves: Inform the supervisor if you know or suspect you have an allergy or react to natural rubber latex or synthetic rubber. There are two types of reactions: (1) *irritant contact dermatitis,* which is a skin rash caused by sweating in gloves or by irritants on the skin that are trapped in the gloves, and (2) *allergic contact dermatitis*, which is a skin rash caused by an immune response to the chemicals present in the gloves. There are two types of allergic reactions – the less serious rubber chemical allergy and the potentially very serious natural rubber latex protein allergy. A person with a natural rubber latex protein allergy should inform the first aid attendant and co-workers and consider wearing a Medic-Alert bracelet and carry an epinephrine autoinjector if they work where there is risk of exposure.
- Glove care and maintenance:
  - Wear gloves that fit correctly. If they are too tight they may rip; if they are too loose, they may come off unexpectedly or your grip may be affected.
  - Carefully inspect the finger tips and the areas between fingers for holes and damage before using gloves, especially if they are designed to protect your hands from chemicals etc.
  - Continuously monitor the condition of the gloves and change them before they wear out.
  - Wash off contaminants before you remove gloves; know how to remove and dispose of gloves properly.
  - Glove failure – know how to address chemical burns. Remove chemical-soaked gloves and wash your hands for at least 20 minutes under cool running water unless the chemical reacts with water. Be familiar with the specific MSDS so that you immediately use the correct first aid procedures.

Additional information regarding hand protection is available at the following websites:
http://www.ccohs.ca/oshanswers/prevention/ppe/gloves.html

http://www.rhdcc-hrsdc.gc.ca/eng/labour/publications/health_safety/hands/page00.shtml

http://www.rhdcc-hrsdc.gc.ca/eng/labour/publications/health_safety/skin/page00.shtml

http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/latex_allergies.pdf

http://www.ccohs.ca/oshanswers/diseases/skin_cancer.html

http://www.ccohs.ca/oshanswers/diseases/washing_hands.html

PDAC 4.2.6 Foot Protection

Treat your feet well by protecting them with appropriate footwear. Improper work boots may result in chronic foot pain or injuries.

Risks and Hazards to Feet

- Slips, trips, and falls may result when footwear lacks appropriate traction (e.g., wrong type, soles are worn out).
- Impact injuries and puncture wounds may be caused by dropping sharp or puncturing objects, heavy core boxes, or heavy sample bags on your feet.
- Blisters or lacerations caused by wearing improperly fitting footwear Snakebite or cuts from sharp vegetation due to inadequate footwear
- Frostbite, permanent tissue damage, amputation of toes may result from exposure to cold weather or temperatures when wearing inadequate footwear.
- Trench foot or immersion foot caused by continuously wearing wet socks and boots "Athlete's foot" may develop as a result of wet, sweaty feet.
- Electrocution caused by working with faulty electric tools and equipment, using tools while standing on wet ground, or contacting live wires without wearing appropriate footwear

Prevention and Preparation

Feet are vulnerable to abuse from heat, cold, water and vegetation (e.g., cactus) and to various diseases and infections. Sandals and athletic shoes are not recommended footwear for field work or work at project sites. Make sure work boots fit correctly to help avoid blisters and break in new boots before the field season begins. Good traction is essential. Consider the terrain and working conditions when choosing footwear:

- Safety boots: Wear approved safety boots when handling core and core boxes, when working underground, in open pits or trenches, around heavy equipment such as drill rigs or excavators, when handling heavy materials, and when using heavy mechanical tools or equipment (e.g., axes, heavy sledges, chainsaws, plugger drills). Wear non-conductive boots if you are likely to encounter electrical hazards.
- Cold climate conditions: Wear heavily insulated waterproof boots with removable wool or felt liners. Take a spare set of liners so they can dry out on alternate days. Carry extra socks and change them frequently to keep your feet dry to prevent frostbite or immersion foot disorders.
- Traversing: Wear durable boots that have proper ankle support. The soles should provide appropriate traction for the terrain. Refer to section 6.3.5 Clothing for additional information on footwear.
- Wet boots dry faster when they are not waterproofed. It is important to dry your feet and keep them warm at night to prevent developing foot disorders generically referred to as foot rot. Refer to 9.9.6 Immersion Foot.
- Wear appropriate leather or winter boots when riding ATVs or snowmobiles and place your feet correctly on the machine to prevent injury.
- Gaiters protect your feet and lower legs from various hazards including snow, mud, ice, and vegetation such as thorny scrub, cholla, and cactus. Strong gaiters made of thick leather are necessary for snakebite prevention.
- Blisters: As soon as you feel a hot spot on your foot, stop and apply moleskin or 2nd skin to the area to prevent a blister from developing. Wash your feet to keep the area clean and put on fresh socks.

- Wear socks appropriate for your working conditions. Cotton absorbs sweat but will not wick it away. Wool insulates and wicks dampness away. Change socks frequently and carry extra clean, dry socks (a Ziploc-type bag will keep them dry). Change footwear, dry your feet, and put on dry socks when you return to camp with wet feet.
- Do not wear athletic shoes where snakes and/or sharp vegetation such as cactus are hazards. Do not wear athletic shoes in place of field boots.
- Walking without boots or shoes to protect your feet increases the opportunity for injury, infections, insect and snakebites. Parasites such as Cutaneous larva migrans, hookworm, and strongyloidiasis can enter your body through unprotected feet. Standing on discarded used needles can be a hazard in any part of the world.

Additional information regarding footwear is available at the following websites:

http://www.rhdcc-hrsdc.gc.ca/eng/labour/publications/health_safety/feet/page00.shtml

http://www.ccohs.ca/oshanswers/prevention/ppe/footwear.html

http://www.ccohs.ca/oshanswers/prevention/ppe/foot_com.html

PDAC 4.3 Lifting and Back Protection

Back injuries may result in muscle spasms and chronic back pain. Falls may result in spinal injuries and even paralysis.

Risks and Hazards

- Slips, trips and falls caused by uneven or steep terrain, poor ground conditions (e.g. mud, snow, ice), and inadequate footwear
- Back strain may result from using improper lifting techniques, carrying overloaded backpacks, lifting heavy core trays, and lifting stuck snowmobiles and ATVs etc.

Prevention and Preparation

Back injuries are a common workplace injury. Employees should be trained to avoid unnecessary physical stress and strain and how to recognize factors that may contribute to back or lifting injuries. They can easily result from the improper lifting of heavy camp equipment, core trays, drill samples, drill pipe and bits – or even from changing a tire or lifting a spare wheel off the roof of a vehicle. Injuries may result if you lift with a bent back or with the object held away from your body or to your side. To avoid back injury, it is important to keep your back muscles strong and flexible and to use correct lifting procedures. In addition, wearing proper footwear with good support will help keep you free of back pain. Make sure your work boots are comfortable. Use good posture when standing, walking and working. Sit correctly when doing office work, especially when using a computer. The screen should be at eye level and the chair should support your back.

Lifting Procedures

Follow correct lifting procedures when lifting any object, especially a heavy one.

- Use mechanical devices when possible (e.g., a hand truck or a pushcart to move heavy loads).

- Take care when lifting heavy core boxes, as many back injuries are a result of lifting very heavy core boxes.
- Bogged down snowmobiles and ATVs account for many back injuries. Take care when lifting the back of a snowmobile that is stuck in snow or slush. Before trying to lift or move a mired ATV, release the suction by digging the mud away from the wheels. Carry a manual winch (a “come-along”) when working where an ATV or snowmobile is likely to get stuck frequently. Take care when loading ATVs and snowmobiles into or out of the bed of a pickup truck or a trailer. Refer to Chapters 14. All-Terrain Vehicles and 15. Snowmobiles for additional information about safe loading and extraction techniques.
- Get help to move or lift very heavy loads.
- Provide refresher training several times a year to emphasize correct lifting methods at project sites where lifting jobs are common.

Follow these correct lifting procedures when you lift any object, especially a heavy one.

- Plan the lift before you begin. Make sure your footing is secure and the route is clear if you must carry the object. Pay extra attention if you must carry a load on a ramp or stairs.
- Position your legs shoulder-width apart with one foot slightly ahead of the other. This position forces you to bend the knees rather than the back.
- Bend your knees and get a good grip. Use gloves if your hands are sweaty or if the object is slippery.
- Lift with your legs, not with your back. Keep your back straight, avoid twisting and never jerk when you lift. Cradle heavy objects close to your body when carrying them.
- Lift within your ability. Try not to exceed 22 kg (50 lb) per lift. Get assistance if there is any possibility that you might injure yourself if you lift the object alone. Do not “show off” by doing the job alone.
- When you lift with a team, make sure to plan the lift together and execute the lift according to the plan. Only one person should call the directions.
- If you hand off a load, make sure the next person has a good grip before letting go.
- Do not carry a load in front of your face – you need to see where you are walking.

Additional information regarding back safety is available at the following websites:

http://www.rhdcc-hrsdc.gc.ca/eng/labour/publications/health_safety/back/page00.shtml

http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/back_talk.pdf

PDAC 4.4 Skin Protection

The skin is the largest organ of the human body (a fact most people do not realize) and its health and condition are often taken for granted. Skin can be damaged easily by heat, cold and injuries so that it becomes the entry way for pathogens and toxins. This section covers information about skin protection from harmful vegetation. Information about skin protection from sun, insects and hazardous chemicals or materials is cross referenced to other chapters as listed below.

Risks and Hazards to Skin

- Abrasions and cuts may result from impact with sharp objects or falling on rough ground. Sunburn may result from exposure to sun without using sufficient sunscreen.
- Frostbite may result from working in cold weather without proper gloves, boots or clothing.
- Insect-borne diseases and allergic reactions may result from insect bites and stings.
- Burns may result from contact with hot machinery, equipment, fuels or chemicals etc.
- Dermatitis, rashes or cuts may result from contact with poisonous and/or sharp vegetation.

Protection from poisonous or skin irritating plants

Be informed about potentially skin irritating plants that may grow in the project area. In some places there are plants with roots, stems and leaves that contain oils or sap that can cause severe skin irritation.

Precautions and Preventions

- Protect your skin from sharp and thorny plants. In temperate regions, devil's club is a common plant with spiky thorns that may be difficult to extract once embedded in the skin. Stinging nettles can also be a nuisance. Cactus, cholla and other spiky plants are common in dry desert regions. Contact with them may cause cuts, infections, dermatitis or allergic reactions.
- General information regarding protection and care for your skin is available at the following website:
  - http://www.rhdcc-hrsdc.gc.ca/eng/labour/publications/health_safety/skin/page00.shtml

Protection from the sun

The sun produces ultraviolet (UV) radiation that can cause serious sunburn to skin and eyes. As both direct and reflected radiation cause burning, avoid exposure to the sun as much as possible by wearing appropriate clothing, using a wide spectrum sunscreen with a high sun protection factor, and wearing sunglasses with lenses with UV protection. Skin damage from repeated sunburn can lead to skin cancers including melanoma. Refer to section 9.10.4 Sunburn for detailed information regarding protection from the sun.

Protection from insects

In Canada and the USA biting insects may be a mere nuisance or a serious distraction. In addition to potential annoyance (and allergic reaction in some people), insect bites may cause serious diseases. Depending on the project location, employees may be exposed to West Nile virus and western equine encephalitis from mosquito bites, Lyme disease and Rocky Mountain spotted fever from tick bites, and fleas that occasionally carry plague.

To reduce insect bites, wear appropriate clothing, use insect repellent on your skin and apply insecticide to clothing.

Protection from potential exposure to chemical hazards

Employees who may be exposed to or use hazardous materials should receive basic and site specific Workplace Hazardous Materials Information System (WHMIS) training plus training to use the products safely. They should be familiar with the Materials Safety Data Sheet (MSDS) for relevant hazardous products, any required PPE, and first aid measures to use after inadvertent exposure.

- Refer to sections 18.2.3 Workplace Hazardous Materials Information System (WHMIS) regarding WHMIS training and 20.7.4 Hazardous Materials for detailed information about specific hazardous chemical substances commonly used at exploration sites.

PDAC 5.0 Field Equipment Safety

Introduction

Chapter 5. Field Equipment Safety covers the safe use of implements and equipment that are commonly used for field work rather than at project or camp sites, although some may be used in both situations. Additional equipment is covered in the following chapters:

- Compasses and Global Positioning System (GPS) units are covered in Chapter 7. Knowing Your Location
- Large generators, camp heating stoves, lanterns and appliances are covered in Chapter 18. Camp Set Up and Management.
- Two-way radios, satellite telephones and other communication and emergency locator devices are covered in Chapter 19. Communications.

PDAC 5.2 Rock Hammers and Chisels

Risks and Hazards

- Eye injury caused by flying rock chips or spalled off metal splinters
- Cuts caused by flying rocks, chips, metal splinters, a hammer head flying off, or falling on a hammer
- Impact or crush injuries caused by striking yourself with a hammer or chisel
- Slips and falls caused by poor footing on slippery or rough ground, wearing inadequate footwear

Prevention and Preparation

- PPE: Always wear eye protection (safety glasses with side shields) when you chip rock samples or are near other employees doing so. Flying slivers can cause cuts and severe eye injuries. Hammers may rebound and cause injury. Consider wearing gloves to protect your hands.
- Keep others and bystanders at a safe distance. Make sure others will not be injured by flying rock or metal fragments due to your actions. When sampling at a rock face, it is easy to dislodge a rock that might fall or roll onto someone standing below or nearby.
- Check that the hammer head is secure before using it.

- When using chisels, beware of flying splinters of steel that may spall off the hammer. Never use another hammer in place of a chisel as the hardened steel of the hammer may splinter. Eye protection is important when using chisels. Use the largest chisel suitable for the job and use a chisel with a hand guard. Never use a hammer in place of a chisel.
- File off any rough edges or "mushrooms" that develop on rock hammers or chisels. Check that no vegetation will obstruct or deflect your swing.
- Carry a rock hammer carefully or in a hammer holster. Falling on the sharp end has injured people.
- Watch your footing; small sharp bits of rock roll easily underfoot and may cause a slip or fall, especially in areas where blasting has occurred.

PDAC 5.4 Augers

Risks and Hazards

- Cuts caused by contact with the auger blade, especially if the auger is not controlled Slips or falls may occur when operating on slippery, icy, snowy or wet surfaces.
- Drowning or cold water immersion hypothermia caused by falling through ice if the ice has not been measured correctly, or if the load bearing capacity of the ice has not been calculated correctly
- Hypothermia caused by working in cold temperatures and/or exposure to wind chill Fuel spills caused by following inadequate fuelling procedures, lack of training

Prevention and Preparation

For all augers:

- Before using any auger for the first time, refer to the manufacturer's operator manual and follow the SOPs in it. Follow the project SOPs when working on ice (refer to sections
- 15.10 Working on Ice and 21.4.3 Winter Access Routes).
- Use the correct blades, extensions, pins and screws. Do not mix parts from different brands.
- Do not auger a hole near exposed rock to avoid blade damage.
- Wear appropriate PPE, which will always include eye protection, gloves, and boots that provide good traction.
- Workers should not wear loose clothing, straps or long hair that could catch in a rotating auger blade.

For powered augers:

- Maintain augers in good working condition. Make sure the clutch works properly before use.
- Check the fuel level and that the throttle and choke release are working.
- Check the pull-cord, auger and blades. When changing blades, make sure the screws are fully tightened.

- Never touch rotating blades. Do not clean the auger flight while the blade is rotating. Follow correct fuelling procedures as described in section 5.1.

For ice augers:

- Use ice augers that have a "safety arm" or a dead man switch that will stop the rotation if you lose control of the auger.
- It is preferable for two people to handle a large ice auger, as it is easy to lose control when only one person operates the machine.
- Always stand on the ice when operating the auger. Never stand on an oil drum to gain height.
- Drill the length of the auger and then place an extension on the machine. Do not join two lengths of auger together before you commence drilling.
- Join each length of auger with the correct cotter pin. Do not use substitutes.
- Wear PPE – waterproof outer wear, ice cleats, safety glasses, gloves, hearing protection and hard hats, as required.
- Dress warmly to prevent hypothermia and wear a PFD or floater suit when testing ice thickness early in the season. Refer to sections 9.9.3 Hypothermia and 15.10 Working on Ice.
- When drilling, keep your back straight and knees bent. Lift the auger up and down in the hole to clear the cuttings. When a hole is drilled through the ice, let go of the throttle and lift the auger out by the handles.

PDAC 5.5 Power Tools

Risks and Hazards

- Electrocution caused by the improper use of tools, working in wet conditions
- Impact injuries including cuts and punctures caused by the misuse of sharp tools, breaking tools
- Severed limbs or digits caused by contact with saw blades or other sharp cutting tools Fires caused by overheating tools, short circuits

Prevention and Preparation

- Before using any power tool for the first time, refer to the manufacturer's operator manual and follow the SOPs in it.
- Be trained to use the tools correctly.
  - Know the danger zones so you avoid contact with moving parts. Only operate power tools with the manufacturer's guards in place.
  - Wear appropriate PPE.
  - Know how to spot problems and how to follow lockout procedures.
  - Follow general inspection and maintenance procedures.
- Inspect the tool before use for wear and damage. Do not operate a tool with a guard removed.

- Make sure the tool is rated for the correct amperage or wattage for the electrical system in use.
- Use the correct fuses. Never replace a blown fuse with one of a larger size, as excessive electric current may start a fire.
- Make sure the tool is switched off before connecting the power.
- Disconnect the power before making adjustments or attaching accessories.
- Keep electric tools away from water, chemicals, gasoline, diesel, oil, and hot surfaces, etc.
- Never use a tool that is overheating. Follow lockout procedures and have it repaired by a qualified person. To prevent overheating, use only approved extension cords with the proper wire size (gauge) and voltage capacity.
- Where possible, connect power tools to sockets with a ground fault circuit interrupter (GFCI).
- Plugs and socket connections must be weatherproof for use at projects and drill sites. Keep a fire extinguisher nearby in case of fire.
- Tie back long hair and do not wear loose clothing, jewellery or improperly fitting gloves that might get caught in the moving parts of power tools.
- Wait to approach a person using a power tool until they are finished so that you do not startle them and cause an accident.
- Do not leave or store power tools overhead where they may fall if the cord is pulled.
- Power cords:
  - Inspect the cord for fraying and damage before each use. Test power cords and socket outlets regularly.
  - Use the correct type and length of cord for the job. A power cord should be as short as possible for the job. Check that the cord is appropriate for the voltage used in the electrical grid system.
  - Use three-wire core extension cords (leads) for connecting power tools unless you are using a double insulated power tool. Double insulated power tools should be labelled as such. Do not ground (earth) the casing of these tools. These tools require only a two-wire power cord.
  - Keep the power cord out of the way while you work. It should never be near your feet where it may be a tripping hazard.
  - Grip the plug when unplugging a tool and not the cord.
  - Do not allow vehicles to drive over power cords. Place the cord between planks to protect it.
- Battery powered tools:
  - The battery used to power the tool should always be the type specified by the manufacturer.
  - Use the correct charger to recharge batteries.
  - Store battery packs correctly. Keep the battery terminals away from metal tools, nails, screws and bolts to prevent a short that might cause a fire.

Watch out for overheating. Store and use battery powered tools away from flammable materials and keep a fire extinguisher nearby.

PDAC 5.8 Water Pumps

Gas powered water pumps may be used for clearing off rock outcrops.

Risks and Hazards

- Slips and falls caused by working on wet surfaces or wearing inadequate footwear.
- Cuts and impact injuries caused by high pressure spray and flying rock bits.
- Back injuries caused by lifting or carrying the pump.
- Burns caused by contact with the hot muffler.
- Hearing loss caused by high noise levels, wearing inadequate hearing protection.
- Brush fires may be started when flammable materials come in contact with hot engine parts.
- Carbon monoxide poisoning caused by inadequate ventilation of the exhaust.

Prevention and Preparation

- Refer to the manufacturer's operator manual and be familiar with the controls and the pressure limits of the pump.
- Follow the SOPs in the operator manual and relevant project SOPs.
  - Follow correct start up procedures, which may include priming and careful levelling of the pump. Place and operate the machine on stable ground so it does not fall over.
  - Check that there is adequate water intake and check periodically that the filter/strainer is clear. Use care if operating with the intake hose in shallow water.
- Wear PPE:
  - Wear safety glasses and/or a hard hat with face visor, as required.
  - Wear gloves to grip the hose well.
  - Wear safety footwear that provides good traction on wet surfaces.
  - Hearing protection – wear ear muffs or ear plugs, as appropriate.
  - Wear appropriate clothing to protect your limbs from flying debris that has been loosened by water spray.
  - If operating a water pump in cold weather, take precautions to prevent hypothermia. Wear waterproof outer clothing and sufficient layers underneath to keep warm. Refer to sections 6.3.5 Clothing and 9.9.3 Hypothermia.
- All high pressure hoses should be in good condition. Worn and rotten hoses are dangerous. Make sure all the hose couplings are tight and the nozzle is firmly in place.
- Make sure the person operating the hose has a firm grip before the water starts to flow. Hold the spray gun securely with both hands. Be prepared for kickback when the nozzle fills due to the sudden water pressure.
- Maintain secure footing at all times, especially on smooth, slippery wet surfaces. Never aim the stream from a pressurized hose at a person.

- Know how to stop the pump immediately.
- Follow correct fuelling procedures as described in section 5.1.
- Follow the manufacturer’s maintenance schedule. Make sure the machine has sufficient lubricants and sufficient water to cool the pump.
- Follow the manufacturer’s instructions for storage at the end of the season.

PDAC 5.9 Small Generators

Small portable generators usually use gasoline or diesel for fuel. Use the correct generator for the job. Do not exceed the load rating recommended by the manufacturer. Carefully follow the manufacturer's instructions regarding the operation and grounding of the generator. It is recommended to use a ground fault circuit interrupter (GFCI) with generators, whenever possible. Information regarding large generators is covered in Chapter 18. Camp Set Up and Management.

Risks and Hazards

- Electrical shock or electrocution caused by contacting generators with wet hands or when standing on wet ground.
- Asphyxiation caused by carbon monoxide poisoning when a generator is operated with improper or inadequate ventilation of exhaust fumes.
- Fire and/or burns caused by contact with hot motor parts Back injuries caused by lifting heavy generators.
- Fuel spills caused by improper fuelling techniques, improper placement of the generator or fuel drum, lack of training.

Prevention and Preparation

- Read the manufacturer’s operator manual and follow all safe operating instructions for the specific generator. Understand how to operate all the controls including how to stop the generator quickly.
- Operate the generator in a well ventilated place. Operate a gas powered generator according to jurisdictional regulations and do not operate one in an enclosed space (e.g., a tent, trench, pit or dwelling). If operation is permitted within a structure, the exhaust pipe must discharge outside so that fumes cannot re-enter the enclosure. Asphyxiation due to carbon monoxide poisoning is a great hazard. Maintain battery powered carbon monoxide detectors where appropriate. Refer to sections 22.7.3 Carbon Monoxide and 18.4.5 Generators.
- Follow the manufacturer’s maintenance procedures and schedules.
- Place the generator on level surface, otherwise fuel and oil spills may result. Do not operate the generator on or near combustible materials.
- Small generators should be placed and operated within a pan to catch spills that frequently occur during fuelling procedures.
- Follow correct fuelling procedures as described in section 5.1.

- A generator is a potential source of electrical shock should you misuse it. Do not touch a generator if your hands are wet. Do not allow the generator to get wet so cover it to protect it from rain or snow.
- Follow correct lifting procedures when moving generators.

PDAC 5.10 Rock and Core Handling and Cutting Equipment

Various types of saws and core splitters may be used at project sites for examining rock and mineral samples. Stationary slab and core cutting saws are used at the site while portable gas powered saws are used at an outcrop. Core handling facilities vary greatly; some are entirely enclosed while other facilities may be entirely open to the outdoors – with or without some shelter from weather and sun. Some common safety issues include ventilation, PPE, lifting, potential sample toxicity, transporting core boxes, and risks and hazard associated with the use of specific cutting equipment.

PDAC 5.10.1 Risks and Hazards

The following risks and hazards are common to all rock and core handling and cutting equipment.

- Asphyxiation caused by carbon monoxide poisoning when gasoline powered equipment is operated with inadequate ventilation
- Electrocution caused by operating electrical saws in wet conditions Eye injuries may result when rock or dust particles enter the eyes.
- Cuts or injuries caused by contact with saw blades, flying rock particles, or disintegrating saw blades
- Slips and falls caused by working wet or slimy floors or ground, inadequate footwear
- Occupational diseases may develop due to exposure to silica dust, toxic substances or toxic minerals (e.g., lubricants, or radioactive, asbestiform, mercury or arsenic containing minerals)
- Back strain caused by improper lifting of core boxes, heavy samples and saws Burns caused by contact with hot motor parts and hot saw blades
- Entanglement injuries caused by loose clothing getting caught in rotating equipment Hearing loss caused by high noise levels and inadequate hearing protection

PDAC 5.10.2 General Rock and Core Handling Guidelines

It is advisable to develop SOPs that apply to core handling and cutting processes. The following topics are important to consider.

- Jurisdictional Regulations: Be aware of jurisdictional regulations regarding PPE, ventilation, and chemical composition regarding the type of rocks and minerals being cut or processed, as some jurisdictions may have regulations that apply to specific substances. For example, Quebec has specific regulations regarding asbestiform and amphibole minerals: Quebec regulations O.C. 885-2001, s. 42. and s. 66 and s. 67 are at the following website: http://www.canlii.org/en/qc/laws/regu/oc-885-2001-2001-go-2-3888/latest/part-1/

- Rock and Core Chemistry: The chemistry of the rocks and minerals being cut will determine, in part, the ventilation for the rock and core handling area and PPE requirements for operators.
  - Silica: Rocks that contain silica (and most do) expose the operator to fine silica particles, which are very reactive with lung tissue and may eventually cause silicosis. The following website has information regarding PPE and silica: http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/quartz_silica/personal_qua.html
  - Radioactive minerals: These minerals and their decay products cause deadly lung diseases. Refer to the safe handling guidelines in Chapter 15. Guidelines for Radiation Protection During Exploration for Uranium in the Excellence in Environmental Stewardship toolkit on the e3 Plus website: http://www.pdac.ca/e3plus
  - Asbestiform minerals: Rocks that contain asbestiform minerals expose the operator to asbestiform fibres, which may eventually result in asbestosis, mesothelioma and other forms of lung cancer. Core shack and PPE requirements may include specific ventilation, respirators, and separate work clothing that must be washed and kept specifically for core logging purposes. Refer to the safe handling guidelines in section 20.7.4.2 Asbestos and Amphiboles.
  - Toxic elements in mineral: Refer to the safe handling guidelines in section 20.7.4 Hazardous Materials.
  - Drilling lubricants or cutting oils: Determine if any drilling substances are being used that could affect the health of employees and provide appropriate SOPs and PPE. Information about drilling and cutting lubricants and additives is available from the product Materials Safety Data Sheets (MSDSs), which should be kept in a central location at each project and/or drill site. Refer to 18.2.3.3 Material Safety Data Sheets.
  - Other chemicals such as “blue juice” or “nickel powder” may be used to aid mineral identification. These are toxic and should be treated with respect and care. Refer to section 20.9.5 Core Logging.
- Ventilation Requirements: Air quality should be tested to determine the requirements for respiratory PPE. Make sure mechanical ventilation extracts the cutting dust and any exhaust fumes from the work area. Contain slab and core cutting saws within a box equipped with an extractor fan at the back for this purpose.
  - Gas powered motors produce deadly carbon monoxide (CO) and carbon dioxide (CO_2). When these motors are used in an enclosed space, the exhaust must be directly vented to the outdoors in such a way that it cannot gain entry through any ventilation air intake or window. It is advisable to keep a carbon monoxide detector mounted in any space with working gas powered equipment. No employee should be allowed to work amid exhaust fumes.
  - It is essential to extract rock dust particles from the work area during cutting processes. Fine rock particles are a hazard to your lungs and may cause deadly lung diseases and even one severe exposure may cause permanent changes to the lungs. See # 2. Rock and Core Chemistry above.

- Personal Protective Equipment (PPE): It is essential to protect yourself from injury by wearing appropriate PPE when risks and hazards cannot be removed or sufficiently mitigated.
  - Safety glasses with side shields (or a face shield attached to a hard hat) are essential as flying pieces from disintegrating samples and saw blades are a hazard during cutting processes. Safety glasses should be worn when testing minerals with hydrochloric acid (HCl) or applying “blue juice” to core. If circumstances are such that safety glasses are required while core logging and they interfere with having a clear view of the core, a company should consider investing in prescription safety glasses or safety glasses high quality lenses for core logging employees rather than dispensing with the use of safety glasses.
  - Respiratory protection: Use the appropriate filter mask or respirator for the dust concentration and composition. Ordinary dust masks are completely inadequate protection, as they are meant to protect from sawdust particles. Use tight fitting respirators with canister filters designed for the size and type of rock particles in the air. Respirators must be fit tested to perform properly.
  - Hearing protection: Wear ear muffs and/or ear plugs.
  - Gloves: Wear properly fitting gloves to protect hands from sharp rocks, splinters on core boxes, potentially toxic minerals and drilling additives or lubricants present on samples or core, where appropriate.
  - Footwear: Wear rubber safety boots and a waterproof apron when appropriate. Clothing: Wear long sleeved clothing to protect arms from flying rock chips.
  - Operators should not wear loose clothing or jewelry that may catch in moving parts of a saw or splitter.
  - Refer to Chapter 4. Personal Safety for detailed information regarding PPE.
- Facilities: When core storage and handling areas contain racks or shelves and tables, make sure they are strongly built to hold the cumulative weight of the fully loaded core boxes. Employees may be seriously injured if core boxes or rock samples fall on them. Tables and benches should be high enough so employees are not forced to constantly bend over while examining core.
- Lifting and handling: Employees should be trained to lift heavy core boxes properly in order to avoid back strain – a common problem that develops when logging core.
- Transporting core boxes: Use trolleys or other devices to move core boxes whenever possible. When transporting core in a pickup truck or with an ATV towing a trailer, make sure the core boxes are secured safely and the trailer is stable. Go slowly. Take care not to overturn the trailer and the ATV. Refer to Chapter 14. All-Terrain Vehicles regarding safe towing techniques. Refer to section 16.12 Slinging for information regarding helicopter slinging safety.

PDAC 5.10.3 General Safety Regarding Rock Cutting Saws

Operator Safety

There is a significant risk during the cutting process of being hit by (1) flying rock pieces if samples break and (2) pieces of a disintegrating saw blade that may fly through the air.

- Before using any saw for the first time, refer to the manufacturer's operator manual. All users should be familiar with and follow the manufacturer's SOPs. Different types of saws and models have different requirements.
- Wear appropriate PPE. See #4 in section 5.10.2.
- Be trained to use the saw safely.
  - Never force the rock through the saw. This often results in the sample disintegrating and rock flying through the air.
  - Know how to stop the machine immediately – the saw should have an emergency stop button or cut off switch to use in case the saw jams.
  - Be able to see what is happening during cutting operations. Stop the saw and restore clear visibility before proceeding.
  - Remove cuttings so they do not accumulate and block the saw. Shut off the saw for this task. Do not use your hand to remove cuttings when the saw is running.
  - Do not operate the saw unattended.
- Watch your footing. Water is usually used for cooling saws. There should be adequate drainage. Even so, the floor or ground will be wet and slippery due to the presence of water spray, rock powders, slimy cuttings, or the presence of slippery minerals such as talc.
- Do not lick core; do not eat or smoke in a core shack. Wear gloves while working with core and wash your hands when you are finished handling core materials.

Safety regarding saw blades

- Inspect the saw blade before use. Make sure the blade is in good condition as well as correctly aligned and securely attached.
- It is imperative to use the correct saw blade designed for the machine. Use the correct blade for the type of rock being cut.
- Never use a broken or damaged saw blade. Replace worn saw blades to prevent them from breaking during use. Saw blades that break while in use will come apart in pieces and fly off the mounting in any direction, which can cause serious injuries or even death.
- Adjust the speed of the saw blade according to manufacturer's instructions.
- Wear gloves. Although the saw blade feels dull when stopped, it can cut your hands when rotating and the blades may be very hot immediately after use.

Cooling and lubrication of saws

- Make sure the saw cooling and lubrication system functions correctly. Maintain adequate and good lubrication. Some saws use water and some use oil.
- When water is used, there should be enough water flowing to cool the saw blade and wash away dust and cuttings but not so much that it floods the area. Check that water hoses and connections are tight and working. Insufficient water flow will damage the machine.
- When oil is used, maintain the correct amount in the reservoir.
- Clean air intake areas, as required.

PDAC 5.10.4 Core Cutting Saws

Core saws may slice core crosswise or lengthwise depending on the setup.

Significant Risks and Hazards include:

- Asphyxiation caused by carbon monoxide poisoning due to improperly vented exhaust from gasoline powered saws
- Electrocution caused by operating electrical saws in wet conditions Eye injuries caused by rock or dust particles entering the eyes
- Respiratory diseases may develop caused by exposure to silica dust, toxic substances or toxic minerals
- Cuts or serious injuries caused by contact with saw blades, flying rock particles, or disintegrating saw blades
- Slips and falls caused by working on wet or slimy floors or ground, inadequate footwear

Prevention and Preparation

Gas powered and electrical powered core cutting saws have some separate and specific risks and hazards associated with each type. Follow the guidelines in section 5.10.3 for all saws and pay attention to these additional safety measures.

- Make sure the saw is well anchored to the ground or concrete floor. The saw should have floor mounted guards around it to prevent movement due to vibrations.
- Make sure an electric core saw is carefully and properly grounded. It is very important that the circuit is equipped with a ground fault circuit interrupter (GFCI) so the saw stops when there is a power surge or there are water problems, etc.
- Saw blades should have shrouds and/or guarding around them to protect fingers and hands. Never operate a saw if these are removed.
- If the height of the core saw is adjustable, position the saw at a comfortable working level for the employee.
- Because water is used to lubricate the saw blade and rock during the cutting process, there should be proper drainage around the saw so the operator can avoid standing in water. Wear a waterproof apron and rubber boots. It may be advisable to stand on a wooden platform (core boxes or a pallet) to raise the feet above standing water.
- Know how to handle the feed mechanism for the saw. It may have manual or automatic feed features.
- Wear appropriate PPE. See #4 in section 5.10.2.

PDAC 5.10.5 Core Splitters

Core splitters may be powered by electricity, gas or hydraulic pressure. Some require a blow with a hammer or hydraulic ram to split the core.

Significant Risks and Hazards include:

- Eye injuries and cuts caused by flying rock chips
- Cuts caused by handling sharp rocks and/or core boxes without gloves, or the incorrect use of tools

- Foot injuries caused by dropped or falling objects and/or wearing inadequate footwear.
- Injuries ranging from minor to extremely serious hydraulic fluid embolism caused by sprays of hydraulic fluid.

Prevention and Preparation

- Learn to use the splitter properly and safely. Refer to the manufacturer's operator manual. All operators should be familiar with and follow the manufacturer's SOPs.
- Before starting work with a core splitter, make sure it is functioning properly and all guards are in place.
- Make sure the rock or core sample is firmly held in place before splitting the core section. Wear appropriate PPE. See #4 in section 5.10.2.
- If the core splitter uses hydraulic pressure, make sure the hoses are in good shape, are securely connected and do not leak. Never check for pinhole leaks with your hands – always use an object such as cardboard or piece of wood to detect pinhole leaks in hoses. The force of hydraulic fluids ejected through a pinhole leak is sufficient to penetrate through clothing and skin into your body, which may result in severe tissue damage or even a hydraulic fluid embolism.

PDAC 5.11 Portable Handheld XRF Analyzers

Portable handheld XRF analyzers may be used to scan the composition of drill core, soils, and rock samples for a range of elements. There are fundamentally two different types of XRF analyzers – those with a miniature X-ray tube and those that use a small radioactive source. These different analyzers have different safety requirements, so it is essential for operators to receive training and certification that meets the requirements of the authorities having jurisdiction (AHJs). The two different types of instruments in some jurisdictions – for example, Canada – may have different authorities that regulate their use and require different regulations, certification and licensing.

Operators should follow the manufacturer's safe operating procedures and training instructions.

- Companies should restrict the use of portable X-ray equipment to employees who have been trained and certified to use the specific equipment, as training and certification in one type of X-ray equipment does not automatically qualify someone to use a different device.
- Do not hold a sample in your hand and test it. Place it in a sample holder or on a flat surface and stabilize core so it will not roll.
- Portable XRF analyzers should never be pointed at a person even when the shutter is closed.
- Stand to the side when using the analyzer so scatter radiation does not hit your body.
- Verify if the analyzer must be transported as dangerous goods, as requirements vary with different types and models.

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PDAC 6.0 Safe Traversing Practices

Introduction

Most field employees enjoy the challenge of traversing. It is important to exercise good judgement at all times, as a fall in isolated or rough terrain can be life-threatening especially when you are alone. An entire field party may be placed at risk when one member is injured. Statistics collected over the past 25 years by the Association for Mineral Exploration British Columbia (AME BC) indicate that slips and falls average about 45% of all lost workday accidents in the exploration industry in western Canada. Do not take chances.

PDAC 6.1 Risks and Hazards

Traversing is inherently risky and the risks are greater when field crews are not sufficiently aware of local hazards. The risk of injury is higher when traversing in hazardous terrain such as in mountainous areas with cliffs, canyons, fast-flowing streams, or rivers, and where there is potential for avalanches and falling into crevasses. Lack of training in safe methods of traversing (including training by experts), lack of helicopter support, traversing alone or with too small a field crew contribute to an increased risk of injury or death.

The following are some of the risks and hazards that may be encountered during traversing:

- Slips, trips and falls caused by working on steep, rough or slippery ground, wearing inadequate footwear, balance difficulties when carrying heavy packs, exploring near abandoned mine openings
- Impact injuries caused by flying rock chips or rock breaking away when sampling, falls of rock from overhead
- Risk of wildlife attacks: bears or other large mammals, crocodiles, venomous snakes
- Health risks caused by temperature extremes, high altitude, unsafe drinking water, local diseases, inadequate first aid support in remote camps
- Hypothermia and hyperthermia caused by wearing inadequate clothing when working in temperature extremes, getting cold and wet, dehydration, working alone and not recognizing the symptoms
- Getting lost caused by inadequate training to use navigational equipment, loss of battery power for equipment, working with insufficient map coverage for the area, panic
- Stranding caused by transportation breakdown, communication breakdown, injuries, rising water levels due to weather, flash floods, getting lost
- Potential survival situation caused by injuries, transportation breakdown, wildfires, falling into water, breaking through ice, animal attack, getting lost, not following the emergency response plan (ERP)
- Security risks caused by the presence of local armed groups, potential for kidnapping Risk of being shot by hunters when traversing during hunting season
- Loss of property and/or injuries caused by forest and brush fires

PDAC 6.3 General Traversing Guidelines

Seek guidance when planning projects or traverses in new or unfamiliar terrain. Make inquiries with knowledgeable people who may provide tips about local conditions (e.g., experts, locals, logging companies, government officials). Use experienced exploration personnel to help plan or run a new project or exploration program. While manuals or guidelines may alert you to problems you may not have thought of, they are no alternative to having specialized and experienced help.

Consider hiring specialists or knowledgeable, experienced, local people to help plan and participate on traverses in hazardous or new terrain. This includes people with expertise in mountaineering, avalanches, glaciers, building ice roads, clearing jungle trails, and security staff (including trained bear guards). In some countries exploration and surveys may be carried out in highly populated areas with unique hazards such as complicated access problems or security issues. In these situations, employ a trusted local guide who can steer employees away from potential dangers (refer to Chapter 12. Travel Safety and Security).

Field Trips and Group Traverses

- When traversing from vehicles, make sure everyone in the party knows the planned route, the destination and the distance. Decide whether to hide the keys on or near the vehicle or have someone carry a second set.

- Everyone should know what equipment is required for the traverse. As a minimum, always take first aid and survival kits and water, as required.
- The party should proceed at a pace so that no single person or small group lags behind or forges ahead. This is especially important when traversing in remote areas or in countries where some participants are not familiar with the area, customs or language.
- See section 6.4.10 Working Along Roads, Highways and Railway Cuts for additional tips.

Permissions

- Obtain permits or permission from the authorities having jurisdiction (AHJs) to enter, cross or conduct surveys on the land, as required. The term “AHJ” includes governmental departments, mines inspectors, landowners, aboriginal groups etc. Give complete information to landowners and traditional land use groups regarding time, place and methods of transportation that will be used and whenever there are special plans (e.g., the use of helicopters, carrying out fixed wing geophysical surveys).
- Abide by the requests of landowners regarding the use of water, roads, stock gates etc.
- When securing permits to enter native or aboriginal areas, check for sacred sites and try to plan traverses that avoid crossing such sites. Refer to section 3. Archaeological & Cultural Sites in the Excellence in Environmental Stewardship Toolkit on the e3 Plus website: www.pdac.ca/e3plus

PDAC 6.3.1 Development of Safe Operating Procedures

Site specific safe operating procedures (SOPs) should be based on the observations and conclusions of risk assessments of the traverse areas. They should include but not be limited to the following measures:

- Compliance: Comply with the applicable jurisdictional regulations regarding working alone, wildlife, firearms, relevant transportation regulations, Mines Acts and Regulations as well as federal, provincial, territorial and municipal regulations. Obtain all required permissions and permits.
- Safe operating procedures: Develop SOPs that address site specific risks and hazards. These may include dangerous terrain such as cliffs, canyons, specific unstable ground, potential technical mountaineering with glaciers and avalanches, crossing water bodies, the use of vehicles or aircraft, firearms and dangerous wildlife, potential security risks, and the use of audio entertainment equipment.
- Emergency response plans: Develop site specific ERPs. Develop procedures that address potential injuries, wildlife encounters, survival issues and rescues, including evacuation from the most remote and difficult terrain in the traverse areas.
- Traverse in pairs using the “buddy system”. Traversing alone is not recommended. Follow all applicable regulations when traversing alone is permitted (see section 6.3.6 below and refer to section 2.1.1 Working Alone Versus the “Buddy System”).
- Planning traverse routes: Plan traversing routes carefully using the best possible maps, air photos and local knowledge. Plan routes that are safe – no route or sample is worth an accident. Take into account worker fitness, required emergency caches,

and potential support from helicopters, boats or ATVs to gain safe access to remote places.

- Equipment: Carry sufficient equipment, gear, and emergency supplies appropriate for the terrain, climate, and degree of risk. This includes good footwear, clothing, appropriate communication equipment, compass and maps, GPS unit, Personal Locator Beacon (PLB) as required, extra batteries, a personal survival kit, first aid kit, and enough food and water to cope with an emergency overnight stranding or injury.
- Tracking system: Develop a system to keep track of all employees including field crews on traverse. Record the following in a central location: all traverse routes, drop off and pick up points and their alternatives, estimated times of arrival and return, potential pick up locations for emergencies and other pertinent information. The whiteboard or maps with the tracking system must be accurate and updated throughout the day as changes are called in. When employees work out of an office or hotel, they should leave their route and estimated time of return with a responsible person who will know what to do if they do not return (e.g., supervisor, hotel manager, spouse).
- Communications: Set up and adhere to a communication schedule between the project, camp, or office and employees on traverse. Employees should notify the responsible contact person when they change plans, encounter problems such as a bear, or are delayed.

PDAC 6.3.2 Emergency Response Plans

Emergency response plans (ERPs) should include potential emergencies that may occur while traversing in the project area. Use the relevant sections below within section 6.4 Traversing in Specific Terrain to help identify risks and hazards to address in site specific ERPs. Refer to Chapter 3. Emergency Response for additional information.

- Plan ERPs that will best use company, contractor and government resources to provide medical care, evacuation and location of missing or overdue persons. Incorporate traversing ERPs into project, office and regional ERPs. Employees and personnel designated to assist during an emergency should be fully informed of the plans, receive relevant training, and demonstrate knowledge of how to implement them. Keep a copy of site ERPs in the district office as well as posting them at the project base. Test the plan to make sure all the contact numbers work.
- Each field party should have a written plan that includes what to do if crew members become separated, are injured or involved in an accident, face a survival situation, are late reporting in or are missing. While traversing, field partners should note potential hazards and discuss any potentially dangerous developments while en route.
- In very remote areas consider equipping employees with Personal Locator Beacons (PLBs) that tie in with government search and rescue operations. If they are carried, a protocol system must be set up with the government to avoid launching a full scale search when a charter aircraft can reach the person in distress (refer to Chapter 7. Knowing Your Location).
- Medical conditions: Inform your supervisor and co-workers about all allergies, medication requirements or adverse reactions you might experience and teach co-workers to recognize symptoms of any impending attack. Co-workers need to know

how to administer medication (e.g., insulin, epinephrine). Should an attack occur, you may be unable to administer medication to yourself. A stressful situation can trigger some symptoms such as diabetes or asthma. If you require a medical kit, keep it on your person at all times (e.g., EpiPen, insulin). Do not leave it in camp or a hotel room. If you regularly take prescription medication, keep a 3-day supply in your day pack in case you become stranded.

- Use the relevant sections below in 6.4 Traversing in Specific Terrain to help identify risks and hazards to address in site specific ERPs. Refer to Chapter 3. Emergency Response for additional information.

PDAC 6.3.3 Training for Safe Traversing

Employees should receive training to recognize, avoid and address local risks and hazards in the field area, as required. New employees to mineral exploration will be unaware of many of the risks and hazards they may encounter. They are not aware of what they don't know. Therefore, new employees should work with experienced employees familiar with the terrain, climate and altitude etc. Experienced exploration personnel who begin work in unfamiliar terrain should receive training relevant to the new terrain. Everyone needs the knowledge and equipment required to address emergencies.

Training should cover:

- Company and site specific SOPs regarding traversing
- Proficient use of all navigational, communication, emergency equipment and aids
- Risks and Hazards of the area, which may include hazardous terrain, hypothermia, hyperthermia, high altitude, dangerous wildlife, and weather-related hazards.
- Site transportation risks and hazards (aircraft, vehicles, ATVs, snowmobiles, boats, as appropriate)
- ERP procedures
- Appropriate survival strategies
- Special equipment required for field work (e.g., chainsaw, ice axe, crampons, ropes) Basic first aid, as required

PDAC 6.3.4 Day Pack Equipment

- When traversing, your life may depend on the contents of your day pack. Carry enough gear and equipment to communicate, establish your location and enough clothing and emergency supplies to survive an unexpected night or two in the worst weather conditions. Some items will be useful each day, but some items can be stored in the bottom or pockets of the pack for use when needed. Everyone has personal favourites in addition to the essential items.
- Choose a day pack made of strong fabric with strong zippers that will take wear and tear. The shoulder straps and waist belt should be wide and comfortable. Interior dividers and exterior pockets are helpful for storing frequently used items. A bright colour will increase visibility and a waterproof pack cover is essential in wet or snowy regions.
- Take weather extremes into account and make sure the equipment can stand up to these conditions (wind, rain, snow).

- The site safety induction meeting at the beginning of the season should cover what equipment is considered essential for traversing in terms of location and the (1) terrain, time of year and (3) distance from the project or camp.
- Each day, assess what will be needed in addition to the basic equipment, especially in terms of the terrain and if there will be air or ground support. You want take enough, yet avoid carrying such a heavy pack that you are more susceptible to having an accident.
- At cold work sites, keep all electronic gear inside many layers of clothing rather than in the pack. Use them sparingly and quickly and replace them inside your clothing.

Equipment for Traversing

Use the following lists to identify appropriate equipment for traversing. While experience is the best teacher regarding what to carry, it is important to be sensible and take sufficient but not too much equipment. Consider what is "essential" for finding location, communication, first aid and survival.

- Satellite phone, two-way radio or mobile/cell phone, as appropriate
- Maps and air photos
- Compass – Attach it to yourself so it won't get lost; verify the magnetic declination
- GPS unit
- Extra batteries for GPS, communication equipment
- Knife or Leatherman‖ type multi-tool – keep the knife blade very sharp
- Matches in waterproof container – in several places including in a pocket
- Lighter, additional fire making equipment
- 10-15 m paracord or light strong rope
- Emergency space blanket or light mountaineering tarp
- Small first aid kit – plus a 3-day supply of personal medications including epinephrine, as required
- Helicopter signal cloth – fluorescent orange
- Signal mirror Rain gear
- Extra warm clothing in waterproof bag
- Water (2 litres minimum)
- Sunscreen
- Hat(s) – for sun, cold
- Flares and flare gun – good ones
- Whistle
- Bug spray
- Mosquito head net and/or jacket (depending on region)
- Bear bangers and pepper spray, as appropriate
- Altimeter (for mountainous areas)
- Sunglasses
- Spare glasses – if you need them to read your map

- Water purification tablets and/or iodine (follow instructions carefully)
- High energy food packets (e.g., chocolate bars, dried fruit, nuts)
- Extra pair of socks
- Sample bags and sampling tools
- Axe or folding saw – mandatory if cutting helicopter pads or there is potential for remaining out overnight in wooded regions
- Toilet paper
- Small roll duct tape
- Wrist watch
- Personal Locator Beacon (PLB), as required

Extra items carried by some experts

- Large orange garbage bags (for tent, keep gear dry)
- Small first aid booklet, small survival booklet appropriate for the field area
- Solid fire starter cubes
- Wire saw – if knife does not have a saw feature
- Metal cup – can boil water, soup cubes, tea bags
- Flashlight or head lamp and extra batteries and bulb
- Light sticks
- Fishing line and hook
- Water treatment filter
- Length of plastic tubing for a siphon
- Lip balm
- High visibility clothing when there are hunters in the area
- Firearm (only with proper firearms certification) when working in high risk areas (e.g., polar bear country)
- Lightweight mountaineering/climbing tarp for emergency shelter
- Walking stick
- Bar of soap in a container

Small First Aid Kit

All first aid kits should meet required government regulations (e.g., regional Workers' Compensation Board specifications in Canada) rather than the arbitrary list of some private supply company. If necessary, supplement with:

- 6 sterile wound cleansing towelettes in individual packets
- 6 or more waterproof adhesive dressings in assorted sizes
- 1 pressure bandage – especially if chainsaw work is done
- A few large dressings
- Triangular bandage Roll of tape
- Ace bandage (crepe, elastic)

- Several pre-packaged tablets of Advil or aspirin for pain, antihistamine for insect bites or stings
- 1 wallet sized instruction card with emergency contact numbers
- Small first aid booklet

PDAC 6.3.5 Clothing

Choose your field clothing carefully. The most suitable clothing for fieldwork depends on climate conditions and terrain; it should be durable and good quality. Clothing should suit the type of activity – continuous or intermittent activity level, snowmobiling, working on water etc.

Clothing should meet certain criteria:

- Comfort: Avoid clothes that constrict freedom of movement. Loose clothing is cooler than tight clothing in hot temperatures. Wear layers that are loose enough to allow air to be entrapped for greater insulation from cold temperatures. Remove layers as necessary to control sweating.
- Safety: Clothing should provide protection from various environmental hazards (e.g., heat, cold, rain, snow, wind, UV radiation, insects).
  - Wear high visibility clothing while traversing. This will help to locate you if necessary. In addition, some wild animals may be less likely to attack. Wear a “hunter orange” hat and vest during open hunting season. (Consider postponing field work during open hunting season.) Reflecting safety vests are required when working around heavy equipment.
  - Items should never be so loose or frayed that they could catch in machinery or on vegetation.
- Survival: Dress appropriately (in layers) to protect yourself from exposure to weather conditions (e.g., deserts, high altitude, tropics or the Arctic). Always take extra clothing on traverses so an unexpected stranding will only be an uncomfortable rather than a life- threatening situation. In a crisis, your chances of survival diminish when you have inadequate clothing.
- Minimize water accumulation in clothing from sweat, rain or snow. Innermost layers should wick moisture away from the skin surface. The ideal outer layer should be permeable enough to allow sweat to evaporate from the outer surface; it should be windproof and waterproof enough to prevent rain or snow from penetrating.
- Rain gear should be suitable for the temperature and humidity where you work. Ask experienced workers for recommendations for the area. Water-resistant gear is inadequate, especially when you are working hard and sweating. Inadequate rain gear may advance the development of hypothermia. The pieces of rain gear should overlap sufficiently so rain does not leak into your remaining clothing. Always take rain gear if there is even a remote chance of rain and put it on before you get wet.
  - Ideally, rain gear should be made of waterproof, windproof, breathable fabric. “Waterproof breathable” fabrics (see below) are designed to allow sweat to evaporate and pass through the fabric, yet keep rain from penetrating the fabric and getting your regular clothing wet. This rain gear functions adequately as long as the outside vapor pressure (humidity, rain) does not exceed the internal vapor pressure (your evaporating sweat). It won’t keep out heavy rain. When worn in

temperatures below freezing, sweat may freeze on the inside when the vapor meets the cold external surface of the rain gear.

- Coated nylon rain gear is non-breathable. It keeps water out but keeps your sweat inside unless there are well placed mesh panels that allow sweat to escape. Often, panels on the back of a rain jacket will be blocked by your day pack.

● Fibre content: Consider the fibre content when selecting clothing and choose what is comfortable for the work environment. Fibres have various characteristic properties.
  - Wool retains warmth even when it is wet (but it is heavy when wet). Wool provides very good insulation and dries relatively quickly. Look for products with fine woollen fibres such as merino.
  - Polyester polar fleece and microfiber provide excellent insulation and they dry quickly. Outer wear and underwear made of these fibres come in several weights for various weather and temperature conditions.
  - Down provides good insulation and warmth only when it is dry. Once down is wet, it mats easily and loses most of its insulation value.
  - Cotton is an excellent fibre for warm and humid conditions as it absorbs sweat and allows evaporation at a slow enough rate to make you feel cool. Cotton clothing is a poor choice for cold and/or rainy conditions as it does not retain insulating properties when wet. Avoid cotton jeans and cotton long underwear when working in cold and/or wet conditions because they dry slowly.
  - Synthetic blends: Consider choosing work clothes made of a tightly woven fabric with a combination of about 65% polyester and 35% cotton. This fibre combination functions well in many climatic conditions because it dries quickly and resists abrasion. It is especially good in cool, wet conditions. Some types of sports clothing made of synthetic blends are considered more comfortable than cotton in hot climates.
  - “Waterproof breathable” fabrics (e.g., Gore-Tex, eVent) are constructed of laminated fabric layers with tiny holes that ideally are large enough to permit evaporated sweat to pass through the fabric yet too small to permit rain to pass through and make you wet.
  - PVC (polyvinyl chloride) coated fabrics are waterproof and have no moisture transfer properties (non-breathable). Polyurethane coated fabrics do not stand up to body oils or wear as well as PVC coatings.
● Footwear: Boots should suit the climate, the terrain and the required work. Boots should provide good ankle and foot support for working in rough terrain. Ask experienced employees if you need advice. Follow the manufacturer’s suggested care routine, although sometimes local knowledge is more useful (i.e., in some circumstances boots dry faster when they are not waterproofed).
● Backpacking boots are comfortable when carrying heavy loads on rough terrain. They offer good foot and ankle support.
● Mountaineering boots are higher and stiffer than backpacking boots and provide better support to help prevent slips on rock, ice and snow. They are designed to be worn with crampons, as required. They are insulated and may be made of leather or plastics; some are double insulated with removable liners.

- Arctic cold weather boots should be waterproof with rubber, leather or Cordura uppers. They should be worn with felt liners (some have a thermal layer).
- Gaiters: Consider wearing gaiters, especially in mountains and in deep snow. They keep your feet dry much longer, prevent stones, soil and snow from getting into boots and protect loose pant cuffs from fraying. Gaiters that come up to the knees help keep your legs dry in wet areas (e.g., alpine grassy meadows, thick moss such as that found in BC and Chile, areas of permafrost, frost boils or liquid mud). Wearing gaiters may help prevent snakebite.
- Caulked boots have nails in the soles for traction on wet logs. They may be leather or rubber and may be suitable when working in wet, slash forested areas.
- Rubber boots should keep your feet dry when you are working in wet conditions, but they offer little foot support and are sweaty.

Cold Weather Clothing Tips

Try not to work up a sweat, as it will make your clothes wet and then it is easier to get chilled. In his article Cold Weather Clothing, Dr. Gordon Giesbrecht stresses the importance of choosing the correct clothing for cold weather.

- Clothing layers should function well together. Wear layers you can loosen and take off easily when you become warm.
- Inner layer: This layer should wick water away from your skin when you sweat. Polyester is recommended.
- Middle layer(s): These layers should be designed to keep you warm. Several thin layers of wool and/or polyester fleece are recommended rather than one thick layer. Remove one or more layers at a time to help control body temperature.
- Outer layer: This layer needs to be wind and waterproof, but permeable, so Gore-Tex, eVent, Cordura and similar fabrics are recommended. Water vapor must be able to escape. If you sweat and remain damp you will get chilled, which can lead to hypothermia.
  - In Arctic winter conditions, wear a loose-fitting, Arctic rated, long, down or fibre-fill parka or anorak with a deep hood, mitts, insulated pants and very warm insulated boots.
  - Protect your head, which is very vulnerable and can lose up to 30% of all body heat when exposed to cold. Wear a good warm hat (wool or fur recommended). Wear a hard hat liner when a hard hat is required.
  - Protect your hands with gloves, preferably several layers. The inner most layer can be thin fleece or polyester so you can do delicate jobs such as writing, phoning, or taking compass or instrument readings without removing them. The outer layer should be windproof or waterproof mitts with extra insulation. It is handy to have a patch of fleece on the back of the outer mitt to use to wipe your nose. Carry spare gloves in your pack.
  - Protect your feet by wearing dry layered socks; wear wicking polyester inner socks and thick warm wool outer socks. Carry extra in your pack. Wear boots with removable insulated liners suitable for cold and/or wet weather. Have spare insoles and liners to use on alternate days so they dry out completely.

- Keep clothes clean to preserve their insulating features. Brush off snow and frost before entering a warm building to help keep clothing dry. Hang them to dry after work.
- Protection from UV radiation: Protect eyes by wearing dark sunglasses or goggles with UV protection and nose pieces, especially when working on reflecting snow surfaces.

- Information about clothing suitable for cold conditions is available at the following websites:
  - http://www.umanitoba.ca/faculties/physed/research/people/giesbrecht/Cold_Weather_Clo thing.pdf
  - http://www.ccohs.ca/oshanswers/phys_agents/cold_working.html

Look for the following features when buying cold weather clothing:

- Zippers that can be opened while wearing mitts
- Armpit zippers for ventilation
- High collar and a good insulating hood (fur trimmed is good in very cold regions)
- Big pockets with horizontal openings – you can put lots in them and items are less likely to fall out, especially when they have Velcro closings
- Sleeves with elastic cuffs inside the sleeve to prevent cold air blowing up your arms Long jackets to keep your trunk area warm
- Balaclava or face mask with high insulating qualities

PDAC 6.3.6 Traversing Alone Versus the Buddy System

In Canada, most exploration projects are classified as mine sites by provincial and territorial Mines Safety Acts and Regulations. These regulations usually prohibit employees working alone unless there is a written system in place that includes safe operating procedures (SOPs) to ensure the health and safety of workers when they work alone or in isolation (refer to section 2.1.1 Working Alone Versus the “Buddy System”).

The PDAC Health and Safety Committee recommends against mineral exploration companies permitting employees to work alone in the bush. It is best practice to traverse in pairs as it is always safer.

When traversing with a partner:

- Remain in sight of each other in high risk areas, which includes very rough terrain or where wildlife is perceived as a major threat.
- When working in low risk areas at some distance from each other, partners should make radio or visual contact at regular intervals. The maximum distance and the frequency of required contact will vary depending on terrain, vegetation density, weather and wildlife risks etc.
- Do not share essential equipment. Each partner should be fully equipped with up-to-date maps and air photos, a compass, a GPS, two-way radio or sat phone, extra batteries, survival kit, and signal devices – and know how to use them properly.
- When one worker is more experienced than the other, the junior worker should be learning as he or she traverses, not just accompanying the senior.

Although the PDAC Health and Safety Committee strongly encourages using the “buddy system” for fieldwork, situations may arise when employees are asked to work alone. Employees should be aware of their right to refuse to work in situations where they feel unsafe, or when they feel inadequately trained to perform a task safely (refer to section 1.2.1.2 Right to Refuse Unsafe Work).

If an employee agrees to work alone:

- Carefully follow the relevant guidelines in section 6.3.1 and written company SOPs regarding working alone.
- Tracking your location: Someone with authority and ability to organize help should know where you plan to work and when you will return. Give them a map with the route information. Depending on the circumstances, the person could be your co-worker, supervisor, or even a hotel manager.
- Establish check-in times and stick to them. Call the contact person when you change plans and when you return. Take appropriate, dependable and functioning communication equipment (satellite phone, two-way radio, or mobile/cell phone) and spare batteries. A company should consider requiring a satellite phone for any employee who works alone in a remote area.
- Carry a written copy of the ERP. Always carry appropriate and sufficient survival and first aid equipment in the field. Have an up-to-date first aid certificate. Be prepared and know what to do should you become lost or injured.
- When working from a vehicle, leave a copy of a grid or sketch or map and the proposed route in the vehicle. Leave a note specifying any changes in plans.
- Periodically check the vehicle safety equipment (e.g., first aid and survival kits, fire extinguishers).
- When contractors are working alone in the field, they should be assigned a contact person.

PDAC 6.3.7 Traverse Planning Tips

Careful planning makes traversing safer and more productive. Critical planning issues include but are not limited to the following topics:

- Be aware of specific hazards that will vary each day when planning the route, the drop off and pick up points and alternates. Avoid impassable terrain and potentially very hazardous areas.
- Develop a check-out routine to use before field parties leave camp. Verify that each crew member has recorded (1) the planned traverse route, (2) the drop off and pick up points, the estimated time of return, and (4) has put all their essential gear and supplies in their day pack.
- Be prepared for changing conditions that may impact your progress on traverse, such as lightning storms, inversion or ice fog layers in mountains, descending cloud cover, strong winds and heavy or torrential rains, snow squalls, whiteouts, rapid temperature changes. These may limit visibility and affect your ability to establish your location and/or the time and place of a scheduled pick up.
- Plan easier traverses early in the season. Plan difficult traverses for a time when people are in the best physical condition and the weather conditions are most suitable.

Try to schedule difficult traverses for times when extra crew, a helicopter, or other support will be available.

- Plan to complete traverses in daylight and allow plenty of time to return to camp before dark. Be careful late in the day when you are tired and feeling less agile. Many slips, trips and falls occur at this time.
- When planning a long traverse, have a backup plan in case it cannot be completed.
- Consider altering the normal daily routine to take best advantage of the most comfortable working conditions.
- Allow extra time for traverses in bad weather or through rough areas (e.g., dense brush, slash areas, old burned areas, jungle, boulder terrain). Haste often results in injury.
- Plan for places where emergency caches can be placed and where emergency response pick ups and drop offs can be made.
- Take time to acclimatize before beginning heavy field work when you are flying from temperate conditions to work in places of extreme altitude, heat or cold (refer to Chapter 9. Weather and Environmental Risks).

PDAC 6.3.8 Tips for Knowing Your Location

Know how to use maps, a compass and a GPS unit and keep track of your location at all times. If you get lost or disoriented, it is unsettling and can be very dangerous if you panic. Stop whenever there is any doubt about where you are and backtrack as necessary to confirm your location.

- Be competent using a compass and equip yourself with good maps, air photos, a GPS and extra batteries and carry them at all times. Do not rely solely on a GPS unit.
- Verify the local declination setting on your compass. Magnetic declination changes from year to year and the correct declination is unlikely to match the number on your map. In places, a compass may be of little use depending on the latitude and longitude of the project.
- GPS units: The readings may not be reliable when you traverse (1) through heavy foliage, (2) at very high latitudes where satellite coverage may be limited, (3) in steep terrain where the vertical component may not be reliable, and (4) when batteries are flat.
- Each field employee is responsible for keeping accurate account of his or her location while traversing. Use several methods when necessary to keep track – pacing, compass sightings as well as GPS waypoints.
- If possible, fly the route before beginning the traverse. Confirm the drop off, pick up and alternate pick up points with the pilot. Look out for wildlife (bears) and other potential hazards (cliffs, deep or rough water). Remember that (1) the topography looks flatter from the air than it actually is and (2) bears may be present whether or not you see them from the air. Be vigilant in bear country.
- At the drop off point make sure you know exactly where you are before the transportation departs.
- Estimate the time, distance, and altitude to be covered and decide on a “go – no go” point. If you have not reached this point by a specific time, it may be better to return

rather than continue and not reach the pick up point by the designated time or by nightfall. Notify your transportation and check-in contact about the change in plans.

- Keep track of "time vs. distance", as it is easy to lose track of time while crossing difficult terrain, sampling or examining outcrops. Keep track of time to accurately estimate your arrival time at the pick up point or notify your transportation that you are behind schedule.
- Do not confine your eyes to the ground. Remember to look up and around, noting landmarks etc. Make plenty of noise, especially in areas where wildlife might be a threat when surprised by your presence (e.g., along creeks).
- If you must return along the same route, mark the route adequately (flagging tape, blazes) so it is visible from multiple directions. Use a method that is legal and causes the least environmental impact.
- Pacing: Practice pacing skills where there is a chance to verify the distance, such as along survey lines. Learn how to adjust your pacing count for changes in terrain (e.g., dense underbrush, swamps, steep slopes).
- When traversing in an area where others will follow (i.e., grid) leave two flags or flagging tape to identify a local hazard (e.g., bees' nest, hole, dangerous flora). This will alert them to the presence of a hazard.
- Keep track of your location as you progress on traverse. STOP if you become disoriented and backtrack as necessary to relocate yourself. STOP if you become truly lost.
- For information about navigation equipment refer to Chapter 7. Knowing Your Location.

PDAC 6.3.9 Communication and Signaling Tips

- Before leaving camp each day, check that your communication equipment is functioning correctly, is fully charged and you have fully charged spare batteries.
- Satellite telephones: In remote areas it may be advisable to be equipped with satellite telephones. Everyone should be trained to use the sat phones as they require certain procedures. Post directions and a list of emergency contact numbers in a central place. Carry the instructions for use with the sat phone.
- In less remote areas, carry two-way radios, mobile/cell phones or a satellite phone – whatever gives appropriate coverage. When using a two-way HF radio to communicate with a pilot, make sure that the radio has the correct aircraft frequencies. Make sure there are an adequate number of two-way radios for field crews.
- Program all the contact numbers you may possibly require into satellite phones or cell phones before leaving camp. When using two-way radios, confirm which channel everyone is using.
- Confirm your drop off and pick up points on a map with the pilot or driver. Before commencing a traverse, identify the GPS co-ordinates of pre-selected pick up points with them. Several methods of communication may be necessary (two-way radios, HF radio, sat phone).
- When you are dropped off by air support, make radio contact with the pilot to confirm that your radio equipment functions correctly. This will require the pilot to tune the aircraft radio to your radio's frequency so do the frequency check prior to take off.

- The planned drop off point may have to be changed due to conditions. Make sure any changes are communicated to camp and not just to the particular pilot or driver who dropped you off.
- Follow a systematic call in schedule with your field partner and camp. Inform the camp and your partner if you encounter problems or change plans. Then you will learn if there has been a change in plans for your pick up transportation.
- Carry extra signalling devices in addition to electronic devices (e.g., flares, mirror, whistle, fluorescent helicopter cloth).
- Communicating or signalling your ground position to a pilot: It is very difficult for the pilot to see people on the ground waiting for a helicopter pick up when they are in shadow, in dark brush, in mist, rain, and in low light conditions etc. To attract a pilot's attention, especially when you are not at the designated pick up spot:
- Use the compass mirror to flash a signal to a pilot when the aircraft is in the right position and there is sun.
- Move and wave bright clothing or fluorescent signal cloth. Tie several signal cloths together for a larger visual target. RUN and MOVE the cloth around as it is much easier to spot a moving object than a stationary one.
- Flares work when correctly used, but the pilot will not see a flare that is fired behind the aircraft.
- For more information regarding communication equipment, refer to Chapter 19. Communications.

PDAC 6.3.10 Emergency and Survival Tips

The successful outcome of an emergency or survival situation greatly depends on prior training, knowledge and preparation. Each day, consider the contents of your day pack and survival kit in terms of how and where you will traverse. Terrain and means of transportation may vary from day to day. Ultimately, you are responsible for your own safety and survival so be as self reliant as possible.

- Equipment: Carry your survival kit, first aid kit, signalling devices, and extra food, water and clothing at all times – whatever is required should you become stranded. Be prepared even when it will only be a short traverse or a short job at a work site near camp; conditions may change or your transportation may fail to arrive. Keep your pack with you at all times.
- Where changing weather or other factors may prevent a pick up (e.g., Arctic barrens, mountains, glaciers), set out an emergency cache(s) that contain sleeping bags, a small gas cylinder and stove burner, tent, water and emergency food rations in a convenient location – preferably at the pick up point. In some areas it may be advisable to include a sat phone with the cache. Place items in animal proof and waterproof containers.
- Plan what action to take if the weather closes in and air support cannot return. Consider the factors of hypothermia, hyperthermia and traversing risks if you try to return to camp without transportation. In most situations it is far safer to stay put. Do not risk getting lost or crossing barriers that you would not ordinarily cross (e.g., rivers, streams, cliffs).

- Keep up your safety awareness as you traverse each day. Watch for suitable sites for emergency shelter, developing storms, safe trees to climb or safe routes to avoid threatening wildlife.
- Pay attention and be aware when risks and problems are adding up. Stop and assess the situation. Emergencies and accidents are frequently the culmination of a series of small predicaments or minor incidents.
- If you become lost in bad weather, stop and carefully consider the alternatives. It may be advisable to seek shelter when you have sufficient supplies rather than attempt a descent to below cloud level.
- In the event of a vehicle breakdown, leave a clear explanatory message (windproof and waterproof) with the vehicle if it is necessary to leave the site. This may avert a full-scale search for you. Remember, it is usually best to remain with the vehicle.
- Carry a whistle. The sound travels farther than your voice. Refer to Chapter 8. Survival for additional information.

PDAC 6.4 Traversing in Specific Terrain

Competency, Training and Local Information

Exploration personnel who are skilled and competent working in one specific terrain are not automatically competent when working in another terrain. When beginning work in a new terrain, employees should receive sufficient training to do the work safely. Training should cover the risks and hazards in the project area and best practices for the terrain. Working below tree line in the Canadian Shield is very different from working in the Arctic barren lands. Conditions in the BC coastal mountains are very different from those in the Rocky Mountains or the Andes. When planning work in equatorial or desert areas, employees should have appropriate training and the company should hire local experts to help. Conversely, when a company hires employees from another country to work in Canada, they are obligated to train them so they can work safely in Canadian wilderness field conditions. It can be dangerous when employees are not aware of what they don't know regarding local risks and hazards. This is particularly true for new employees and anyone who is new to a project area.

PDAC 6.4.1 Mountainous Terrain

Risks and Hazards

Specific risks and hazards of traversing in mountainous terrain include but are not limited to:

- Slips, trips and falls caused by inadequate footwear, carrying heavy packs, rough steep ground and slippery surfaces
- Stranding caused by inclement weather (fog, rain, snow, whiteouts, lightning, flash floods), transportation breakdown, rising water levels
- High altitude health risks caused by lack of acclimatization, dehydration, hypothermia, frostbite, hyperthermia, sunburn
- Health risks caused by hypothermia, and waterborne, insect-borne or other potential diseases (e.g., Giardia, malaria)
- Helicopter accidents caused by bad weather, pilot fatigue, lack of training to carry out hazardous manoeuvres such as toe-in pick ups, overloading

- Vehicle accidents caused by difficult driving conditions on winding mountain roads, inclement weather, lack of training for the vehicle and/or driving conditions
- Off-road vehicle accidents caused by difficult off-road driving conditions (e.g., high risk of getting stuck, rollover), lack of training for the terrain

Prevention and Preparation

Mountainous terrain varies from forests and alpine glaciers to hot, humid jungles to barren deserts. If you work in mountainous areas, be thoroughly prepared for the climate, topography, wildlife and for potential isolation. Mountainous terrain is inherently more risky than flat terrain and reading instructions in a manual is not a substitute for training and experience.

When a project is located in particularly risky mountainous terrain, the company should seriously consider hiring experienced mountaineering experts (e.g., high altitude, very steep terrain, snowfields and glaciers, avalanches, rock slides). The experts should work with field crews either to train staff or on a continuous basis. Avalanche risk assessment and crevasse rescue are highly specialized tasks and require advanced level training and expertise.

- Develop and follow SOPs for working in mountainous terrain. It is especially important to traverse in pairs.
- Weather: Develop a thorough understanding of the weather patterns in the area. Local people or the weather office may be a useful source of information about when to expect sudden storms and the signs to watch for.
- Be aware of how marginal weather conditions increase the dangers of traversing. For example, clouds or fog may obscure cliffs, crevasses or avalanche slopes and you may not be aware of them until it is too late. Also, it is easy to lose direction or get confused when you encounter low clouds or heavy weather. Use your maps/air photos, compass and GPS.
- Clothing: Wear appropriate clothing to address mountain weather conditions – sun, wind, rain and snow. Carry good rain gear and extra items for warmth; nights are cool at altitude even in equatorial regions. Boots should be very high quality, well maintained and provide excellent ankle support. Wear gaiters for additional protection. Wear a hat with a wide brim when it is sunny and carry a warm hat for cold days.
- Survival: Always carry extra clothing and survival gear. In some areas, bad weather might strand you for days. In an emergency situation, extra clothing may make the difference between discomfort and disaster. Keep essentials in your pockets and never become separated from your day pack. Be trained in appropriate survival techniques (refer to Chapter 8. Survival).
- Training and equipment: Be prepared with good quality equipment that meets the needs of the terrain, flora, fauna and weather. Know how to recognize and avoid dangers that may include crevasses, ice cliffs, hanging glaciers, avalanche chutes, cornices, whiteouts and rock falls. See section 6.4.2 below.
- Health risks: Have a thorough understanding of hypothermia, hyperthermia and altitude illness. Become acclimatized; this may save your life.
  - Refer to section 9.9 Cold Injuries
  - Refer to section 9.10 Heat Illnesses and Solar Injuries
  - Refer to section 9.11 Altitude Illness

- Carry and consume plenty of food and water throughout the day. Dehydration is a serious risk at high altitude and you need to be well hydrated and well fed to think clearly, especially in an emergency situation. Dehydration contributes to the advance of hypothermia, hyperthermia and altitude illness. Eat frequent small meals and avoid alcoholic beverages.

Mountain Traversing Tips

- Develop detailed emergency response plans for search and rescue. Learn survival skills appropriate for the region. Weather may strand a crew for days.
- Try to maintain established communication schedules with the camp, project and office.
- Always leave detailed traverse route information and notify them of any changes. Weather and topography may interfere with communications.
- Always carry good maps of the work area and the adjacent areas. Carry an altimeter; a GPS may be unreliable in steep ground.
- Be aware of the habitats of any dangerous wildlife. Carry bear spray, as required. Refer to section 10.3 Bears.
- Choose traverse routes appropriate to the skill and fitness level of the field crew.
- Continuously assess the route as you progress so you do not get into a difficult and perhaps life-threatening situation.
- Avoid walking above cliffs on snow covered terrain where a fall can send you sliding over the edge. Do not glissade down snow slopes; if you lose control you may be injured.
- Avoid impassable areas. This includes cliffs, fast-moving cold water streams, deep water bodies, new beaver ponds, swamps, muskeg of unknown depth etc.
- Be wary of narrow ridges, especially when they have snow, as there may be cornices (overhanging snow and ice) that appear solid but are, in fact, unsupported and may collapse.
- It can be difficult and dangerous when traversing above timberline in fog or bad weather. Dangerous terrain such as cliffs below your route or avalanche slopes may be obscured.
- Glacial polish can be very slippery, especially where wet vegetation meets the rock surface.
- Steep slopes:
  - They are more difficult to climb down than climb up.
  - They seem less steep when viewed from above, which includes viewed from an aircraft.
  - If it is necessary to set aside your clipboard and hammer to climb and obtain a sample, the slope is probably too steep. Reassess the goal.
  - Do not descend a convex slope where you cannot see the bottom.
  - Gullies: In mountainous areas, gullies may appear to be the easiest access route up or down a slope. When traversing gullies, be aware of the hazards of loose rock, rock falling from above, unstable sides, and sudden changes in the degree of

slope. They may end in a cliff or cornice and/or they may be particularly dangerous to descend.

- Helicopters are frequently used to aid field work in mountainous areas. Know helicopter safety procedures. Locate yourself precisely on your map and never leave the aircraft without your day pack and survival kit, as something may happen to prevent it from returning as planned. Refer to Chapter 16. Aircraft.
- Be aware of potential changes in stream levels. A hot sunny day can create enough glacial runoff to change a small stream into a deluge of meltwater. Also, tropical storms may cause rapidly rising stream levels or mudflows in a very short time. Know how to address the hazards of local streams and rivers (refer to Chapter 9. Weather and Environmental Risks.)

Refer to Chapter 5.7.1 Arctic and Alpine Terrains in the Environmental Stewardship Toolkit to learn how to reduce the impact mineral exploration, including traversing, in this terrain. 3 Plus website: www.pdac.ca/e3plus

PDAC 6.4.2 Snowfields and Glacier Terrain

Risks and Hazards

Specific risks and hazards when working in snowfields or glacier terrain include but are not limited to:

- Slips, trips and falls caused by ice or wet, slippery surfaces, inadequate footwear and equipment (crampons, ice axe, ropes), crevasses, slopes of snow that may turn into ice, streams on glacier surfaces, glissading down slopes and going out of control
- Injuries or death caused by avalanches, cornice collapse, rock falls, ice falls
- Health risks: acute mountain sickness, hypothermia, sunburn, and snow blindness caused by high altitude, cold wet conditions, exposure to ultra violet light
- Stranding (potential survival situation) caused by transportation breakdown, communication breakdown (loss of battery power), injuries, inclement weather (fog, whiteouts, rain, snow)
- Attack by bears (they may den in moraines and snow holes)
- Helicopter accidents caused by bad weather, pilot fatigue, overloading, lack of training to carry out hazardous manoeuvres such as toe-in pick ups

Prevention and Preparation

- Consider hiring mountaineering experts with special glacial and avalanche expertise to train and work with field crews. Avalanche risk assessment and crevasse rescue are highly specialized tasks and require special training.
- Develop and follow SOPs for traversing on glacier and/or snowfield terrain.
- Clothing: It is often cold, foggy and wet for days at a time. Be prepared with gloves, good rain gear and lots of extra warm, dry clothing each day. Carry extra gloves and socks.
- Suitable footwear: Take two pairs of boots to use on alternate days so one pair can dry out. Otherwise take extra liners. If possible, wear double boots with liners as they are warmer.

- Special training and equipment: Be trained and only use proper procedures; do not use shortcuts.
  - Glaciers: Be trained in safe techniques, including crevasse rescue, and how to correctly use necessary equipment.
  - Equipment: Climbing ropes and harnesses, ice axes and crampons etc., are required. Climbing ropes should not be used for other purposes and crampons must fit properly.
  - Avalanches: Be fully trained and equipped when working where avalanches may be a hazard. Know how to recognize terrain, weather and snow conditions that produce avalanches. Wear and use specially designed avalanche transceiver beacons, and take probes and avalanche shovels when there is any danger of avalanche.
- Health risks: The risks are the same as in section 6.4.1 Mountainous Terrain, but pay extra attention to (1) hypothermia and frostbite, (2) protecting your skin from sunburn and eyes from snow blindness due to reflection of UV radiation on snow, and (3) acclimatizing to the altitude, as required. Wear polarizing sunglasses and apply sunscreen frequently with at least SPF 30 no matter what the temperature.
- Camp location: Do not set up camp in the path of a potential avalanche or a glacial outburst flood – water release from a lake contained by a glacier, a sub-glacial lake or the failure of a terminal moraine. (Refer to sections 9.4 Avalanches and 9.5 Floods.)

Tips for Traversing or Working on Snowfields

- Carry an ice axe and learn the correct technique to arrest yourself if you fall. A rock hammer is not a substitute. On steep hard snow, falls can often be arrested only with an ice axe. If a snow slope turns into ice, self arrest may be very difficult or impossible.
- Know how the quality of snow surfaces varies during the day. The surface may be icy and treacherous in the morning yet be too soft to support you in the afternoon.
- A patch of snow may cover a pool of icy water with ice at the bottom, especially early in the season.
- Maintain an upright position when walking across snow covered slopes; if you lean into the slope your feet may slip outwards and you may fall.
- Do not cross a snowfield where a slip will send you sliding into rocks or over a cliff.
- Beware of slopes that increase in angle as you descend (convex slopes). Be able to see to the bottom to make sure you are not going to end at a cliff.
- Keep track of your location. It is easy to move from a snowfield to a snow covered glacier without realizing it.
- Do not travel during whiteouts and use extra caution during flat light conditions (refer to section 9.3 Whiteouts).
- Icefalls: Keep away from areas beneath ice cliffs and hanging glaciers, especially where there is recently fallen debris. Danger from falling ice is generally least early in the day and greatest during the afternoon and evening, when it is raining, or after weather warms rapidly.
- Cornices: Avoid cornices as they often collapse. Be very cautions when approaching a ridge line and travel well back from the edge. Cornices are easily seen from the

leeward side, but from the windward side it is difficult to identify where they begin. Do not travel below a cornice. Look for fracture lines and other signs of cornice instability. Cornices may collapse without warning and can carry people down a slope in an avalanche.

Tips for Working on Glaciers

- Field parties should always rope up when crossing snow covered glaciers. Turn back if the least experienced and least skilled person feels uncomfortable or if there is any doubt about someone's ability to handle the terrain.
- Be trained in crevasse rescue techniques.
- Crevasses may be completely covered by snow, especially early in the season; they may appear as a narrow crack at the surface but widen beneath the snow surface.
- Never cross streams flowing on the surface of a glacier. The icy stream bottoms are extremely slippery and you will not be able to recover your footing if you fall. These streams often disappear into crevasses.
- Ablation line on flat glaciers: By afternoon, melting may result in up to a metre of icy, cold, slushy water on the glacier surface that covers extremely slippery blue ice. It is very dangerous to cross.
- Glacial moraines are inherently unstable and are very slippery, especially those that are ice covered or without vegetation. Watch your footing and use caution, as boulders may be loose and easy to dislodge.

PDAC 6.4.3 High Arctic Latitudes

Risks and Hazards

Specific risks and hazards when working at high Arctic latitudes include but are not limited to:

- Weather-related risks: hypothermia, frostbite caused by inclement weather (nearly constant winds, snow any time, unexpected storms including blizzards in summer); generally cold working conditions; inadequate clothing and/or equipment; sunburn, snow blindness caused by exposure to UV light especially when ground is snow covered
- Slips, trips and falls caused by inadequate footwear, rough terrain, boulder fields Getting lost (potential survival situation) caused by difficult navigation challenges (compass), loss of battery power for GPS unit
- Cold water immersion hypothermia caused by falling into water or breaking through ice
- Dehydration caused by inadequate fluid intake, lack of training
- Stranding (potential survival situation) caused by transportation breakdown, loss of battery power for communication and/or navigation equipment, injury
- Transportation risks (aircraft, ATVs, snowmobiles, boats) caused by navigation challenges, mechanical breakdown, cold temperatures
- Risk of injury or death caused by polar bears or barren land grizzlies
- Survival situation caused by injuries or transportation breakdown combined with bad weather, inadequate clothing and equipment, lack of survival cache, or getting separated from your day pack, communication breakdown (loss of battery power)

Prevention and Preparation

- Develop and follow appropriate traversing SOPs. Keeping track of your location and bad weather are usually the most significant problems at high latitudes.
- Location: Equip yourself with good maps, air photos, a compass, a GPS and extra batteries and carry them at all times. Depending on the project location in relation to the magnetic north pole, your compass may be of little use. In addition, it is very difficult to determine your location on nearly featureless terrain.
- Communication: Communicate carefully before starting a traverse and identify and confirm the GPS coordinates of your drop off and pick up points with the pilot. Several methods of communication may be necessary. Always carry extra signalling devices (flares, mirror, and helicopter cloth). It may be very difficult for a pilot to locate you so RUN and MOVE the fluorescent helicopter cloth to make a better visual target.
- Wind: Most areas at high latitudes are cold deserts where wind is a serious problem. Wind can cause dehydration so drink plenty of water throughout the day. Make sure to select equipment that is rugged enough to withstand constant winds for the entire field season.
- Hypothermia: Take all precautions to avoid hypothermia, a major risk in high latitudes. Conditions are often windy with the temperature near freezing. This is especially true in the Arctic Islands. Wear sufficient clothing and stay warm, dry, hydrated, and well fed (refer to section 9.9 Cold Injuries).
- Survival: Due to extremely harsh climatic conditions, always be fully prepared with various survival kits. Everyone traversing needs to take a personal survival kit in their day pack. Big survival caches should contain a tent, radio, a small gas cylinder and stove burner attachment, food, chemical heat packs and sleeping bags. In some circumstances it may be wise to place several survival caches in strategic locations, such at the middle and the end of a traverse. Everyone must know the precise GPS coordinates of all the caches in order to locate a cache in an emergency. This is very difficult in foggy or snowy conditions or when it is dark and everything looks the same. Caches must be bear proof, rodent proof and as visible as possible.
- Ice: When working on ice, each team should carry a waterproof hypothermia kit. The kit should include chemical hot packs, floating throw-rope packet, spare clothes, sleeping bag, food and drink mixes and a small gas cylinder and stove burner attachment. This type stove is recommended because it lightweight and has no fuel to spill (refer to sections 15.4 Equipment Lists for Snowmobiles and 15.10 Working on Ice).
- Where polar bears or barren land grizzlies are a hazard:
  - It is advisable to hire locals to work as trained bear guards to protect the camp or project site and traversing employees, especially in polar bear country.
  - Follow wildlife regulations, company SOPs, good camp management guidelines and provide employees with bear safety training, as required (refer to section 10.3 Bears).
  - Take traversing breaks in high open areas where you can observe the surrounding area, especially in polar bear country.

- Use extra caution during whiteouts. Polar bears cannot be seen when approaching a camp or emergency survival shelter.

- Clear Arctic air makes it difficult to estimate distances; people more commonly underestimate distances than overestimate them.
- Wear very good boots that give the best ankle support, especially working in boulder fields.
- Protect exposed skin (including your lips and under your nose) by frequently applying sunscreen with an SPF 30+. Use lip balm on lips and inside nostrils to prevent cracking. Your hands, feet and face will dry out so it is advisable to use hand cream.
- Refer to Chapter 5.7.1 Arctic and Alpine Terrains in the Environmental Stewardship Toolkit to learn how to reduce the impact mineral exploration – including traversing – in this terrain. 3 Plus website: www.pdac.ca/e3plus

PDAC 6.4.4 Cliffs and Steep Terrain

Risks and Hazards

Specific risks and hazards include but are not limited to:

- Slips, trips and falls caused by steep, rough terrain and inadequate footwear; falls caused by collapsing benches, cave-ins underfoot at old workings or open pits
- Impact injuries caused by loose rock falling from above, flying bits of rock or unstable rock breaking off while sampling, not wearing PPE

Prevention and Preparation

- Develop and follow SOPs for working in steep terrain and cliffs. Wear PPE – a hard hat and eye protection
- When taking samples, make sure no one is below you or close enough to be injured by flying rock.
- Stay back from cliff edges as they can break off and collapse, whether composed of soil, rock or snow.
- Avoid working for extended periods below a cliff face; this is especially important when working below frozen cliffs with the sun shining on them. Be alert for rock falls – falling pebbles often precede a larger fall of rock.
- When it is safe, use parallel routes spaced well apart to climb up steep terrain so you avoid knocking loose debris onto your field partner. Otherwise, wait until the leader has reached the top and follow in the same path, which may actually be the safest way to ascend.
- Employees should shout a loud warning – “Rock!!!” if they dislodge a stone or boulder.
- Employees should not look up and should get as close to the rock face as possible when they hear the warning “Rock!!!”
- Do not work directly below someone who might dislodge rocks or boulders.

When working where there are numerous canyons, select your traverse route carefully to avoid impassable terrain.

PDAC 6.4.5 Traversing Safety and Streams, Rivers and Lakes

Risks and Hazards

Specific risks and hazards include but are not limited to:

- Drowning caused by not wearing a PFD (personal flotation device) when working on or near bodies of water; being swept away while crossing on foot, taking samples, or by a flash flood; not wearing fall protection when working on steep banks
- Cold water immersion hypothermia caused by falling into water, breaking through ice, capsizing a boat
- Slips, trips and falls caused by smooth and slippery surfaces such as algae covered rocks, round rocks, inadequate footwear – sprained ankles are a common injury
- Risks caused by wildlife: leeches, waterborne parasites, snakes, crocodiles

Prevention and Preparation

- Develop and follow site specific SOPs regarding which streams to avoid crossing, which ones can be crossed on foot, and safe crossing methods.
- Plan traverses to avoid the risks of crossing streams and rivers. Do not cross a stream or river unless it is absolutely necessary. If you must cross, plan it carefully and do not rush.
- Most Canadian lakes and streams are classified as "cold waters" (less than 21°C or 70°F). Refer to section 17.12.3 Cold Water Immersion Hypothermia and understand the risks and treatment.
- If you are dropped off on an island or a bar, the helicopter must wait until you and your party reach safe ground.
- Make sure there are no hazards downstream such as rapids, snags, sweepers, ice dams etc.
- Be very careful when jumping from rock to rock, as they can be unbalanced, slippery, algae covered, and can tip over causing you to fall in. Even rounded pebbles can cause a fall when they move underfoot.
- Release the pack waist strap and loosen the shoulder straps so you can discard it immediately if you lose your footing. When carrying a very heavy pack, consider dividing the load and making two trips. Be sure there are dry clothes and matches in each load.
- Always carry a long, strong stick to probe ahead and increase your stability.
- In mountain areas, do not cross streams following a heavy rain as the depth can rise suddenly and without warning.
- Do not wear waders. If they fill with water you may not be able to get out of them, and if they fill with air you may become submerged with your head underwater.

General Water Crossing Strategies

- Plan the water crossing very carefully. When in doubt, do not cross.

- Carry survival and emergency gear in your pockets in case you lose your pack. Consider which emergency gear and equipment must stay dry. These include matches, batteries, electronics etc. Consider the depth of water and how to keep essentials dry.
- Search for the best crossing place with the shallowest, slowest running water, and preferably with sand or gravel on the bottom. This may be where the river or stream breaks up into several discrete channels. It is safer to cross several small streams than one large one.
- When you are below a glacier, go back up to the glacier, cross the glacier and then come down the other side, which is usually much safer than crossing the outlet river. Glacial meltwater is cloudy and extremely cold.
- Crossing techniques:
  - Face upstream for the best balance and to watch for debris. Do not face downstream. Cross at a diagonal toward the upstream direction. Use a long, strong stick to probe ahead to increase your stability. Place it on the upstream side to break the current. Cross carefully, one step at a time. Consider using two walking sticks and keep one stationary to hang onto and one probing ahead for the next place to step.
  - Link arms with a partner; lift only one foot (of the four) off the stream bed at a time. Cross slowly and steadily. Keep in balance by taking little steps, with everyone keeping together – roped or arms around the waist. There is the risk that if one person slips they will drag the partner in as well.
  - Carry a lightweight nylon rope to help cross difficult streams.
    - Anchor the rope to a tree or a large boulder rather than a co-worker. A person acting as an anchor can easily be dragged into the stream if an accident occurs.
    - Some resources suggest rigging a rope between banks and using it as a hand line. Each person can hold on and work their way across.
    - Some resources suggest roping up each person and crossing one at a time. Depending on the depth of the river or stream, there is the potential risk that the roped person may be held underwater if they slip.
    - Some resources suggest that when fording a deep stream, rope up and let the shortest party member cross first. Taller people might lead shorter people into water that is too deep for them to cross safely.
- When traversing in a group, make certain that everyone crosses safely before the party continues.
- If you fall in, try to get into a sitting position, point your feet downstream and work your way to the stream bank.
- Keep clothing dry:
  - Inexpensive lightweight athletic shoes are useful for crossing creeks to provide footing, prevent cuts and keep your boots dry. Or wear rubber boots.
  - Remove socks, long johns and pants. Wear waterproof pants and put on gaiters over boots or shoes.

- If the water is cold, wear waterproof pants to insulate your legs to help avoid muscle cramps. Your feet can become numb very fast and may not be able to feel what you are stepping on when wearing athletic shoes.

Crossing Fast-Moving Streams and Rivers

Never attempt a dangerous crossing.

- Arrange for transportation across a river by a dependable boat or a helicopter whenever possible. Never swim across a river.
- Take time to search for the safest place to cross when it is necessary to cross a stream. Never cross swift rivers above rapids or ice dams. Avoid places where the current is swift.
- Glacier melt-water creeks can be particularly hazardous to cross as they are very cold, fast flowing, carry moving boulders, and the water is milky or clouded so you cannot see what you are stepping on. Cross only when absolutely necessary and use all precautions.
- Ice or snow fed streams that are easy to cross in the morning may be too dangerous to cross after a sunny day due to the increased snowmelt runoff.
- Tropical rainstorms can turn a slow-moving stream into a raging torrent. It is better to be stranded for a night than to attempt a dangerous crossing.
- Fast flowing water above lower thigh depth can easily sweep you off your feet. Use shuffling steps without crossing one leg in front of the other for best balance.

Crossing Slow-Moving and Meandering Streams

- Always use a long, strong stick to probe the bottom ahead and to provide support as you cross. Cross carefully one step at a time.
- Meandering streams frequently are muddy and have a shallow shelf at each edge of a deep main channel. Beware in case you encounter a drop off – probe carefully with the stick.

Traverses on Coastal Areas and Large Lakes

- Wear a PFD at all times whenever you work on water or traverse on steep shorelines.
- Protect yourself from drowning and cold water immersion hypothermia.
- Take appropriate training courses. Consider hiring certified pilots or local experts as guides who are familiar with the risks and hazards and navigation requirements of the waters.
- Boats should be large enough for the job and weather risks, and be fully equipped with up-to-date charts and tide tables, navigational and survival equipment and drinking water, as required.
- Tidal zones: Pay attention to your footing as rocks covered with algae and seaweed are very slippery.
- Refer to the guidelines in Chapter 17. Boats, Canoes and Inflatables and section 17.12.3 Cold Water Immersion Hypothermia.

PDAC 6.4.6 Wet Terrain

Risks and Hazards

Specific risks and hazards include but are not limited to:

- Slips, trips and falls caused by wet, slippery surfaces, algae-covered rocks and boulders, lichen-covered logs or rocks, inadequate footwear
- Disorientation and becoming lost caused by poor visibility (fog, rain) in heavy vegetation or forest areas (especially when combined with lack of training in the use of navigation equipment), loss of battery power in a GPS unit
- Hypothermia caused by cold wet conditions, inadequate rain gear and/or clothing Immersion foot caused by wet feet when working in cold wet conditions
- Foot fungus caused by wet feet when working in hot humid conditions
- Risks caused by wildlife: leeches, insects and large animals (depending on region)
- Stream crossing risks including drowning caused by poor traverse planning, lack of training, lack of equipment (see previous section)

Prevention and Preparation

- Develop and follow SOPs that address traversing safety where wet surfaces are a hazard.
- Wet surfaces can be extremely slippery, especially those covered with vegetation. Use extra caution when traversing across moss covered logs or boulders. Wet, lichen-covered rocks can be extremely slippery. When working on wet boulder fields, it is easy to slip and break a leg.
- Wet alpine grassy meadows and steep, wet grassy slopes can be treacherous. If you slip on wet grass or heather while wearing rain gear, it may be difficult to arrest your slide.
- Bark and moss on fallen trees frequently peels off in slabs when stepped on.
- Footwear: Wear appropriate boots for the terrain. Have plenty of dry socks and/or extra felt inserts for boots. An extra pair of boots to wear on alternate days should enable you to start each day with a reasonably dry pair of boots. This will help prevent foot disorders that may develop from prolonged exposure to cold or heat and dampness. Refer to section 9.9.6 Immersion Foot.
- See the previous section 6.4.5 Traversing Safety and Streams, Rivers and Lakes.

PDAC 7.0 Knowing Your Location

Introduction

Every employee who traverses or works in the field away from the immediate project site should know how to use a compass and develop good topographic map reading skills to help navigate and keep track of their location. Reliance on global positioning system (GPS) technology should not be the only method used to determine location, as GPS instruments can fail electronically and because the batteries they require can go flat.

In addition to knowing your location, it is very important to follow safety guidelines before heading out to work each day.

- Tracking system: There should be a tracking system in place to record planned travel routes and off site work locations on a centrally located map. Record all routes, whether they are traverses on foot or trips using vehicles, snowmobiles, all-terrain vehicles, aircraft, or boats. Indicate the destination, planned route, drop off point, pick up point, estimated time of arrival and return etc. Leave grid coordinates whenever possible. Refer to Chapter 6. Safe Traversing Practices.
- Check-in system: There should be a communication system in place to keep in contact with employees. Field employees should check in at prearranged time intervals and notify the appropriate person whenever they change plans. Check-in schedules should include all employees who work off site, including those who work from a hotel or are travelling in other countries. Refer to Chapters 6. Safe Traversing Practices, 12. Travel Safety and Security, and 19. Communications.
- Emergency response plans (ERPs): Each project should develop site specific ERPs that addresses local risks and hazards. Each employee should be familiar with the ERPs and carry contact numbers and/or radio frequencies to use if an emergency situation develops. Refer to Chapter 3. Emergency Response.

Acronyms

ELT – Emergency Locator Transmitter

ERP – Emergency Response Plan

GPS – Global Positioning System

NAD – North American Datum

NTS – National Topographic System

PLB – Personal Location Beacon

USGS – United States Geological Survey

UTM – Universal Transverse Mercator

WGS – World Geodetic System

PDAC 7.1 Risks and Hazards

Injuries and death may result from various risks and hazards associated with keeping track of your location:

- Disorientation and getting lost may be caused by:
  - Lack of training to use navigational aids correctly Programming the wrong datum into the GPS unit
  - Loss of battery power and/or electronic failure for navigational aids and communication equipment
  - Inadvertently traversing beyond the map area Inadvertently entering dangerous terrain

  - Panic leading to bad decisions after initial disorientation
- Being caught out after dark or overnight may be caused by:
  - Inadequate planning of traverse routes (e.g., terrain, route, time allocation, access, required equipment)
  - Transportation breakdown
- Unnecessary survival situation may be caused by:
  - Not knowing the location of emergency supplies or existing shelter in the field area (emergency cache, cabin)
  - Getting separated from your day pack
  - Not keeping essential survival kit components on your person Panic leading to bad decisions
- Endangering others who conduct a search may be caused by:
  - Not following SOPs regarding check-in routines
  - Not stopping after initial disorientation, panic

PDAC 7.2 Topographic Maps and Map Grids

Topographic Maps

Topographic maps are essential tools for field employees who work outside the confines of a camp or a well defined project work site. Topographic maps accurately show the user various features on the ground such as relief, water bodies, wooded and clear areas, roads, railways and infrastructure such as power lines. Always use up-to-date map sheets. People who develop good map reading skills seldom get lost.

- Mark on all maps the location of critical features such as camp location, helicopter drop off and pick up points, emergency cache drops, and predetermined meeting points if you become separated from your partner.
- Field workers should develop skills to read and interpret topographic maps so they can judge the type of terrain they are likely to encounter.
- Original coloured topographic maps should be used in the field. Black and white reproductions do not easily discriminate between types of lines (e.g., lake shore outlines from contour lines). If a small section of a map is photocopied for field use, make sure the grid coordinate numbers are included on the photocopy. Remember, if you zoom in or out on a photocopier, you are changing the map scale.

Scales

- Topographic maps are available in various scales, depending on the country. In Canada, topographic maps are based on the National Topographic System (NTS) and are available in the following standard scales:
  - 1:50 000 scale where 1 cm represents 0.5 km
  - 1:250 000 scale where 1 cm represents 2.5 km
- For field work, it is generally advisable to use map scales at or less than 1:50 000 scale as these maps show considerably more detail than the larger scale 1:250 000 maps, which may work well for reconnaissance work or when flying in aircraft.

- The correct NTS map sheet must be specified when purchasing maps. Natural Resources Canada provides an easy to use index map on its website where the appropriate NTS designation of a specific map area can be identified at both standard scales. The website also lists regional distribution centres where topographic maps can be purchased. http://maps.nrcan.gc.ca/topo_metadata/topo_click_e.php
- In Canada, topographic maps and other types of maps can be downloaded in digital form compatible with computer mapping systems (e.g., Mapinfo) from the GeoBase website. The maps are available without charge at both 1:250 000 and 1:50 000 scales. Website: http://www.geobase.ca/
- In the USA, topographic maps are published by the United States Geological Survey (USGS), which include Primary Series topographic quadrangle maps at scales of 1:24 000 and 1:63 360, although maps at other scales are available in some states.
- Topographic maps are available for many other countries in various scales. Website: http://topomaps.usgs.gov/index.html

Map Grids

Map grids are used to determine precise locations on the surface of the earth. NTS maps in Canada are based on the Universal Transverse Mercator (UTM) projection and show two grids, a UTM grid and a longitude/latitude geographic grid. More information about NTS maps and projections can be found on the following Natural Resources Canada websites:

- http://maps.nrcan.gc.ca/index_e.php
- http://maps.nrcan.gc.ca/topo101/index_e.php

Datums

A geodetic datum is used to define the shape of the earth and as a reference point for mapping the earth. In 1990, Natural Resources Canada adopted North American Datum 1983 (NAD 83) as its new geodetic reference system replacing the former North American Datum 1927 (NAD 27).

Maps published or revised after 1990 are based on NAD 83. Similarly, newer maps published in the USA use NAD 83. The datum usually appears on the margin of the map.

Check which datum was used for making the map and set your GPS receiver to the same datum so you can use the map with the GPS without having to make a conversion (see below). If the datums do not match between your GPS unit and the topographic map (NAD 27 or NAD 83), there will be an error in every GPS position placed on the map, which may vary from a few to hundreds of metres.

Natural Resources Canada, Geodetic Survey Division supplies a downloadable software package called the National Transformation Version 2 (NTv2) for converting coordinates between the NAD 27 and NAD 83 reference systems. To download the software, go to the following website: http://www.geod.nrcan.gc.ca/online_data_e.php

Some countries use unique datums that may not exist in most GPS instruments (e.g., Jamaica). In these cases, a mathematical conversion formula may be required or use latitude and longitude.

Learning to use maps and map grids

Employers should make sure that anyone working in the field understands the basics of map navigation or is accompanied by a qualified field worker. Field workers should also be familiar with map grid references and how to specify location using both UTM and the geographic grid (longitude and latitude). It is particularly important to make sure that young or new employees are mentored in basic map skills. Field employees should be able to:

- Understand map legends, colour codes, and contour lines and intervals
- Understand map scales – which scales are appropriate for the specific tasks of traversing on foot and/or air reconnaissance.
- Know and understand how to use both UTM and geographic latitude and longitude map grids.
- Know how to locate a position on a map and specify the grid reference.
- Develop skills using contour lines and contour intervals to interpret topography. This will help determine where to expect steep slopes, ridges, cliff areas, rivers, rapids, swamps, glaciers and other topographic areas that may be difficult to traverse.

Know how to plan traverses and field work using topographic maps.

- Know how to use a map in conjunction with a compass. This is very important so you do not have to rely only on a GPS unit. Do not begin a traverse or get out of a helicopter without being able to place your position accurately on a map.
- Knowledgeable users can estimate the difficulty of a traverse that crosses rugged topography with many changes in altitude by estimating the total incremental elevation change from the start of a traverse to the finish.
- Knowledgeable users can estimate the time it will take to complete a traverse with some degree of accuracy.
- It is advisable to use maps with a protective plastic coating for field work to prevent paper maps from disintegrating in wet weather.

Topographic maps cannot provide precise information at all times.

- Terrain features will not show if the elevation difference is less than the contour interval.
- The colour and contour density on the map may not accurately indicate the difficulty of traversing the terrain.

Recent changes in the map area will not be evident, such as new roads. However, the latest release of a map should always be used in the field.

PDAC 7.3 Air Photographs and Satellite Images

Air photographs are useful in addition to topographic maps for traversing and mapping and can aid in determining your location. Although some physical features and landforms are more easily identified on air photographs than maps, it is always advisable to use air photographs in conjunction with topographic maps. Keep both in a plastic protective coating or laminate to minimize damage from the elements.

Because of the way air photographs are taken, they may be distorted near the edges; they must be orthorectified to make the scale uniform. Air photographs can be printed at various scales. Air photos, when used as a stereo-pair, have the added benefit of allowing the user to view the terrain in three dimensions (3-D).

In areas of poor map coverage, satellite images available from various sources are proving to be useful tools in mineral exploration not only for location mapping, but also for exploration (e.g., mapping lithologies or alteration patterns).

Information about air photos, their use and purchase is available from the following websites:

- http://airphotos.nrcan.gc.ca/photos101/index_e.php
- http://airphotos.nrcan.gc.ca/photos101/photos101_info_e.php
- http://airphotos.nrcan.gc.ca/prod_e.php

Satellite Images

Satellite images are replacing air photos to some degree. They have the following advantages:

- They are much cheaper to acquire due to the cost of aircraft for air photos; archived satellite images can be much cheaper than air photos.
- True colour images can be produced.
- The resolution of some satellite images is almost as good as air photos. Satellite images can be cheaply orthorectified.
- Using a computer it is easy to merge satellite images with a digital topographic base to produce the equivalent of an air photo with topographic contours. They can be easily printed.

Various satellite images are available for download at no cost on the Canadian GeoBase website: http://www.geobase.ca/.

PDAC 7.4 Compasses

A compass is an essential piece of equipment for keeping track of your location while traversing or carrying out field work. Various types of compasses are available and the choice of compass is a matter of preference – but minimum features should include a rotating housing marked in degrees that is mounted on a transparent plastic base. Geologists normally prefer to use a compass with liquid dampening, a built in dip needle indicator and a mirror; the latter is useful in taking bearings or backsightings. The mirror can also double as a signalling device during emergencies, if necessary. Field staff should also be familiar with their pace so that they can use pace and compass orienteering in conjunction with a topographic map.

Although all field employees should be familiar with using a compass, many tend to rely on a GPS for location, which can create problems if they malfunction or the batteries die. Field employees should not rely solely on a GPS unit (see section 7.5).

Compasses are unreliable in areas of iron formations or areas where there are other strong magnetic attractions (e.g., magnetic polarity reversals). When working in regions with these challenges it may be advisable to learn to use a sun compass/chart in the event that your GPS unit fails.

You can generate a sun chart by accessing the following website and entering the co-ordinates where you work (anywhere in the world):

- http://www.usno.navy.mil/USNO/astronomical-applications/data-services/rs-one-year

In addition, Transport Canada sells a publication for $12 entitled “TP 784 Finding the Sun’s True Bearing – Precomputed Tables – Printed Publication”. This book may be useful in the field and may be ordered from the following website:

- http://shop.tc.gc.ca/TChtml/ibeCCtpItmDspRte.jsp?JServSessionIdrootncras147=qlpir o6kd1.pAb MmlaLb3qIr6aInQaImQ4UtxCLbx0Ta0--&item=40663

Declination

Declination is the difference between true north and magnetic north. In Canada the declination can range from a westerly declination in eastern Canada to an easterly declination in western Canada. As a compass needle always points to magnetic north and a map is normally oriented with true north at the top, it is very important to accurately set the declination for the map area where you work.

- Topographic maps show the declination for the map area in the legend; use this with caution as declination changes over time.
- Topographic maps also indicate the annual rate of change in declination. The present day declination must be calculated based on the number of years since the map was published and the annual rate of change.
- Natural Resources Canada provides a web based declination calculator that allows the calculation of current declination anywhere in the world by specifying latitude and longitude. It is available at the following website:
- http://geomag.nrcan.gc.ca/apps/mdcal-eng.php
- If you are working at several sites across Canada, set the declination on your compass each time you change location.
- Be cautious when using a compass at high latitudes because compasses rely on the horizontal component of the earth’s magnetic field to work properly. As the magnetic fields become increasingly steep closer to the magnetic pole, compass performance becomes erratic and unreliable. This is especially true in northern Canada near the actual location of the magnetic north pole.

Training

Companies should make sure that their employees – especially new ones without field experience – become proficient using a compass in conjunction with topographic maps. It may be advisable for employees to take an orienteering course to become proficient. As a minimum, everyone who does field work should be able to:

- Take bearings and be able to follow a bearing on the ground.
- Check a bearing by taking a backsighting.
- Recognize and avoid potential deflection due to nearby metal objects or possibly by magnetic rocks (e.g., magnetite- or pyrrhotite-bearing rocks).
- Use a compass in relation to a baseline.

Set a compass to compensate for declination in the field area. Find their location on a map using triangulation.

PDAC 7.5 Global Positioning Systems (GPS)

Handheld GPS units have become quite inexpensive and are useful for determining or recording relatively precise locations when traversing or sampling etc. GPS receivers utilize signals from a network of orbiting satellites to establish the location of the receiver.

- A GPS receiver should never be considered as a substitute for a map and compass.
- Read the manufacturer's user manual and be familiar with the features of the GPS unit.
- Digital maps can be uploaded onto some of the newer GPS units, but the larger colour displays on these units generally result in increased battery drain and reduced battery life.
- Differential and Real Time Kinematic (RTK) receivers can achieve levels of accuracy required for detailed land surveys.
- Always carry an adequate supply of spare batteries for your GPS unit. Use either alkaline or lithium batteries for longer performance or in cold weather.

Datums

Many GPS receivers are referenced to the World Geodetic System WGS 84 datum, which will be valid until 2010. GPS units use the WGS 84 and NAD 83 as default datums in North America.

When using a map with a GPS unit, check which datum was used for making the map and set your GPS receiver to the same datum so you can use a topographic map directly. If the datums do not match between the GPS unit and the topographic map (NAD 27 or NAD 83), there will be an error in every GPS position placed on the map, which may vary from a few to hundreds of metres.

Information about conversions between NAD 27 and NAD 83 is given in 7.2 Topographic Maps and Map Grids.

Advantages of using GPS units include:

- Determining location either in latitude and longitude or UTM grid coordinates – this can be helpful if your location on the map is in doubt.
- Determining distance to the next waypoint or your destination
- Determining travel speed – this helps to determine your progress on a traverse Determining the return route
- Generally high accuracy in pinpointing grid location
- Not affected by magnetic anomalies such as iron formation or magnetic reversals (areas of high magnetic flux)
- Storage of critical waypoints such as (1) camp location, (2) helicopter drop off and pick up locations, (3) emergency cache locations etc.

- It is advisable to upgrade GPS units periodically to take advantage of improved technology.

Limitations of using GPS units include:

- Batteries: GPS receivers rely on battery power – always carry spare or freshly recharged batteries on your person (i.e., in breast shirt pocket) to keep them warm so they will retain their charge when not in use. For reliability, use very high quality/powerful batteries (e.g., lithium) rather than cheap poor quality ones. In addition, make sure batteries are firmly in place within the case or the GPS unit may not function well.
- Temperature: Cold weather can cause batteries to drain rapidly so they last a much shorter time. LCD (liquid crystal display) screens on GPS units may not work well in sub- zero temperatures.
- Signal reception: A GPS should be positioned to maximize visibility to open sky as it normally requires the reception of clear signals from a minimum of three (preferably four) satellites – and signal reception requires a clear line of sight between the satellite and the receiver. Poor GPS signal reception may occur under various conditions.
  - Satellite signals will not penetrate water, metal, concrete, rock or soil.
  - Satellite signals are degraded by tree canopy or very dense vegetation. Newer receivers have overcome this degradation to a large extent and are better for work under the canopy.
  - Steep terrain can affect GPS performance if the terrain blocks the signals of some of the satellites used for triangulation.
  - Metal roofs and chain link fencing (near open holes and shafts) can affect performance of GPS units.
  - For maximum efficiency, use an external antenna when doing road work in a vehicle with a GPS.
- Satellite configuration geometry can affect the accuracy of a GPS. If the receiver is picking up signals from closely spaced satellites, the accuracy of the triangulation will be less precise than if the signals are coming from more widely positioned satellites. Your receiver will indicate the accuracy of the position.
- Datum reference: Using an incorrect GPS datum setting can affect the accuracy when determining your location. GPSs must use the same datum and coordinate system as the topographic map. Check the legend on the map for the datum.
- Entering erroneous data: It is very important to enter the correct numbers. If working in UTM, and one digit is off you may be 1, 10, or 100 km out in your location. This error happens more frequently to field employees who do not read maps well. Transfer all data digitally to/from the GPS unit. This avoids the errors as described above.
- Overconfidence: When using a GPS you may know exactly where you are but if you do not have communication no one else will know where you are. Good communication is essential so carry what is appropriate for the field area. This may be a portable satellite phone in a remote area or an appropriate radio. Refer to Chapter 19. Communications.

General tips when using a GPS unit

- You need to lock onto the signals from at least three satellites – preferably four – for your GPS unit to determine the location.
- If you are in a canyon or steep valley and having reception trouble, move toward the centre or climb out of it.
- Search for a clearing to find your location when traversing through heavy foliage.
- Your body can block satellite signals. Hold the unit away from your body and turn your body to find more signals.
- For greater accuracy, take the reading of a position more than once at different times of the day. Use the "averaging" feature found on most handheld GPS units for greater accuracy; average them for five minutes before selecting the save button.
- Carry a good map and compass at all times and be able to use them.

PDAC 7.6 Emergency Locator Devices (ELTs, PLBs)

There are various emergency distress radio beacons available but only those designed for use with the Cospas-Sarsat international system allow the signals to trigger emergency response search and rescue.

Three types of emergency beacons are currently in use with the Cospas-Sarsat system.

- Emergency Locator Transmitters (ELTs) for aircraft
- Personal Locator Beacons (PLBs) for individual use
- Emergency Position Indicating Radio Beacons (EPIRB) for maritime use

Emergency Locator Transmitters (ELTs)

ELTs are specifically for use in aircraft and are designed to activate automatically upon impact; they can also be activated manually. The newer digital ELTs operate at 406MHz and only signals at this frequency are processed by the Cospas-Sarsat system (effective February 1, 2009). Frequencies of 121.5 and 243 MHz no longer alert search and rescue.

- Pilots of charter aircraft should indicate the location of the ELT and describe how to manually activate the unit in the event of emergency. Refer to section 16.10.2 Regular Pre-Flight Safety Briefings.

Personal Locator Beacons (PLBs)

PLBs are small radio frequency transmitters that are designed to be carried by an individual in remote areas away from normal emergency services. They are intended for emergency use, not as navigational tools.

- In an emergency the PLB is activated manually and transmits on 406 MHz, the frequency of the receiving Cospas-Sarsat international search and rescue satellite.
- 406 MHz PLB units provide global coverage but need to be coded according to the specific country where they will be used. This code should be included in the planning documentation for any remote foreign trip. Take the unit to an authorized dealer to be recoded.
- PLBs are now available with GPS units that transmit a more accurate position fix.

- Older analogue PLB units that operate exclusively on the 121.5 MHz frequency should not be used because the Cospas-Sarsat international satellite system for search and rescue only processes signals from the newer 406 MHz emergency beacons.
- Be familiar with the operator's manual for your PLB. Use the correct batteries and make sure they are up-to-date before departing on a long trip.
- A PLB must only be activated in a distress emergency situation where there is serious danger to human life and only in areas where mobile/cell phone coverage or other communication methods are not available (two-way radio or satellite phone). Most field employees should have other means of notifying their project or camp of an emergency. Refer to Chapter 3. Emergency Response.
- PLBs should be registered with the appropriate authorities in the country where it may be used. In Canada, you can register the PLB directly with Cospas-Sarsat or online at:
  - http://www.canadianbeaconregistry.forces.gc.ca/Logon.asp
  - https://www.406registration.com/

PDAC 7.7 Batteries

Various kinds of batteries are used at project sites, including in GPS receivers, ELTs, and PLBs. Most handheld GPS units use AA or AAA batteries; rechargeable NiMH or Lithium ion batteries are recommended by some manufacturers. General information regarding batteries is available at the following website:

- http://www1.servicecanada.gc.ca/eng/labour/fire_protection/policies_standards/guidelines/safe_st orage.shtml

General Battery Tips

- Cheap batteries are a false economy in the field.
- Start each day with fully charged batteries and carry sufficient fully charged spare batteries for your navigation and communication equipment.
- Follow instructions and install batteries correctly.
- Do not mix batteries: Use the same brand and chemical type. All batteries should be the same age – replace them all at the same time.
- Remove depleted or damaged batteries. Do not leave them in equipment as they may corrode or leak and cause damage.
- Do not leave equipment switched on when the batteries are depleted.
- If you carry battery powered equipment in very cold weather, keep the items inside several layers of clothing to preserve the charge. Take them out briefly to use them and replace in your clothing as soon as possible.
- Pay attention to the expiry date on batteries used for PLBs and ELTs. Batteries should be replaced before expiry date. Good batteries in ELTs should provide continuous transmission for 48 hours.

Battery Recharging Tips

- Follow the manufacturer's directions when using battery rechargers and rechargeable batteries. Match the charger with the battery. Some batteries should be almost, but not totally depleted before recharging.
- Charge batteries at room temperature whenever possible – not at temperatures below 0°C or above 40°C.

Battery Storage Tips

- Store batteries in cool, dry, well ventilated areas. Keep them away from any heat source, including direct sunlight.
- Never store batteries with flammable or explosive materials or with food.
- Store batteries of like chemistry together – not mixed with other types of batteries.

Safe Battery Disposal

- Follow the jurisdictional regulations for disposing of batteries safely. Recycle them when possible.
- Nickel cadmium and lead acetate batteries can contaminate the environment and cause health problems for people. Make every effort to recycle or dispose of these batteries according to regulations.
- Do not throw batteries into a fire as they may explode and injure people and contaminate the environment.

PDAC 8.0 Survival

Introduction

Mineral exploration employees often work in hostile terrain and weather conditions where the risk of facing a survival situation is higher than for the average person. A crisis may develop for individuals or crews on traverse, at a work location or during travel to and from a work site. A project drill site or a field survey crew could become isolated due to sudden storms, flooding, avalanche, forest fire, a whiteout or the loss of backup transportation (e.g., mechanical breakdown, the loss of a boat or helicopter). Field camps are vulnerable to fire, which can leave people with serious burns and without shelter, food, water, clothing, communication and transportation in temperature extreme conditions. Although people often ignore the possibility, a survival crisis may develop very near civilization. Therefore, employees need to take survival equipment on every job at all times.

Proper preparation in advance may mean the difference between life and death in a crisis. Preparation should include seeking local expert knowledge about the area (e.g., the location of safe water and emergency shelters such as a remote cabin).

Try to locate a small survival book suitable for the region where you work. It should be small enough to carry in your pack so it is available to help prioritize your actions during an emergency.

Acronyms

CPR – Cardio Pulmonary Resuscitation

ELT – Emergency Locator Transmitter

EPIRB – Emergency Position Indicating Radio Beacon

ERP – Emergency Response Plan

GPS – Global Positioning System

PFD – Personal Flotation Device

RCMP – Royal Canadian Mounted Police

SAR – Search and Rescue

OLAS – Safety of Life At Sea

SOP – Safe Operating Procedure

PDAC 8.3 Prevention and Preparation for Survival Situations

The nature of mineral exploration work requires that each employee is ultimately responsible for his or her own personal safety; this is especially true during a survival situation. Therefore, employees should become as self reliant as possible through training, experience, and planning.

Experts claim that survival is:

- 80% ATTITUDE
- 10% KNOWLEDGE
- 10% EQUIPMENT

PDAC 8.3.1 Attitude

A tough mental attitude is required for survival during a crisis. A clear-thinking, innovative mind is your best ally. This is best developed through taking formal survival training courses appropriate for the terrain and climate to prepare to meet the physical and mental challenges you may face. Training should include emphasis on the following points that are dependent on attitude:

- You need a very positive attitude and a strong will to live. You must think rationally in order to withstand the challenges and stresses that threaten your well being. It is essential to avoid panic.
- Improvise to solve problems. Think your way through the challenges. While working with limited resources is one of many challenges during a survival situation, people usually have more resources to work with than they realize. When you lack something, find an alternative or create a substitute. Keep trying because success will probably not come on the first effort. Keep trying because there is always something you can do that will make a positive difference and increase your chances of survival. Humans are the toughest species on earth – they are survivors – be one.
- Keep on track until rescue arrives. Devise a plan and stick to it. Enhance a strong positive attitude by creating daily proactive routines. Keep doing something useful to occupy time and improve your situation (i.e., collect fire wood, purify water, improve your shelter, improve your ground signals.) You will have the greatest energy level

during the first three days so use this to your advantage. Continue to carry out activities to combat apathy and despair.

Pitfalls to guard against:

- Weather is likely to be the most serious challenge over which you have no control. Be alert for and assess changing weather condition in order to return to camp, or set up, adapt or reinforce your shelter if you are already stranded. Hypothermia, hyperthermia, dehydration and fatigue will affect your mental and physical condition and all these conditions can be affected by weather.
- Lack of self-confidence can greatly affect your chances of survival. Accurately assess your mental and physical condition and work to improve both through proactive routines.
- Avoid overconfidence and complacency or you may place yourself in additional danger. This may occur through ignorance, being oblivious to hazards, or even by believing that you are so prepared and experienced that nothing will happen that you cannot handle.
- Do not disregard your own emergency plans and preparations because other people around you disregard theirs. If others are just waiting for rescue and not working to solve problems, it is even more important for you to have a strong attitude and continue to work to resolve them.

PDAC 8.3.2 Knowledge

Familiarize yourself with the field area. Carry the complete, latest Google Earth satellite photo coverage in addition to maps because maps are always out-of-date. Obtain local knowledge regarding essential information such as the location of potential shelter (a remote cabin), safe water, the location of recent logging roads, clear cuts, beaver dams and ponds, snow, ice and rock falls, changes in river courses due to flooding and bank collapse etc.

Survival Training and Planning

Employees should have survival training that is relevant to the project area, the job conditions and time of year. Survival skills must be appropriate for summer conditions or winter conditions, as required. Skills that may be relevant for one type of terrain may not be appropriate for another terrain. For example, different skills are required in alpine mountain terrain, Arctic tundra, high altitude or a hot desert. Periodic refresher training will help keep skills sharp.

Companies can augment survival safety training and planning in various ways:

- The site orientation meeting should include time for employees to examine contents of both aircraft survival kits and survival caches. Make sure that employees know how to use the contents; if a tent is included they need to know how to erect it quickly.
- Allocate time for everyone to propose and debate potential “scenarios” relevant to the program. People who traverse and people in camp should debate the potential emergency scenarios, agree on the best plan and know what each other would most likely do in each emergency situation. Take into consideration the variables of climate, terrain, means of transportation and how they may impact employee behaviour and the emergency response procedures.

- When inclement weather confines everyone in camp, use some of the time to practice and rehearse survival skills. Practice building and lighting a fire and setting up a survival tent or shelter under very adverse conditions. Practice using a signal mirror under various weather conditions to develop competence.
- Regular safety meetings can occasionally address relevant survival skills or provide refresher information about proactive routines to prevent hypothermia, hyperthermia, dehydration, the necessity to avoid fatigue, symptoms of mountain sickness etc. Refer to sections 9.9 Cold Injuries, 9.10 Heat Illnesses and Solar Injuries and 8.6.5 Water and Food.
- Integrate survival training with relevant outdoor knowledge.
- Know what is safe and what is not safe – obtain local knowledge if you don't know.
  - Which local materials will burn when wet?
  - Where is water safe or not safe to drink?
  - Which vegetation is safe to eat and which vegetation is dangerous?
  - What dangerous terrain is in the area besides the obvious?
  - Which access routes are subject to unexpected closure?
  - What constitutes "bad weather"? How is the onset recognized? When are certain weather patterns likely to occur?
- Survival equipment has limited value if you cannot use it. You need basic skills to use a compass, maps and signal mirror, how to operate an aircraft emergency locator transmitter (ELT) etc. Be able to start the emergency stove and erect the tent in the survival cache. Practice starting fires with fire starting equipment other than matches and a cigarette lighter.
- Learn and practice survival techniques. Practice skills until they are automatic. This will enhance your self-confidence and mental attitude, which in turn will help minimize fear that leads to panic.

Pro-active routines to prevent survival situations

"Be Prepared." The better prepared you are before starting work, the better prepared you will be to meet a survival situation and the more likely you will have a successful outcome.

- Take care of yourself: Your physical well being in a crisis is affected by how well you dressed and ate before you started work. Be prepared to face the weather conditions and terrain. This means:
  - Wear clothing that will protect your body from heat, cold and dehydration. Take enough clothing to meet the worst weather you may encounter that day plus enough to get you through an unexpected night away from the project. Dress in layers that allow for ventilation as you work. Carry insulating outer wear and rain gear, as required. Remember, deserts as well as tropical forests at moderate and high altitude may be cold at night. (Refer to 6.3.5 Clothing.)
  - Start each day with a nourishing meal and plenty of fluids. Eat sufficiently and drink enough water throughout the day to prevent dehydration and fatigue. Then, if you must face a crisis your body will be better prepared to cope. Take plenty of fluids and nourishing food for snacks.

- Consider the means of transportation that you will be using and wear (or have easily available) appropriate clothing in the event that your transportation breaks down, has to make a forced landing, crashes or sinks.
- Carry a suitable survival kit. It contains the makings for a shelter to combat hypothermia and hyperthermia, plus supplies combat fatigue and dehydration. Don't skimp, but don't overload yourself. See section 8.4 Survival Equipment Lists.
- Carry a suitable first aid kit to deal with injuries. Refer to section 18.5 First Aid.
- Develop and use an equipment and routines checklist and methodically tick off against the checklist before leaving to make sure you are prepared for the day's traverse or work.

- Communication and tracking routines: Follow communication tracking and check-in routines outlined in Chapter 19. Communications. Leave accurate details, including grid coordinates of travel destinations and traverse routes. If you do not return or make contact at the appointed time, a search can be initiated shortly thereafter.
  - Use appropriate communication equipment for the area. The importance of good communication in emergency situations cannot be overemphasized. In cold areas, keep batteries warm next to your skin and use them sparingly. Refer to section 19.6 Emergency Communications.
  - Carry extra communication devices (e.g., fluorescent orange signal cloth, whistle, signal mirror). Wear brightly-coloured clothing, especially when working in brushy or forested areas, working from boats and/or during hunting season. You will be easier to locate from the air and less likely to be mistaken for game.
  - Keep track of your location throughout the day by pacing, using air photos or other methods – don't just rely on your GPS or your best guess. Refer to 7. Knowing Your Location.
  - Immediately relay any changes in plans, traversing routes or dangerous developments to the responsible person (e.g., impending bad weather, vehicle breakdown). If you don't inform the base communication station, they may search in the wrong direction or the wrong area.
- Traversing routines
  - If your work includes traversing, prepare yourself each day taking into account the tips and routines in the relevant sections of 6. Safe Traversing Practices. Information and knowledge cannot be restricted to one person. Everyone, not just the traverse/party leader, needs to know and understand:
    - Where they are going – including the details of the route(s), meeting points as well as the destination
    - How and when they will be dropped off and picked up, the means of transportation on the traverse etc.
    - What the objectives of the traverse are, what risks and hazards to expect, what the check-in schedule is etc.
  - Look out for good emergency camp sites or places to seek shelter as you traverse.
- Transportation routines

  - Follow SOPs for all means of transportation used at a project. Some of the most important considerations to prevent survival crises are listed below. For additional information see the chapter listed.
  - Vehicles: Make sure vehicles are in good mechanical condition and are properly equipped with first aid and survival kits and manuals. Field vehicles should be equipped with reliable communication devices. Refer to Chapter 13. Vehicles.
  - Cold environments: Carry appropriate survival equipment including plenty of extra warm clothing, blankets, food and water; keep the vehicle fuel tank at least half full.
  - ATVs and snowmobiles: Plan for potential survival situations that include mechanical breakdowns or accidents in the most remote part of the project area. Carry appropriate survival equipment and supplies when working on ice. Refer to sections 14. All-Terrain Vehicles and 15. Snowmobiles.
  - Aircraft: Develop a plan of action in case the weather closes in and your air support cannot return. In most situations it is far safer to stay put. Whenever you fly, dress for the outdoor conditions – wear sufficient clothing for warmth in case you are stranded, cannot reach your destination, and cannot retrieve your pack/baggage after a crash. Refer to Chapter 16. Aircraft.
  - Boats: Use a boat of the appropriate size and type for the waters and wear a PFD (Personal Flotation Device). Use checklists before departure to make sure all safety equipment and supplies are on board. Refer to Chapter 17. Boats, Canoes and Inflatables.
- Good judgment and awareness
  - Try to obtain the daily weather forecast and heed warnings of potential problems (e.g., major storms, high winds, heavy rains, a major drop or rise in temperature, snow).
  - If stranded, consider the risks involved should you try to return to the project site.
  - Don’t risk getting lost or crossing barriers that you would not ordinarily cross (e.g., rivers, streams, cliffs).
  - Keep track of your location on your map or you may become lost. STOP anytime you are not sure where you are. STOP if you discover you are not where you think you are. Back track, if necessary, to place yourself accurately on your map. Do not continue until you know where you are. If you are truly lost… STOP.
  - Recognize when risks and problems are adding up. Work to reduce the risks that produce hypothermia, hyperthermia, dehydration and fatigue

PDAC 8.3.3 Equipment

Carry some basic essential survival equipment with you at all times and know how to use it automatically. For equipment suggestions, see section 8.4 Survival Equipment Lists.

- Assemble a personal survival kit in a waterproof container with items appropriate for your project area.
- Keep your kit in a waist pack or attached to a belt rather than inside your pack, which may be lost in a capsizing or a helicopter crash. Keep the most essential items zipped in your pockets. Keep fire lighting equipment in at least 3 different places – in the pockets of your pants, field vest and pack, plus more inside your pack.

- Employees who do occasional field work should assemble and carry a small personal survival kit.
- Take the survival kit on every traverse and to each work site every time a vehicle, aircraft or boat drops you off. Do not send it ahead or leave it in a vehicle. Keep it with you so it is available at any time.
- Companies should equip vehicles with sufficient survival supplies for each potential passenger.
- By law, all charter aircraft in Canada, the USA and Australia must carry survival equipment. Employees should make sure it is on board for each flight; know where it is stowed and how to retrieve and set it up correctly.
- Carry a small survival booklet appropriate for the region in your survival kit (and vehicle) to help focus on priorities.

PDAC 8.3.4 Confronting a Survival Situation

Be aware of the risks and hazards where you work and that they may change from day to day. Recognize when various risks are "adding up". During daily work routines, events that begin as a series of small predicaments may escalate and become a serious situation. It is far easier to address the small problems over which you may have some control than to cope with a situation that has grown out of control.

If you suddenly face a survival situation, you can expect rescue within an interval of as short as a few hours to two to three days – if you have followed the established communication and check- in procedures with your base.

Challenges

Your survival depends on (1) your physical and emotional reactions, (2) the planned actions you carry out and (3) how you adapt to challenges as they arise. Prior preparation will make it is easier to deal with a crisis.

Recognize that challenges and stresses may include many of the following: injury and pain, cold and/or heat, thirst, hunger, fatigue, fear, boredom, loneliness and group dynamics. You need skills to combat any combination of cold or heat and thirst, which along with fatigue can dull your mind so you cannot think clearly. When you do not think clearly, you may make poor decisions that compromise personal safety and that of others.

- There are three levels of reaction to a survival crisis that end with panic.
- **Concern** – It is easiest to think clearly at this stage.
- **Fear** – Do not deny fear; use it to direct your actions in a positive way.
- **Panic** – It is almost impossible to reverse panic once it starts. As difficult as it may be, try to remain calm.
  - Because panic often leads to death, you must control any urge to panic. Work to KEEP CALM. PANIC IS A KILLER
  - If part of a group, panic can be averted through careful organization, good leadership and working as a team. Group dynamics can accentuate or reduce problems so good leadership is essential. A group leader must constructively focus the group to address their physical needs and keep the anxiety level at the stages of concern and/or fear.

- If you are alone, it may be more difficult to cope and to control the urge to panic.
- It is essential to manage your emotions and assess the emergency situation quickly and correctly with a calm, clear mind. Confirm your feelings of fear and utilize them to direct your actions to meet your immediate requirements to increase your chances of survival. People frequently die if they deny fear and refuse to admit the existence of danger.
- Refer to the small survival manual to remind yourself how to tackle and prioritize problems.
- If you start to travel blindly – stop; you are dangerously close to panic.

PDAC 8.4 Survival Equipment Lists

The contents of a personal kit and survival cache will vary depending on the season, the geographic location and terrain. Assemble a personal kit using the best products available. Off the shelf kits do not usually contain high quality products and are rarely suitable for Arctic or other extreme conditions. Test the contents of kit and survival caches to make sure they work and perform under the worst potential weather conditions.

Suggested items for a personal basic survival kit:

- Large brightly-coloured, heavy duty plastic garbage bags
- Matches – waterproof or in a waterproof container, cigarette lighter, plus another type of fire making equipment (see section 8.6.4 Fire)
- Water purification tablets (follow instructions carefully)
- Transpiration bags to collect water (as appropriate)
- Candle
- Knife
- Signal mirror
- Mountaineering tarp (or space blanket depending on region and preference)
- Whistle (plastic in cold climates)
- Insect repellent
- Mosquito head net, bed netting (depending on region)
- High energy food packets, soup cubes, tea bags, chocolate bars, dried fruits etc.
- Container for the kit – (heavy-duty plastic bag, small metal or Tupperware-type sandwich box). Use as a water container; a metal containers can be used to boil water.
- Adhesive tape
- Nylon line – 15 metres brightly-coloured braided fishing cord or parachute cord
- Flares and flare gun
- Tin foil – for boiling water, signalling etc. Fold or wrap it around a flat item
- Small survival book – appropriate for region
- Small first aid kit and booklet

Additional Items for a Personal Survival Kit

- Wire saw
- Length of plastic tubing for siphon
- Extra space blankets
- Solid fire starter cubes
- Metal cup
- Small gas cylinder and stove burner attachment
- Aspirin, Benadryl
- Water-treatment filter
- Light sticks
- Extra socks
- Fishing hooks and line

Survival Cache Contents

- Tent
- 35 metres of nylon cord
- Sleeping bags – 1 per person
- Flares and flare gun
- Candles
- Waterproof matches, lighter
- Solid fire starter cubes
- Signal cloth and mirror
- Fishing gear – hooks and line
- Small gas cylinder and stove burner attachment
- Extra batteries for radios, GPS
- First aid kit including first aid book (appropriate size for several people)
- Cooking pot
- Extra clothing, appropriate for region Food supplies – totally animal proofed Insect repellent
- Axe, small cross-cut saw, knife, small shovel
- Ensolite Pad
- Sheet of plastic

Equipment Tips

- Tarps versus space blankets: Many field experts prefer to carry a high altitude mountaineering tarp as they are light, wind and waterproof, and have corner grommets to facilitate use. Tarps come in various sizes, fabrics and weights and are suitable for alpine, Arctic, desert (shade) tropical and temperate rainforest (wet) conditions. Space blankets come in various sizes and qualities; they are more fragile than mountaineering tarps and rip more easily. They do not provide as much protection as they are usually thinner. Once the reflective surface is abraded, they are no longer able to provide the same insulation.

- Cook stoves: a small gas cylinder and stove burner attachment is quite lightweight and easy to use. They can provide a warm drink or soup when working in cold or wet conditions.

PDAC 8.5 General Advice for Survival Situations

- If an accident occurs, assess the situation and if possible, contact others for help before attempting a rescue.
- Remain at the destination or pick up point if your transportation fails to arrive. Co-workers will know where to find you.
- Remain with your vehicle. If the vehicle becomes stuck or disabled, you are safer remaining with a well supplied vehicle than walking out alone. It can provide shelter from hot or cold climatic conditions. It is more visible from the air than a person, especially when the doors are opened wide.
- Leave your stranded vehicle, crash site, pick-up point etc., only if conditions are too dangerous to remain. Then, travel only until you find a safe location for an emergency camp. Leave a complete windproof and weatherproof note to indicate your intentions, state your destination, route, time of departure and the date. Mark it with flagging tape to draw attention to it and mark your trail as you proceed so rescuers can follow you.

If you fall into water or capsize your boat or canoe, you must avoid hypothermia. While it is difficult to accomplish, make every effort get into dry clothes and build a fire for warmth, if necessary. Follow the advice in section 17.12.3 Cold Water Immersion Hypothermia.

Direction Finding

Everyone in the party should carry a copy of the map/air photos/Google Earth satellite photos in waterproof Ziploc-type bag on their body. Everybody should carry a compass and a watch for keeping track of traversing progress and finding direction if necessary.

- Shadow-tip method: Place a stick vertically in the ground and mark where the tip of the shadow is located. Wait 20 minutes and mark shadow tip again. Draw a line between two points and that is general East – West line. Draw a perpendicular line, which will indicate the North – South direction. This method can be used on both level and sloping ground.
- Simple watch method: On the ground, mark the location of the sun between 9 AM and noon and again between 3 PM and 6 PM. Draw a line between the marks to determine the East-West direction. North-South is perpendicular.
- Watch method: Use your watch set to standard time to roughly determine the North and South directions. This method is not very accurate within 23° of the equator.
- In the Northern Hemisphere, point the hour hand at the sun. South is located half way between the hour hand and the 12 on the watch-face.
- In the Southern Hemisphere, point the 12 on the watch-face at the sun. North is located half way between the hour hand and the 12 on the watch-face.

PDAC 8.6 Priorities for Survival Situations

Prioritize problems and work to solve the most pressing ones. In order, these usually are:

- First Aid
- Location
- Shelter
- Fire
- Water and food
- Signalling for help

You increase chances of survival if you immediately recognize when there is a potential crisis and maximize efforts to help yourself and control the situation. You will have the greatest energy level during the first three days, so use this to your advantage. By the fourth and fifth days, depression frequently sets in and people loose their will to live and ability to think clearly. To combat apathy and despair, it is essential to have a plan and stick to it (see section 8.7.1 Guidelines for the Lost or Injured Person). If you survive these days, your attitude usually improves as you grow familiar with the situation. Only a very strong will to live and a positive mental attitude will pull you through. As described in section 8.3, prior planning and practice will increase your awareness of potential survival challenges so you can respond appropriately.

In a crisis, first check for injuries and administer any necessary first aid. After this, your priorities are location, shelter, fire, water/food and signalling for help – usually in that order. Signalling may be a higher priority as in the case of an aircraft mishap when you should make certain that the aircraft ELT is transmitting a distress signal as soon as first aid is administered. Take action in the following order of priority.

PDAC 8.6.1 First Aid

Injuries may be part of a survival situation with additional challenges, or an injury itself may be the focus of a survival situation. Administer first aid as necessary. The injured need shelter as soon as possible but try not to move them too far. Project emergency response procedures should cover the following potential injuries:

- Vehicle, ATV, snowmobile, boat and aircraft crashes Falls with broken bones, internal injuries, abrasions
- Axe and chainsaw wounds
- Hypothermia, hyperthermia, dehydration, and altitude illness (depending on region) Serious burns
- Animal attack
- Refer to section 18.5 First Aid for information regarding treatment priorities and section 3.0 Emergency Response.

PDAC 8.6.2 Location

- If you have radio or satellite telephone contact, give a clear, accurate description of your position so rescuers can locate you easily. If you are familiar with the area and location, you can utilize nearby features to aid your survival (e.g., water sources, safe shelter).

- If you are completely lost, stop and remain where you are and do not waste energy wandering around. Proceed with the priorities – avoid exhaustion so you can think clearly. If you continue to wander, you may walk out of the area where rescuers are focusing the search. This has occurred when employees were unable to competently use a compass and/or GPS unit.
- Remember to remain with or very close to your transportation, crash site or traverse route.

PDAC 8.6.3 Shelter

Use care when selecting the site for a shelter. You need protection from the elements (cold, snow, rain, heat, and wind) to avoid hypothermia, hyperthermia and dehydration. Use your ingenuity to create shelter that is as comfortable as possible without expending much energy. Allow enough daylight to build any necessary shelter – it is a much harder job to build one in the dark. Always remember to insulate yourself from the ground by making a mat of boughs or grasses to rest on to prevent heat loss. Make use of local materials and use the contents of your survival kit (tarp, garbage bags, or space blankets) to your best advantage depending on the climate.

Criteria for Shelter Sites

Shelter should be located so you are visible yet prevent exposure to the local risks and hazards. Stay dry. Keep warm or cool. It is important to avoid exposure to wind unless wind will keep insects away. The ideal location provides good water, materials for shelter, and fuel for a safe fire for warmth and signalling.

- Remain with your transportation. Incorporate it or use it as shelter, if appropriate.
- Suspend plastic or space blankets etc., from the vehicle, aircraft or boat.
- Avoid obvious dangers such as wet overhanging branches or potential avalanches, mudslides or rockslides. Also avoid low flood-prone areas and wet insect-infested areas.
- In cold or wet weather it is vitally important to have protection from the wind. Avoid the bottom of a valley or hollows, which may be cold and damp.
- In hot climates find or create shade in an elevated place, as the temperature there will be lower than at ground level.
- A hillside or ridge may provide a breeze to relieve insect annoyance, but may not be warm enough and it may provide a target for lightning.
- Check any tree you use for shelter for insect nests (bees, wasps, ants). Check for rotting or dead branches that might fall if it becomes windy. Avoid a solitary tree (lightning target).

Types of Shelters

Plastic garbage bags

These are an essential part of a survival kit as they can be used for many purposes. Carry fluorescent or bright orange garbage bags for high visibility and signalling.

- Two large plastic garbage bags (opened at the ends and taped together to form a tube) can create shade or immediate shelter from water and wind.

- Crawl inside the tube or suspend it to make a tent. Use a rope or stick to prop up one end. Insulate beneath yourself. Anchor the edges to the ground with rocks, bark or vegetation. Note: When plastic garbage bags are used for a tube shelter, water from your sweat and respiration may condense on the inside of the plastic tube so you end up soaking wet and chilled. Plan for ventilation to avoid this dilemma.
- Slit the bags to open them up flat. Use separately or tape them together to form a large tarp. Use as a ground sheet and a cover for wind and/or rain protection.
- Use them for waterproofing for a roof on a shelter built of boughs, rocks, logs, etc.

Lean-to shelter

This simple shelter can be constructed from a wide variety of materials and is adaptable to many environments.

- Build your lean-to only as long as your height so you do not waste energy heating extra space. Allow at least two hours of daylight to build a lean-to.
- For a simple lean-to, suspend a tarp between trees, bushes, rocks etc., for a windbreak.
- Position it to protect yourself from the wind. Insulate beneath yourself.
- Build a framework from trees, sticks or tree branches – or even in combination with rocks. Make upright supports by using trees or two or three crossed, freestanding poles. These must support a ridge pole against which you lean more upright sticks at a 45° to 60° angle. This slope will allow rain to drain away efficiently. Place smaller sticks horizontally on these sticks to support the roofing material. Tie the components together using ropes, vines, grasses, shoelaces etc. Roof coverings for a lean-to shelter can consist of a plastic tarpaulin, evergreen branches, bark, palm leaves, split bamboo stems or whatever is available. Build up vegetation in layers from bottom to top as though shingling a roof.
- Make sure that layers of evergreen branches are at least 15 cm thick so rain does not penetrate. If there are heavy rains or winds, use the plastic covering on top of the branches.
- Thick bark (split bamboo in the tropics) can be laid like pan tiles. Make a gutter to drain water away. The roof need not extend to the ground in a warm climate where ventilation is desirable.
- Stuff the ends of the lean-to with vegetation to stop winds. Insulate beneath yourself.
- Build a long fire at the opening of the lean-to. Do not build two lean-tos facing each other with a fire between, as one shelter will fill with smoke.

Rock shelters

- Arctic and alpine areas above tree line are challenging terrain to find shelter. Rock can be used for shelters by creating a stone wall and windbreak combined with a tarp for a roof to control wind. An old fashioned bee hive shape can work well.
- In hot desert terrain, utilize rock overhangs and look out for caves to use for shade and shelter.

Other Simple Shelters

- Use an overturned canoe or inflatable boat as the foundation of an emergency shelter.

- Insulate beneath yourself.
- Use a fallen tree as the foundation of a lean-to shelter.
- Use two adjacent logs of unequal size with a plastic sheet stretched over them for shelter with drainage. Or use mounds of sand or rocks to support and control the placement of a tarp or space blanket. Scoop out dirt between the logs and insulate.

Cold Climate Shelters

Shelters built into snow are relatively quick to make but you need a shovel or snowshoe to dig one with any ease. Carry a lightweight, collapsible avalanche shovel. This item should be standard equipment in a survival cache for snow areas.

Keep the shelter space small – not much bigger than your body. Line the area with plastic where your body will contact snow so you don't get wet. It can be surprisingly warm if you have a small source of heat. Place the entrance to a snow shelter in the downwind direction. Always remember to insulate beneath yourself.

Hazards of Snow Shelters

- Asphyxiation: If you block the entrance to retain warmth, you must create an air hole to avoid asphyxiation. Ensure the air hole remains open throughout the night, which may be difficult if there is a storm or windblown snow. Don't forget to create an air hole in any solid snow shelter.
- Collapse: Tent shelters may collapse from heavy snow and bury and/or asphyxiate the occupants. Snow shelters may collapse if they are not strong enough or if a storm adds more weight. Keep a stick inside to help burrow out if this occurs.
- Hypothermia: Melting snow from heat generated within the shelter may get you wet.
- Snow shelters require a lot of energy to built so that you may become sweaty and then chilled from the construction.
- Lack of ventilation: Do not cook in a confined space such as a tent or snow shelter as the carbon monoxide from the cooking fuel can asphyxiate you. It is very risky to cook in any closed shelter.

Quinzhee (create your own cave)

Sometimes, only powder snow or very little snow is available. In this situation, you can scrape the snow into a mound and let it settle for several hours. Place your pack where your shelter chamber will be and heap snow on top to create a large mound. Place sticks of equal length into the mound at intervals; they should be a bit longer than the desired thickness of the walls, which must be at least 30 cm thick. After the snow has recrystallized and the snow particles are bonded together, dig a small tunnel into shelter. Remove the pack and equipment and continue to hollow out the chamber. When you encounter a stick you will know the thickness of the wall at that point. The floor should be higher than the entrance opening to retain warm air. Insulate, make an air hole for ventilation and leave an air hole at the entrance. This is a lot of work, but it provides shelter. If you make a very small fire inside for a very short time, ice will form on the ceiling and reflect your body heat.

Snow Tunnel

Locate a good sized snow drift and dig out a tunnel into it. Make an air hole for ventilation and leave an air hole at the entrance.

Snow or Fighter Trench

This is the least desirable type of snow shelter. Detailed construction is described and illustrated in *Down but not Out* and involves cutting uniform slabs of snow and stacking them at a 45° angle over the trench from which they were cut. Avoid this form of shelter if you do not have a sleeping bag as it will become a cold tomb. Dig a snow cave or a build a quinzhee instead.

Combine a trench with tree branches: Below tree line, a better solution is to dig a trench and use the snow to form walls. Make a thick insulation layer with boughs and create a roof with branches and/or a tarp.

PDAC 8.6.4 Fire

Fire provides warmth, boils drinking water, dries wet clothing, signals your location, keeps bugs away, heats food, and lifts your spirits. You should be able to light a fire under any weather conditions you may experience, which takes practice. The section on fire methods in Down but not Out contains good tips.

Ignition

Always carry at least three methods to start a fire and some dry tinder (in a waterproof bag) in your pockets. Good fire lighting materials include:

- Regular matches – carry in a waterproof container. You can make your own waterproof matches by dipping regular wooden matches in paraffin wax.
- Waterproof matches – these usually require a special surface to strike on.
- Cigarette lighter – not dependable in very low temperatures. It should have an adjustable flame, which makes lighting easier.
- Magnesium spark rod – this method takes practice to become proficient.
- Magnifying glass, camera lens – focus strong sunlight through the glass or lens onto dry woody tinder to create an ember to light the remaining tinder. This works when there is no wind.
- Vehicle battery: Use two pieces of wire and connect one to each battery terminal. Touch the free ends of the wires together next to your tinder to create a spark. It is safest to remove the battery from the vehicle and use long pieces of uninsulated wire.
- Warning: As hydrogen is present, the battery may explode, especially if you use metal tools in place of wire (spanners, knives etc.). Do not allow the wires to touch any other metal (vehicle frame) or a short circuit may occur. Flashlight or radio batteries may have enough power to produce a spark.

Fire Components

Assemble everything before building and lighting the fire. Know what local materials will burn when wet. The fuel should be within reach. Have water available to extinguish the fire.

- Tinder: Good tinder must be dry and easy to light. Use bits of cotton lint, pitch or sap, fir and pine needles, moss, shredded dry birch or cedar bark, powdered wood from insect borings, seed fluff from plants, fine steel wool etc. These catch fire quickly and they can be soaked in fuel oil if available. 100% cotton balls saturated with Vaseline are invaluable for tinder as one ball will burn for several minutes. Pack them tightly in a film canister.

- Kindling: It must catch the flame from burning tinder. Use very small twigs, dead leaves or grass, shaved wood bits, fir cones, inner bark of dead trees, dried animal scat etc.
- Sticks should be no larger than a pencil so they catch fire easily.
- Fuel: Start with dry wood. Dead branches on trees are dry and burn easily. Start with finger-sized sticks for fuel and gradually increase the size of the wood. Add fuel slowly so the fire does not smother. Green or wet wood burns slower and creates smoke to help keep insects away. Mixing dry and wet wood helps a fire last longer. If only wet fuel is available, it will require hard work to make the fire go.

Fire Location

Choose a safe place to build a fire.

- Try to locate the fire so it is visible to rescuers.
- Clear a large circle and scrape down to bare mineral soil. Build a fireplace of scraped up earth and rocks. This offers wind protection and diminishes heat loss. The fire area should be at least 2 metres wide – more if it is windy or if vegetation is very dry. Make certain no overhead branches will catch fire or drop snow on your fire and extinguish it.
- Do not build a fire on moss, needles or roots. Do not start a fire in a peat bog, as they are nearly impossible to extinguish and may smoulder for years. Do not build a fire at the base of a tree or stump or against a log because it cannot be controlled easily and may continue burning after one thinks it is extinguished – and even start a forest fire.
- Avoid using “river rocks” around the perimeter or as a foundation for a fire, as they may retain moisture inside and explode when heated. Any layered rocks that contain moisture may do the same.

Fire Building Tips

Use materials that will burn easily even when wet.

- Make your fire only as large as necessary; collect enough fuel so you don’t run out.
- Collect some extra fuel so you can quickly increase the size of the fire to attract attention when a plane is heard. One large signal fire is easier to maintain than three smaller fires separated by many metres. It is difficult to gather sufficient fuel, and smaller fires are less visible from a distance or the air than one large fire.
- Do not waste matches trying to light a poorly built fire. Build it well and then light it.
- Light a bundle of twigs and dry grasses off the ground to get it going and then insert it into carefully laid kindling and fuel sticks.
- Windy areas: Dig a trench and build a fire in the trench. Make a fire circle with rocks large enough to offer wind protection.
- Wet areas: Build a platform of green wood and cover it with earth, if possible. In flooded areas, raise this platform on stilts. Build your fire on the platform.
- Stack green or wet logs and sticks at the back of a fire to dry. They will reflect heat as well.

- Pine sap scraped from trees will burn easily. It can be added to tinder and a fire should start even when it is damp or raining. Usually pine sap can be found at the base of trees that have been scarred; it flows down and forms large clumps.
- Practice building and lighting a fire under difficult condition. Consider how much more difficult it would be if you were injured when having the warmth of a fire might be critical.

Fires in the Arctic and Alpine Areas:

- Wood for fuel is rare in the Arctic except along the coast where driftwood can be found. Carry fuel and stove or improvise with fuel from a vehicle etc. A small fuel canister and stove attachment is useful and lightweight.
- Kerosene or diesel fuel can be drained from aircraft, vehicles, ATVs or drums. Fill cans with dirt or sand, soak with fuel until saturated and then set them alight. Use rags soaked in fuel for starting a fire if wood is available. Do not use gasoline as the vapours are explosive.
- Take care not to cause a tundra fire. Build it on a platform of rocks if necessary.
- Use a platform to prevent a fire melting through deep snow, which will extinguish it.

PDAC 8.6.5 Water and Food

Water is more important for survival than food. You can live only a few days without water while you can survive a month without food. If you work in areas where water is often not safe to drink, carry water purification equipment (e.g., tablets, filter, a container for boiling). People often forget that dehydration can be a serious problem in the Arctic; do not count on streams carrying water during summer months – even when marked on a map. Never travel in desert terrain without sufficient water for everyone, extra water for emergencies, and equipment to obtain water.

Each person needs at least 10 litres (2.5 gallons) a day when working in hot climates. If you become stranded, stop work immediately and make every effort to conserve the drinking water you possess as well as the water within your body – by doing everything possible to prevent the formation and evaporation of sweat. It is better to “ration your sweat, not your drinking water”. Do not reduce your water intake in the first 24 hours of a survival situation because dehydration impairs your ability to think clearly.

To conserve body fluids:

- Make every effort to avoid sweating, crying or vomiting. Do not eat anything that might cause diarrhea.
- Drink sufficient water frequently enough to quench your thirst. Don’t just sip small amounts; you must drink enough to avoid dehydration.
- Follow the guidelines in this section for clothing, rest and shelter.
- Work to avoid sweating in cold regions or you will waste energy drying yourself and your clothes.

Sources of Water:

- The best source of water is that which you carry from the project or camp. Fill up all your containers and drink a lot to pre-hydrate yourself before departing each day. Do not presume that a stream or creek etc., will exist just because it is marked on your map.

- Surface sources such as lakes, streams, pools or watering holes may or may not provide clean safe water. They may contain viruses, bacteria, and numerous parasites including flukes, leeches etc. In dry regions, water sources may be contaminated with mineral salts.
- When searching for ground water, look for areas where plants that require water are growing. Typical plants in temperate areas include willows, rushes, cattails and cottonwoods. In Australia, look for greasewood, casurinas and baobobs.
- Check pockets and depressions in rocky areas, cavities in trees, areas with abundant insects and look for seeps in shady areas at the base of cliffs.
- Filtering water: Filter muddy or scummy water through a handkerchief if you do not have a proper filter. Let sediment settle out, decant the water and then purify it by boiling or chemical treatment, whenever possible.
- Melted ice yields more water than snow. Eating snow lowers your core body temperature unless you are very active so it is best not to eat it. If there is no source of heat, squeeze snow in your hand to liquefy it. Normally water procured by melting ice does not require purification, although it is not particularly clean.
- Lay out black plastic (bag or sheet) so that it drains into a cup. Place a very thin layer of snow (snowflakes) on the plastic and the ultraviolet energy absorbed by the black plastic will melt the snow. This method works down to -10°C and under cloud cover so it is not necessary to waste fuel melting snow to obtain water. This is especially useful in Arctic and alpine areas.
- When it rains, spread out plastic sheets, rain gear and extra clothing to catch it.
- Remember not to wet clothing that you need for warmth. Depending on the situation, hypothermia may be a greater threat than thirst.
- If you cannot remove surface water to filter it, lay a handkerchief on the surface and sip the water through the cloth.
- Sop up dew from vegetation or the surfaces of trees, vehicles, rocks etc. Do this before dawn before dew evaporates.
- Learn which plants in the project area will yield water and how to retrieve it. Some vines yield water when cut and held vertically. Some plants are easily chewed to release water. Be careful, as it may be difficult to correctly identify many plants.
- Never drink water from plants with milky sap or sap that turns black if exposed to air. Cacti may not a good source of water as some contain toxic water.
- Use clear plastic transpiration bags to obtain water. Select healthy, lush, non-poisonous, broad-leafed plants. Seal a clear, plastic bag around several leafy branches that receive direct full sunlight. A pebble in the bag will weigh it down so water can collect at the bottom. Depending on the source, up to about 125 ml of water can collect before the atmosphere within the bag becomes saturated and the tree stops producing water. Drain the water by making a small hole. Reseal the bag with tape to repeat the process. Place several bags on a tree or shrub at once. This method often yields more water than a solar still, but the water will taste of the plant of origin and may be unpalatable.

- Make a solar still: Water can be obtained by distillation by digging a solar still. The best site to make a solar still is where the earth is damp and easy to dig, although dampness is not necessary. Dig a new one when the still no longer produces water. This method requires high energy output for a low yield of water. Water procured by this method does not require purification.
  - Dig a hole 0.75 m deep and 0.75 to 1 m wide. The sides should slope so they do not cave in.
  - Place a container in the bottom and cover the hole with a 2x2 m piece of clear or white plastic.
  - Anchor the plastic around the edge of the hole and weigh it down with a stone to form a cone (about 0.5 m deep) over the container.
  - As the air warms within the still, water from the ground will condense on the underside of the plastic and drip down into the container. Insert a piece of tubing in order to sip the water without disturbing the still. Add cut vegetation, water from a vehicle radiator or urine to the hole to provide additional moisture for distillation.
- Create a simple desalination unit with two containers and a piece of tubing. Place one container with water over a heat source, preferably a fire, but a hot engine might work. Cover the container but allow the tubing to extend from the top into a second cool container. Steam produced in the first container should condense in the second container after passing through the tubing. Use aluminum foil, leaves etc., for the covering material if a lid is not available. Salt water and non-potable water, including urine, can be turned into potable water by using this distillation process.
- Never drink urine because it forces your kidneys to filter concentrated impurities from your body. Do not drink water from vehicle radiators as it is toxic. However, you can add urine, sea water, polluted water or water from vehicle radiators to the earth of a solar still or to a desalination unit. Then, potable water will be distilled into the container.
- If you are dehydrated and lack water treatment equipment, it is better to drink scummy, dirty water than none at all. Let it settle as long as possible and heat it if possible. It is not advisable to drink water containing alkali salts. Check that the water contains living creatures to indicate it can support life and is not toxic.
- Dark coloured urine is an indication of dehydration.

Sources of Food

The availability of food sources depends in good part on the season of the year, the latitude and elevation of the region.

- Most foods require water to aid digestion. The less water available, the less food you should eat. You can live far longer without food than without water. Do not eat anything if you have no water available at all.
- When you carry freeze-dried food packets and cans of sardines etc., in your pack, you will have better nourishment than what chocolate bars provide.
- Use any food supplies that are already open as they will spoil first.
- Try to consume protein foods first because they require water to digest. Save your carbohydrate foods for later, as they produce water within your body during digestion.

- Eat native plants and animals only if you are certain that they are not poisonous. Obtain local knowledge to be certain about which plants and animals are edible.
  - In general, avoid any with red, yellow or white berries; those with milky sap; stinging, bitter or acidic tasting plants; and fungi. Just because birds and animals eat a plant or berry does not mean it is safe for humans to eat. If in doubt – do not eat it.
  - Many insects, and small animals (e.g., rodents, amphibians, reptiles) are edible, as well as small game and birds. Depending on the region, local knowledge is important because some insects and small animals contain toxins (e.g., tropical tree frogs).
  - *Down but not Out* contains information about making snares and traps, fishing methods and cooking procedures.
- Clean and wash all food sources, if possible. Make sure they are as fresh as possible as toxins occasionally develop as plants age. It is advisable to cook most gathered foods so there is less chance of getting sick. All meats, including insects and grubs are best cooked before eating to kill potential parasites, etc. Vomiting and diarrhea, even in cold weather, can quickly cause dehydration that may progress to death.
- In Canada, stinging nettles are edible. Employees working in temperate areas should be familiar with stinging nettles. Harvest them with gloves and boil them like spinach; they do not sting once immersed in hot water. Cattails are edible any time of the year. Peel the roots before cooking them; shoots and immature flowers are edible boiled or steamed.

PDAC 8.6.6 Signaling

Signals must stand out against the existing background and look man-made. When you are the target of a search make signals as visible and noticeable as possible. Remain in the vicinity of your signals.

- Locate signals where they will be seen by searchers. A ridge top or high point and an open meadow on flat land will be visible from the air; signals on slopes may be seen from below but not necessarily from the air if the searching aircraft approaches from the far side of the ridge. Therefore signals placed at or near the top of a hill/ridge are most likely to be noticed.
- Consider what signals will stand out best, which depends on the season, the weather and the light conditions. Use any and all possible methods that are safe and appropriate for attracting attention.
  - Flashes from a signal mirror can be the most effective as they can be seen for many kilometres.
  - Fluorescent orange helicopter cloth is highly visible. It is most visible when you wave or run with it – so move it to attract attention. Tie several together to make a bigger block of colour. Stake it to the ground if necessary. However, when foliage is highly coloured in the fall, consider carrying fluorescent blue helicopter cloth as the fluorescent orange may blend with the foliage.
  - Fires: Smokey fires are noticeable during the day, especially if the smoke is black. At night, flames of large fires are visible.

- Flares: Flares are useless in the day except for smoke flares. Red distress flares can be seen for only a short distance. Set flares off at night only when you are certain they will be seen. Flares with dye markers work well on water and leave a bright mark on snow and ice.
- Three of a signal indicates an emergency (e.g., fires, smoky fires, blasts of a whistle, flashes from a mirror, flashes of headlights, gun shots).
- Wave with both arms to attract attention. A single arm wave may be regarded as a greeting.

● SOS is the internationally recognized signal for distress. The signal: 3 short – 3 long – 3 short. The sequence can be made with lights, whistle blasts or other noise making devices, or spelled out with letters etc. Stay near your SOS sign – do not leave unless you leave a clear detailed message indicating your direction of travel and date.

● Do not set off an EPIRB (Emergency Position Indicator Radio Beacon) unless you are in a life-threatening emergency situation. EPIRBs tie into international search and rescue organizations and an inconvenient night out in the bush is not a reason to activate an EPIRB. Refer to Chapter 19. Communications.

● Destroy all ground signals when you are rescued.

Signal Mirrors

A flash from a signal mirror can be seen a long distance even in dull weather. Directing the sun's reflection onto a target is quite easy when the sun is high in the sky, but it can be difficult to do when the sun is low. Practice helps.

The best signalling mirrors have a small sighting hole in the centre to use to pinpoint the target. Any mirror will work – a Brunton or Silva compass mirror are excellent – and if necessary, you can improvise with a can lid, aluminum foil, a chrome piece or the side or rear-view mirror from a truck. Use three quick flashes to signal an emergency. Repeat them, but DO NOT sustain a flash signal onto a nearby plane or landing aircraft as the signal may momentarily blind the pilot.

To use a signal mirror without a sighting hole:

● Hold a mirror under your sighting eye.
● Extend your arm outwards and form a "V" with two fingers.
● Sight the aircraft or object in the point of the "V".
● Tilt the mirror under your eye so the sun's reflection also passes through the "V" in the direction of the aircraft. Flash the reflection on your target.

Fire and Smoke Signals

● Prepare signal fires but do not light them until you hear a plane. This preserves fuel and the required energy to keep them going. Stack smoke-producing material near each fire to add when required. Cover prepared fires to keep them dry if necessary.

● Smoke is most visible during the day. Try to create smoke that contrasts with the landscape or vegetation. To produce smoke, add ferns, green leafy branches, green leaves, wet magazines, moss, rubber tires or diesel fuel (carefully). Fuel, rubber and plastic produce dark smoke. Soak fuel into logs and then add the logs to a fire. Do not add fuel directly to the fire. Puncture tires to prevent an explosion.

- Fire is most visible at night, on dull days or in low light conditions. Where possible, make three fires a minimum of 30 m (100 ft) apart to form a triangle. Fires in a straight line are acceptable along a river or restricted area. One good fire is better than three small ones.
- You can set an isolated tree (torch tree) on fire by building a fire in the lower branches. Light it when you see or hear a plane. Make very sure that you will not start a brush or forest fire.

Noise Signals

- Three repeated sounds are recognized as a distress signal. Leave at least 5 seconds between each sound and at least 15 seconds between each series of sounds (one minute is a better interval).
- A whistle blast carries much farther than shouting. A whistle is a highly recommended part of a survival kit. Keep it on a cord around your neck or fastened to your field vest.
- Gunfire attracts attention except on an aircraft, as the sound cannot be heard. Never fire in the direction of an aircraft. Gunfire will not attract attention in daylight hours during hunting season. It is wiser to use other signals and preserve ammunition for other uses.
- Other noises to attract attention: banging rocks together, hitting sticks on a tree, firing bear-bangers etc.

Pyrotechnic Signals

Flares designed for marine use are recommended for use on both land and water. These flares are far superior in terms of visibility than the pencil variety that is standard issue for most field work. Carry signal flares that produce enough smoke or light to be seen from a long distance. Small flares fired from pen-like holders are not very effective. Flares fired from pistols are brighter and reach a higher altitude – therefore, they are more useful in a survival situation.

Tips about Flares

- Do not scrimp on flares. Emergency caches should be well equipped with an assortment of flares, especially parachute and meteor flares. Buy the best brand available regardless of cost because your life may depend on the effectiveness of the flares.
- The best flare to buy carries a SOLAS designation (SOLAS is a division of the International Maritime Organization). SOLAS designated flares meet very strict specifications. They are waterproof, easy to fire and extraordinarily bright – all essential requirements of a flare when you want someone to spot it. Cheap ineffective flares will only give you a false sense of security and will fail to perform when really needed (i.e., in a life-threatening situation). The flares and flare gun must be able to propel a flare well above the tree canopy.
- Use red flares to indicate distress and use white flares for illumination.
- To fire flares, hold them at arm’s length above your head. Aim them in a near vertical direction, away from all people. Note: Plastic cases may crack in cold weather; if the case is cracked, a flare may shoot sideways.

- Flares have expiry dates. Make sure to have fresh flares – but you may keep expired flares as backup if they are in good condition. Discard any flares that show signs of leaking or corrosion according to jurisdictional requirements.

Types of Flares

There are two major categories of flares – hand-held and aerial. See the table below to compare various features of flares.

- Hand-held flares are similar to highway flares. They provide a ground signal that burns for a relatively long time, usually one to two minutes. Use them when you want a rescue vehicle or aircraft to home in on you.
- Parachute flares are high altitude signals. They are propelled upwards to 300 m (1,000 ft) in the air so they are visible for a great distance. They burn for 25 seconds with a brightness of 10,000 to 30,000 candlepower. SOLAS parachute flares have a self- contained launcher; other types require a launching pistol and typically burn for a shorter time and with less brightness.
- Meteor flares rise from 75-150 m (250-500 ft) in the air and last 10 seconds. They fall quickly; therefore rescuers must be looking in your general direction to see them. They should be launched in pairs. The first flare attracts attention and the second confirms the first. Meteor flares are launched from either a special flare gun or a launching barrel.
- Smoke flares provide visible signals only in the daytime and are effective for aerial searches. They last a short time but are good for indicating wind direction to a pilot. Their ash will leave a noticeable mark on snow. SOLAS versions can be tossed into water and will not ignite oil or fuel on the water.
- Shell crackers and screamers emit a loud noise and many emit a bright light as well. Refer to section 10.3.9 Bear Deterrents for additional information.

Aircraft Emergency Locator Transmitters – ELTs

- In most countries, an ELT is mandatory equipment on every aircraft. The device automatically broadcasts a distress signal to the Cospas-Sarsat search and rescue satellite system when an aircraft is involved in a crash. ELTs have a manual switch for testing purposes and emergency use if the automatic switch fails. Pilots should show passengers where the ELT is located before flights. Information regarding Cospas-Sarsat is available at the following website: http://www.sarsat.noaa.gov/
- Employees who use charter aircraft should know how to activate an ELT in case it fails to engage after an emergency landing or crash. To broadcast a signal with the best range, remove the ELT and place it as high as possible so that it has a 360° range. Always make sure the ELT is connected to an antenna, which should be in the vertical position.
- If you are forced down and no emergency exists (e.g., bad weather), DO NOT activate the ELT. Notify the project, anyone in charge of the flight plan or itinerary, or an aircraft passing overhead of your situation. This will prevent an unnecessary search and rescue effort. If you cannot contact any of these parties, a search will begin at the agreed upon time in project SOPs and ERP. At this time – when the search begins – turn on your ELT to help rescuers locate you.

- Once started, an ELT signal should not be turned off. Search and rescue efforts need to receive the continuous signal to home in on it. ELTs should transmit a signal for 48 hours at -20°C, if the batteries are properly maintained.

Ground to Air Emergency Signals

- The following standardized symbols are used to communicate from the ground to an aircraft when there is an emergency. Be familiar them even though they are not used frequently because people routinely carry satellite phones in the field. Symbols 1 to 5 are internationally accepted; symbols 6 to 9 are for use in Canada only.
  - Require Assistance V
  - Require Medical Assistance X
  - No or Negative N
  - Yes or Affirmative Y
  - Proceeding in The Direction -
  - All Is Well LL
  - Require Food and Water F
  - Require Fuel and Oil L
  - Need Repairs W

Tips for creating noticeable ground to air signals:

- Make the symbols BIG. Symbols should be a minimum of 6 m long, but 15 m long is better. Space them at least 3 m apart. They should be visible from 360° if possible.
- Contrast is the key. Use what will be most visible for the season, light conditions and their location on the ground.
- Letters should be angular with straight lines and square corners so they look man-made and stand out from the natural background.
- Make a trench in snow or sand in the shape of the signal. Pile the snow or sand all on one side of the trench to help maximize a shadow effect.
- Outline letters trampled in snow or sand with brush, dirt, peeled logs, green boughs, rock piles, seaweed etc.
- Scrape away vegetation or turn it upside down to expose soil.
- Cut or trample grass to form signals in a field or meadow. Burn grass only of you can control the fire.
- Destroy the signals when you are rescued to avoid initiating a second search.

PDAC 8.7 Search and Rescue (SAR)

When you are lost or injured, follow the priorities set out in section 8.6 to keep yourself safe. Maximize your chances of being seen by rescuers by following tips in this section that are appropriate for the climate and terrain. If an employee is missing, alert the project supervisor and follow project SOPs and ERPs.

PDAC 8.7.1 Guidelines for the Lost or Injured Person

Be aware when small problems are adding up to become a large problem. A bad situation is frequently the end result of a series of small mishaps. When things begin to go wrong or you become lost, disoriented, are injured or are in a crash, do the following:

- Sit down and calmly evaluate your situation. Do not panic. Your greatest resource is your intelligence; do not go anywhere or do anything without carefully thinking through the situation. Mentally review the group discussion scenarios, company SOPs, appropriate ERPs and act accordingly (see below, and section 8.3.2 Knowledge).
- Immediately go into survival mode. Do not wait to see if someone shows up. Do not expect your situation to suddenly improve.
- Stay at the site if there has been a crash or a breakdown. Otherwise, find a place where you will be easily located by search teams such as a clearing, high spot, or along a grid line; if you are injured, administer first aid. Get organized, get set up and stay there. Use the remaining daylight, warmth of the day, your strength and resources to organize your field crew or yourself and build a shelter and fire. Set out signals to indicate your location. Do not wander off. If it is necessary to hunt for wood or water, leave a detailed message with the date and time, where you have gone and when you will return.
- Consider the means of transportation in terms of what mode of transportation you were last using and what mode of transportation will most likely be used to rescue you. Often it may be a combination so give consider the following options:
  - Vehicle – try to go to a road
  - ATV – go to a track or trail
  - Snowmobile – go to a track, trail or frozen lake
  - Boat – go to river, lake or sea
  - Helicopter – find a place where a helicopter can land
  - Float plane – go to a lake where the plane can land
  - On foot – could be anywhere so find a highly visible location where signals will be seen and heard.
- Make a plan: List your options. List of pros and cons and consider them to arrive at a "best option". Then, devise a plan and stick to it unless there is a radical change in circumstances. If this occurs, go back to your list of options and start the process again.
- Document what is happening in order to keep an account of details. Record what works and what does not work and keep an inventory of supplies (food, water, batteries etc.). It is easy to lose track of time. Without information it is difficult to plan.
- Avoid panic. Control your anxiety by gathering fuel etc., setting priorities and work at solving immediate challenges.

Potential Scenarios

The following are potential scenarios with general suggestions to handle the emergency.

- If you do not appear at the pick up spot: Do not retrace your route unless there is lots of time. When the pilot (or driver) realizes you are overdue, the first search will be along your planned route from the finish point back to the starting point looking for signals from you. If you are able, go to a conspicuous place, light a fire or make ground signals and wait. If the pilot cannot locate you, a crew will start following your planned traverse on foot while helicopter searchers try to analyze where you may have gone astray. Attend to the fire, build a shelter, prepare a smoke or signal flare and wait.

- If you are at the correct pick up spot and your transportation does not arrive – stay there. A helicopter or vehicle may have broken down and it make take several hours, or even days, to repair or replace it. Your location is recorded by those in camp so stay at the pick up point. There may be other employees scattered through the area or stranded with the aircraft. If you know of another crew or person and their traverse is close by, you could try to communicate and meet up with them. However, return immediately to your pick up point if you fail to locate them. Leave a prominent signal and a note indicating your plans and direction of travel at your pick up point if you leave for any reason, even for a short time.
- Aircraft accident or breakdown: Always follow the pilot's instructions regarding the aircraft and setting up the ELT etc. If this is not possible, the most experienced or most senior person should be in charge to make sure the ELT is functioning and sending signals. It may be difficult to spot the aircraft if it is in water, thick timber, or covered in snow. The ELT signal may not transmit through the body of an aircraft if it is upside down. Follow the priorities in section 8.5 and prepare for a wait – it should be a short wait if the aircraft is on or near the flight plan route. If the aircraft is off the flight plan route or not easily visible, be prepared for a longer wait. Stay with the aircraft and move from the site only if you require a safer or more visible location. Leave a prominent detailed note with the aircraft indicating your plans and leave markers along the trail for searchers to follow. Searches will normally be conducted during daylight hours so prepare signal fires for use.
- Once clear of the aircraft, the most experienced or most senior person should take charge of organizing the survival situation. This person may or may not be the pilot, as many bush pilots today rely heavily on technology and lack relevant survival training and bush experience in the local terrain.
- When a search is conducted by aircraft, it can be very difficult to see a person on the ground, especially if they are in brush or timber or if the person is not moving. Run and wave helicopter signal cloth to create motion, which will catch the eye of the searchers. Searchers will be looking for unusual sights that stand out from the background, so make sure signals contrast with the background. In addition, use a mirror to attract attention when you hear an aircraft in the distance.

PDAC 8.7.2 Guidelines for the Project or Camp Manager

Anyone who has failed to check in by a predetermined time interval should be reported as "missing" and the appropriate project ERP should immediately be activated. Follow set procedures when a person, vehicle, boat, or aircraft is overdue. Refer to Chapter 3. Emergency Response.

Person in Charge

Contact the employee's supervisor and provide the following details:

- Who is missing: name, age, description, clothing, physical and mental state, equipment being carried
- Length of time the person is overdue
- Location where the person was working: Work site, details of traverse route, grid line etc.
- Last known position, last location seen, last location heard from
- Working alone or with a partner
- Direction person was moving; speed at which the person is capable of moving
- Destination: where they are supposed to be
- Weather conditions Other pertinent facts

Search and Rescue Headquarters

Organization Requirements

- One designated person is in charge, which would normally be the project manager or second in command if that person is not present.
- Communications: One person should be in charge. Check that all means of communication are working because good communication is essential. Only one designated person should talk to the media or public.
- Designate who should organize food, water, supplies and fuel for searchers. This may be the expediter.
- First aid assistance should be organized and ready at search headquarters Keep a master map at the headquarters.

Search Parties Organization

Follow the company emergency response plan and procedures. If an immediate search or rescue is attempted before engaging officials:

- Go to the place where the person is most likely to be found (i.e., where his or her truck is parked).
- If the missing person is not found right away, notify the organizations in charge of search and rescue. Depending on the jurisdiction, there may be different SAR organizations for land, sea, and air searches (e.g., police, RCMP, military, Coast Guard).

PDAC 9.0 Weather and Environmental Risks

Introduction

Exploration field employees may work in highly variable physical and climatic environments, and possibly where they have little or no previous experience. Consequently, they risk exposure to unfamiliar natural hazards, which may be weather related, environment related, terrain related or a combination of these hazards. When commencing exploration projects in new and unfamiliar or high risk areas, the best approach is to learn as much as possible from knowledgeable sources and perform risk assessments to determine which risks and hazards are likely to be most significant. It may be advisable to hire experts to help assess the risks, develop safe operating procedures (SOPs) and train field crews, especially if crews are inexperienced. Additionally, it is important not to become complacent about risks and hazards after gaining experience in a region. Information in this section should be helpful in developing safe operation procedures and training topics for safety meetings and to mitigate risks.

PDAC 9.1 Weather Hazards

Local and regional weather may impact project management. For example, a project field headquarters or a camp should be located where it will not be vulnerable to unusual winds, flooding, lightning strikes, or avalanches etc. Risk assessments should include the means of access to and from the site because access may be compromised by weather if aircraft cannot fly, or if flooding, snow or other events prevent access by road. Contingency plans should be developed to address these possibilities. Traversing activities should be planned to take into account local weather patterns as some areas may be subject to unique weather (e.g., sudden electrical storms, fog at certain times). Therefore, it is advisable to learn about potential weather patterns and know how to make short term predictions. Potential weather patterns can be determined using resources such as Weather Underground and AccuWeather.com that provide current weather conditions as well as seasonal weather averages (almanac) information. The World Map of Natural Hazards has information regarding some weather related natural hazards such as lightning and severe storms.

Websites:

- http://www.wunderground.com/
- http://www.accuweather.com/
- http://www.munichre.com/publications/302-05972_en.pdf

PDAC 9.1.1 General Preparations

Weather related risks and hazards should be addressed for each project.

- Complete a risk assessment and include the potential impact of weather related hazards (refer to section 2.1.5). Include the following:
  - Location: field camps, work sites, drill sites, fuel storage areas, helicopter landing sites, air strips etc.
  - Transportation: potential for stranding and accidents en route to and from sites.
  - Terrain hazards and traversing routes for those working on foot.
  - The project supervisor should develop site specific safe operation procedures (SOPs) and emergency response plans (ERPs) that take into account the observations and conclusions of the risk assessment.
  - Develop plans to mitigate risks. For example, if late afternoon lightning storms are common, employees should be required to complete traverses in the early afternoon.
  - Training should cover the SOPs, ERPs and specific ways to handle potential weather related emergencies. Hold a practice drill if an ERP includes evacuation procedures.

Employees who traverse or work away from camp should:

- Obtain up-to-date weather forecasts for the project area (if available).
- Receive training to recognize the signs of impending severe weather appropriate for the project area (e.g., flash floods, thunderstorms, whiteouts).
- Learn to recognize cloud formations and the weather they indicate in order to make short term weather forecasts. Watch for sudden shifts in wind direction, rapid temperature changes etc., and recognize the significance of the changes.

Learn the prevailing weather patterns in the area such as:

- When to expect local storms.
- When to expect thunderstorms.
- The time of day strong winds may develop.
- The potential effect of winds or squalls causing dangerous waves etc., if working on or near water.
- The potential risks of blizzards, whiteouts, ice storms etc., in winter.

PDAC 9.3 Whiteouts

PDAC 9.3.1 Risks and Hazards

Some of the risks and hazards include but are not limited to:

- Serious injury or death caused by hypothermia and/or frostbite, lack of emergency shelter and supplies, inability to locate emergency shelter or cache.
- Slips, trips, and falls caused by walking on slippery or steep ground with limited visibility.
- Disorientation or getting lost caused by limited visibility, loss of battery power (navigation and communication equipment).
- Vehicle crashes caused by operating when visibility is reduced.
- Stranding (a potential survival situation) caused by inadequate preparation, lack of emergency shelter and supplies, getting lost, loss of battery power (communication and navigation equipment).
- Risk of animal attack due to the fact that polar bears approaching Arctic camps cannot be seen in whiteout conditions.

PDAC 9.3.2 Prevention and Preparation

Whiteout conditions greatly reduce visibility. The term “whiteout” refers to weather conditions that produce a combination of light, atmospheric and ground conditions when landscape features and the atmosphere appear to merge and become indistinguishable. Due to the loss of depth perception when you cannot distinguish between the land, sky and horizon, it is easy to become disoriented and it can be impossible to see changes in terrain. Whiteouts may occur in the Arctic, in mountain regions, in open areas without trees – especially on plains, or along highways with little side shelter from trees etc. They often develop when blowing snow on snow covered ground obscures visibility and loose, wind-driven snow swirls high into the air. Whiteouts may also develop during heavy snow squalls, blizzard conditions and when clouds merge with glacier or snow-covered ground surfaces. A dense fog on a snowy surface may produce true whiteout conditions. “Flat light” conditions may occur when low light is produced by overcast conditions or fog, or when a thin fog covers a snowy surface. Whiteouts may be very local in extent or may cover many square kilometres.

Whiteouts are always dangerous. As whiteouts and flat light conditions may seriously reduce visibility and affect safety, be prepared when working away from the project or camp. It need not be snowing or foggy for whiteouts to occur; sudden winds may cause whiteout conditions to develop rapidly. Make sure company vehicles are equipped with survival equipment. When renting a vehicle, always carry personal survival equipment and food and water – especially in winter.

Preparations for projects located where whiteouts may occur:

- Develop SOPs and an ERP to address potential whiteouts specific to the project area and train all personnel in the procedures. Hold a drill to make sure employees respond correctly and rescue/evacuation procedures work.
- Designate an experienced person to declare a “whiteout alert” when whiteout conditions occur – or are likely to occur – so warnings can be issued in time for people to return safely to the project or to access established survival shelters.
- Maintain a rigorous tracking system for the location and movement of all employees. Erect survival shelters at all drill sites and supply them with food, water, a heat source, first aid and communication equipment.
- Equip projects with sufficient Global Positioning System (GPS) units and spare batteries to allow all employees or field crews who must travel in poor weather conditions to carry them. Make sure everyone working outside the project site knows how to navigate using a GPS unit.
- Consider supplying larger projects with an enclosed Challenger or Bombardier type snow machine equipped with GPS for rescue purposes.

Prepare travel routes in areas where whiteouts may occur.

- Mark all regularly travelled routes with fluorescent orange painted pickets every 10 to 20 metres. Remember that windblown snow may fill in tracks or trails very quickly so the pickets may be the only trail indicators.
- Map routes carefully with a GPS. Label each picket so travellers can identify their position at each stake.
- Stay on established routes whenever possible.
- Employees who travel in poor weather conditions should be required to carry a GPS unit, a satellite telephone and extra batteries in addition to their survival equipment and be trained to competently use all items.
- Snowmobiles should always be fully equipped with survival and communication equipment for long journeys on unmarked routes. Carry extra fuel.
- Fuel: Check that the vehicle is full of fuel before departing on each trip. This is very important when weather conditions are marginal. Vehicles should be fully equipped with survival equipment. Always maintain the fuel tank at least half full when travelling long distances.

When a whiteout is declared:

- All travel should halt and people should remain where they are.
- All mechanical operations should go on standby (e.g., drilling). All work that might result in injury should cease, as rescue is likely to be impossible until the weather clears.
- Contact all personnel outside the base camp or project by radio and verify their location.
- Maintain radio contact on an hourly schedule.
- Employees at the project site should not walk to any nearby destination unless there is a clearly marked path (e.g., water pumps, garbage disposal areas or fuel caches). They risk becoming disoriented, getting lost, developing hypothermia and/or death.
- Rescue attempts of persons stranded in a whiteout should be undertaken only if the condition of the person is critical and a GPS-mapped route to follow exists. Otherwise, the risk of the rescuers becoming lost is too great.

If you are caught in a whiteout:

- Do not try to travel to the project site if you are near a survival shelter. Go to the shelter.
- If no established shelter is available, build a snow shelter using your survival equipment (refer to section 8.6.3 Shelter). Moving is too dangerous and there is extreme danger of becoming lost or walking off a cliff etc.
- Communicate with the project base and give GPS coordinates if you know them. Keep in contact with the project base on an hourly schedule.
- Think about your precise location and any possible geographic hazards between you and the project site in order to caution potential rescuers.

If travelling on public roads and whiteout conditions develop:

- Slow down and increase your following distance. Avoid passing and changing lanes.
- Make sure your headlights and tail lights are turned on.
- Find a safe location as soon as possible and pull off the highway as far as possible and wait for conditions to improve. Turn off your lights or another vehicle may think you are on the road and “follow” you. For more information, refer to section 8.5.1. Survival Advice for Cold Climate Conditions.
- If it is necessary to leave your vehicle during whiteout conditions, always tie a cord to yourself and the steering wheel or door handle so you can find your way back.

PDAC 9.7 High Winds

Strong winds can pose a significant threat to safety. Isolated or diseased trees and those in marshy areas may be easily uprooted by winds. If working in a forested area when high winds arise, the safest place is in a large clearing or a sheltered ravine. Old forest fire burns can be especially dangerous as the tops of burned trees easily break free. Avoid the base of cliffs. When working on water, follow the SOPs and safety tips in Section 17. Boats, Canoes and Inflatables.

Preparations for projects where dangerous high winds may occur:

- Take potential high winds into account before locating a project, camp or work site. Avoid locations where individual trees might be blown over by winds (remove diseased trees). Consider the potential for windblown dust, sand or snow.
- Carry out a risk assessment and develop site specific SOPs and an ERP to address potential risks and hazards associated with high winds. Train personnel to follow the procedures. Hold a practice drill if the ERP includes plans for emergency evacuation.
- When setting up camp, make sure stationary camp equipment is very securely anchored to prevent damage by wind (e.g., propane cylinders and generators). Tents must be very durable and secured with extra lines.
- Where tornadoes are a high risk, projects should be located in reinforced concrete buildings.

The Beaufort Wind Scale below can be utilized as a gauge for the severity of wind conditions both on water and land. It is a useful tool when it is necessary to judge the wind speed in a remote location where there are no local weather reports.

Beaufort Wind Scale Table

Force	Wind Speed		Descriptive Term	Effects Observed at Sea	Effects Observed on Land
	Km/h	Knots			
0	Less than 1	Less than 1	Calm	Sea surface like a mirror, but not necessarily flat.	Smoke rises vertically.
1	1 - 5	1 - 5	Light Air	Ripples with the appearance of scales are formed, but without foam crests.	Direction of wind shown by smoke drift but not wind vanes.
2	6 - 11	4 - 6	Light Breeze	Small wavelets, still short but more pronounced. Crests do not break. When visibility good, horizon line always very clear.	Wind felt on face. Leaves rustle. Ordinary vane moved by wind.
3	12 - 19	7 - 10	Gentle Breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered whitecaps.	Leaves and small twigs in constant motion. Wind extends light flag.
4	20 - 28	11 - 16	Moderate Breeze	Small waves, becoming longer. Fairly frequent whitecaps.	Raises dust and loose paper. Small branches are moved.

Force	Wind Speed		Descriptive Term	Effects Observed at Sea	Effects Observed on Land
	Km/h	Knots			
5	29 - 38	17 - 21	Fresh Breeze	Moderate waves, taking a more pronounced long form. Many whitecaps are formed. Chance of some spray.	Small trees in leaf begin to sway. Crested wavelets form on inland waters.
6	39 - 49	22 - 27	Strong Breeze	Large waves begin to form. The white foam crests are more extensive everywhere. Probably some spray.	Large branches in motion. Whistling heard in telephone wires. Umbrellas used with difficulty.
7	50 - 61	28 - 33	Near Gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	Whole trees in motion. Inconvenience felt in walking against wind.
8	62 - 74	34 - 40	Gale	Moderately high waves of greater length. Edges of crests begin to break into the spindrift. The foam is blown in well-marked streaks along the direction of the wind.	Breaks twigs off trees. Generally impedes progress. Walking into wind almost impossible.
9	75 - 88	41 - 47	Strong Gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.	Slight structural damage occurs, eg. roofing shingles.
10	89 - 102	48 - 55	Storm	Very high waves with long overhanging crests. Dense white streaks of foam. Surface of the sea takes a white appearance. The tumbling of the sea becomes heavy and	Trees uprooted. Considerable structural damage occurs.

Force	Wind Speed		Descriptive Term	Effects Observed at Sea	Effects Observed on Land
	Km/h	Knots			
				shock-like. Visibility affected.	
11	103 - 117	56 - 63	Violent Storm	Exceptionally high waves. Sea completely covered with long white patches of foam. Visibility affected.	Widespread damage.
12	118 - 133	64 - 71	Hurricane	Air filled with foam and spray. Sea entirely white with foam. Visibility seriously impaired.	Rare.

Source: Beaufort Wind Scale Table, URL: http://www.msc-smc.ec.gc.ca/weather/marine/beaufort_e.html, Marine Weather Services, 2007. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2009.

PDAC 9.8 Environmental Risks

Exploration workers face many challenging environmental conditions: cold and windy, hot and humid, or high altitude – which can be either hot or cold and windy. Exposure to temperature extremes and to high altitude can cause disorders with subtle and progressive symptoms that are difficult to diagnose accurately. Your body can function well only if your core body temperature (that of your heart, lungs, liver, kidneys and brain) remains very close to “normal”, which is 37ºC. Your body may tolerate a variation of ±1.5°C from this optimum core temperature without much impact. A variation beyond this range will result in stresses that interfere with your biochemical processes and may result in a life-threatening condition. Your brain requires blood at the correct temperature and oxygen level in order for you to think clearly. For this reason, confusion and lack of muscular coordination are some of the signs of dehydration, hypothermia, hyperthermia, and altitude illness.

Your body controls its internal and surface temperatures through processes that result in heat loss and heat gain. Heat loss takes place through evaporation, convection, conduction and radiation from your skin surface and through respiration from your lungs. Heat gain is a function of your metabolism and activity level. Under extremely hot conditions you may experience heat gain through radiation from the sun and/or the environment. To a great extent, you can control heat loss and heat gain through your behaviour (e.g., food and water intake, clothing, exercise, rest). Keeping your body properly hydrated and acclimatized along with the proper use of clothing are major factors in preventing hypothermia, hyperthermia, and altitude illness. Thorough preparation before work and an understanding of these environmental disorders may save your life or that of a co-worker.

PDAC 9.9 Cold Injuries

It is usually possible to prevent cold injuries by wearing appropriate clothing in layers to regulate your comfort level, by taking warm-up breaks, and by paying careful attention to preventing dehydration and fatigue. Dehydration will affect your blood flow, which in turn affects your circulation. Diminished blood circulation will lead to hypothermia, frostbite, and immersion foot.

PDAC 9.9.1 Risks and Hazards

Some of the risks and hazards related to cold injuries include:

- Death or injuries caused by hypothermia, falling into cold water, breaking through ice Injuries to body parts caused by frostbite or immersion foot. Injuries may include temporary or permanent tissue and/or nerve damage.
- Loss of fingers, toes or feet caused by serious cold injuries (frostbite, immersion foot)
- Hypothermia or frostbite may be caused by:
  - Wearing inadequate clothing, getting wet, dehydration, fatigue
  - A work schedule that lacks sufficient warm-up breaks
  - Travelling by snowmobile at too high a speed
- Increased severity of cold injuries may be caused by:
  - Low temperatures combined with wind chill
  - Lack of training, lack of an emergency shelter and/or emergency cache
  - Remote location causing difficulty getting a patient to medical care
  - Co-workers that do not recognize the symptoms of cold injuries
- Transportation risks: delays in moving a victim to a medical centre caused by storms, whiteouts, mechanical breakdown
- Survival situation for individuals or a group caused by one or more members developing hypothermia

PDAC 9.9.2 Project Planning to Prevent Cold Injuries

Project planning should include the following measures:

- Complete risk assessments that include a review of the potential impacts of cold-related risks and hazards on project and drill site locations, traversing routes, fuel storage etc., and first aid emergencies. Develop strategies to mitigate the risks and hazards.
- Develop site specific SOPs and ERPs that address the observations and conclusions of the risk assessments.
- Training should cover the SOPs, ERPs and specific ways to recognize and handle potential cold-related emergencies. First aid attendants should be trained to recognize and treat hypothermia, cold water immersion hypothermia, frostbite and immersion foot. Hold a drill if an ERP includes evacuation procedures.
- Plan outdoor work schedules with warm-up breaks appropriate for the daily temperature and wind chill factor.
- Extensive information regarding working in cold conditions is available at the following websites:

- http://employment.alberta.ca/documents/WHS/WHS-PUB_gs006.pdf http://www.labour.gov.sk.ca/coldconditions

PDAC 9.9.3 Hypothermia

Hypothermia is preventable. Hypothermia develops when your body loses heat faster than you can produce it through metabolism and exercise. As a result, your core body temperature falls to a level where internal organs, including your brain, cease to function effectively. Hypothermia can develop quickly and it can be fatal. Wet, cold, windy weather combined with hard physical effort can lead to exhaustion and leave you vulnerable to hypothermia. Temperatures need not be especially cold for hypothermia to develop; it frequently sets in at temperatures between -1° and 10°C.

Prevention and Preparation

Stay Warm – Stay Dry – Avoid Fatigue – Avoid Dehydration – Avoid Hunger

- Stay warm: Dress appropriately in layers. Wear several layers of loose-fitting clothing with enough space between each layer to entrap 4 mm (1/4 in) of air. Keep your head warm by wearing a wool hat. Wool clothing is recommended, as it retains 80% of its insulating qualities even when wet. Polar fleece fabrics offer good warmth. Down is a good insulator only when it is dry. Try to avoid 100% cotton as it provides minimal insulation even when dry; when wet, it conducts heat away from your body many times faster than wool. Wear an external windproof layer and always carry waterproof rain gear, preferably the “breathable” kind, as it allows perspiration to escape. Refer to section 6.3.5 Clothing.
- Stay dry: Try not to work up a sweat as wet clothes may chill you. Strive to maintain a comfortable body temperature. Anticipate how your activity will impact your body temperature and remove a layer of clothing before you begin strenuous activity. You will warm up soon, and if you don’t, you can put the layer back on. If you get too warm while working, cool down by removing gloves first (if your hands won’t be exposed to ice or snow). Next, remove your hat and scarf exposing your neck area. Then, loosen the clothing at the wrists and waist. Some jackets have armpit zippers that open to provide ventilation. Finally, remove layers of clothing. A polar fleece or down vest helps keep your trunk warm and allows your arms to remain cool. Rain gear: Rain jackets should be long enough to prevent rain from leaking into your pants. For the best protection, put on rain gear before you get wet.
- Avoid fatigue: Rest frequently. Fatigue is often the factor that aggravates a difficult situation. When resting, take shelter from the wind and sit on something (a pack) for insulation from the ground or snow. If it will be necessary to set up a camp, do so before fatigue sets in as it is easier to warm up if you are not fatigued.
- Avoid dehydration and hunger: Your body cannot combat the cold efficiently if you are dehydrated or hungry. Dehydration reduces your blood volume and impairs circulation, so drink plenty of fluids throughout the day. Start the day well nourished and snack often on high energy foods. Carry waterproof matches and fire making materials to make a fire and a hot drink, if necessary.
- Recognize weather conditions that may cause hypothermia. Be prepared.

- Beware of wind chill. The cooling effect of wind on your body can be enormous. Wear windproof clothing, a hat and take shelter from the wind, if necessary. See 9.9.7 Wind Chill Calculation Charts.
- Use the "buddy system" and be on the lookout for signs of hypothermia in yourself and others. Recognize and address the early signs and symptoms to avoid further problems.
- Always believe the signs, not the patient, as he or she may not recognize them as hypothermia.
- Be aware of and follow Workers Compensation Board guidelines for time limits for working outdoors in cold temperatures. Come indoors periodically to warm up and drink hot fluids.
- If there is the slightest chance that someone is suffering from hypothermia, never leave the person alone or let them wander off, as their condition may suddenly deteriorate.
- Use good judgement and respect safe outdoor procedures.

Symptoms and Recognition

Hypothermia is a progressive disorder. The severity of hypothermia is clinically determined by core body temperature, which is difficult to measure in a field setting as it requires a rectal thermometer that measures lower temperatures than regular thermometers. It may be possible to treat mild hypothermia (core temperature 32°C) in the field, but severe hypothermia (<28°C) is life-threatening and is extremely difficult to treat in the field. Therefore, it is vitally important to recognize and address early indications so that hypothermia does not progress to the severe stage and create a potential field medical emergency. There are both physical and behavioural signs and symptoms caused by reduced blood circulation to the limbs and brain. Early symptoms can be subtle and hard to recognize, and no single symptom is diagnostic of hypothermia. Never leave a potential hypothermia patient alone as their condition may deteriorate suddenly.

To help remember the signs of mild hypothermia, a mnemonic from Medicine for Mountaineering & Other Wilderness Activities, by James A. Wilkerson is very helpful:

"The hypothermic subject mumbles and grumbles (personality changes) and fumbles, stumbles, and tumbles (loss of coordination)."

Mild Hypothermia (35-32ºC)

- Cold extremities: Feeling cold and numb is the first symptom. Shivering may be intermittent or constant and uncontrolled. Rapid heart rate (tachycardia)
- Rapid breathing (tachypnea)
- Slight loss of coordination (i.e., some difficulty performing tasks with the fingers and hands)

A person with mild hypothermia may be alert and answer questions sensibly – or not. He or she is focused on getting warm rather than the task at hand. A person may just appear "tired" when he or she is actually hypothermic. It is very important to treat a hypothermic patient at this stage. Do not allow him or her to become colder.

Moderate Hypothermia (32-28ºC)

- Further loss of coordination and clumsiness (may stumble frequently) Weakness and drowsiness, fatigue (wants to rest or go to sleep)
- Reduced shivering Dehydration
- Slurred speech and amnesia Apathy, poor judgement

A person with moderate hypothermia stumbles frequently and is uncooperative and may be confused. Speech becomes slurred and shivering may cease as the patient loses more body heat. The patient may wish to be left alone. A patient of moderate hypothermia is in grave danger and may die if hypothermia progresses. Stabilize the patient to stop further heat loss and gently transport him or her to a medical facility.

Severe Hypothermia (<28ºC)

- Total loss of shivering
- Inappropriate behaviour (e.g., removes warm clothing)
- Reduced level of consciousness
- Muscle rigidity
- Slow heart rate and low blood pressure
- Cardiac arrhythmia (irregular heart rhythm)

The inability to walk or stand indicates severe hypothermia. A person who appears asleep may actually be in a coma. Severe hypothermia cannot be properly managed in the field so evacuation to a medical facility is necessary. Handle the victim very gently as rough handling may cause ventricular fibrillation due to the presence of arrhythmia, which often results in death.

Treatment for Mild Hypothermia

When you encounter someone with hypothermia, take immediate action to prevent further cooling. Mild hypothermia can be treated in the field, but moderate and severe hypothermia should be treated at a medical facility.

- Prevent the patient from losing more body heat. Insulate the patient from the ground.
- Get the patient into some sort of shelter. If there is no indoor shelter, use whatever is available (a tent, an overturned canoe, a space blanket or tarp, branches, rocks or snow) for a windbreak to help prevent the patient from cooling further. Build a fire as soon as possible, but beware of potential carbon monoxide poisoning from a heat source in an enclosed space. Carbon monoxide directly reduces the oxygen carrying capacity of the blood and this effect increases with altitude.
- Gently remove the patient's wet clothes without exposing the patient's bare skin to wind or rain, if possible. A group can share dry clothing to the extent that no other member becomes endangered. If wet clothing cannot be replaced, gently remove clothes, wring them out and replace them.
- Hypothermic wrap: Insulate the patient including the head and neck. Insulate all extremities with a hat, gloves and socks to prevent further heat loss, but do not apply external heat to these parts of the body. Covering the head is very important, as about 50% of body heat can be lost from the head of a hypothermic person. Wrap a survival blanket or other vapor barrier around the (wet or dry) clothed patient to prevent evaporation and add more insulation by further wrapping with blankets, sleeping bags, spare jackets etc.

- Warm the patient:
  - Place warmed objects next to the patient such as chemical hot-packs, hot water bottles or heated rocks that have been wrapped with a cloth to prevent burns to the skin. Place them under the armpits and the sides of the chest; do not warm the extremities (limbs) initially, as this can cause the peripheral blood vessels to dilate and result in a drop in blood pressure. The dilation of peripheral blood vessels also allows cooler peripheral blood to enter the torso area, which can cause the core temperature to drop further – a condition known as "afterdrop".
  - If a hypothermic wrap is not possible, you can warm a patient by placing him or her, stripped, in a warmed sleeping bag next to or between one or two other stripped people who are not suffering from hypothermia. Their body heat will slowly warm the patient.

The following measures will also help treat hypothermia.

- Give warm drinks (without caffeine or alcohol) to a patient who is conscious and not shivering uncontrollably. Sweeten drinks with sugar (not with sugar substitutes) and dilute full strength soft drinks and fruit juices with lots of water.
- Always handle the patient gently. Do not rub the skin or make the patient perform vigorous exercise if they are approaching signs of moderate hypothermia. Rough handling and movement can cause cardiac arrhythmias that may cause death.
- A patient with moderate and severe hypothermia should avoid unnecessary activity to prevent cold blood from circulating from extremities into the body core. Place the patient in a horizontal position so cold blood does not pool in their legs. Seek medical attention as soon as possible; complications frequently develop with hypothermia.
- Severe hypothermia may result in respiration and pulse rates that are undetectable; the pulse may be less than 20 beats per minute and even as low as one beat per minute. For this reason, never consider a patient to be dead until he or she is "warm and dead".

PDAC 9.9.4 Cold Water Immersion Hypothermia

Falling into cold water (<21ºC) is a life-threatening emergency that may put an individual or an entire group at risk by creating a serious survival situation. Hypothermia develops swiftly if you fall while crossing a cold mountain steam, capsize a raft or fall through ice. It is essential to wear an appropriate personal flotation device (PFD) while working where you could fall into cold water.

You won't float without a PFD, and the combination of "cold shock" and wearing heavy clothing, boots, hammer, a vest with field equipment (and perhaps a heavy pack with rocks) makes it almost impossible to swim. Your chances of survival are very poor unless you are wearing a PFD, as demonstrated on the following website: http://www.coldwaterbootcamp.com/

Note: Even prolonged exposure to water as warm as 27ºC will cause cold water immersion hypothermia.

Treatment

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. Once on shore, build a fire immediately with the contents of your survival kit, which should be distributed in your clothing. Concentrate on warming the head and trunk areas and put on dry clothing. If none is available, remove clothing one item at a time, wring it out to reduce the water content and put it back on. Transport victims horizontally to a medical centre, if possible.

- Refer to section 17.12.3 Cold Water Immersion Hypothermia for detailed general and technical information.
- Refer to section 15.11 Cold Water Immersion Hypothermia – Falling Through Ice for additional information including the best self-rescue method.
- Refer to Section 17.5.3 Information about Specific Equipment regarding various PFDs.

PDAC 9.9.5 Frostbite

Frostbite occurs when body tissue freezes. Early indications of frostbite are white patches on the skin. Exposed skin (ears, nose, neck, cheeks) and extremities (fingers, toes) are most commonly affected because blood circulation is reduced when your body attempts to keep its core temperature stable. Blood circulation is further restricted when wearing tight clothing or boots. Hypothermia and frostbite often develop at the same time and wind chill is frequently a contributing factor.

Risks and Hazards

- The risk of frostbite is caused by:
  - Exposure to cold temperatures below freezing when wearing inadequate clothing or boots, restrictive clothing or boots that cut off blood circulation, skin is exposed
  - Lack of training when co-workers fail to recognize or ignore the signs of frostbite
  - A work schedule that lacks sufficient warm-up breaks
- Permanent tissue damage, gangrene, and even amputation caused by severe cases of frostbite to extremities (hands and feet), the ears and nose
- The severity of frostbite may increase with exposure to wind chill caused by riding a snowmobile at high speed.

Prevention and Preparation

- Stay warm and stay dry. Many precautions to prevent hypothermia apply to frostbite.
- Wear appropriate clothing: Pay attention to the areas of your body that may be exposed to cold and wind.
  - Boots: Make sure that boots are not tightly laced or fit too tight. Much heat is lost through the soles of the feet so if insoles are worn for extra insulation, buy boots large enough to accommodate them. Don’t wear extra socks if they cause boots to fit too tightly. If working on glaciers, release tight crampon straps when taking a break.
  - A balaclava or face mask will protect your face (especially your chin and throat) better than a hat alone.
  - Wear mitts rather than gloves for greater protection.
  - Avoid tight clothing that might restrict circulation (i.e., jacket cuffs or gloves).

  - Clean clothing insulates better than dirty clothing (e.g., socks, long underwear and outer garments).
- When riding a snowmobile, the combination of speed, exposed skin and weather conditions may lead to severe wind chill and frostbite. Wear appropriate clothing including a special warm helmet with liner and very warm gauntlets. See section 9.9.7 Wind Chill Calculation Charts below and refer to Section 15. Snowmobiles.
- Use the “buddy system” and watch for signs of frostbite on co-workers – white patches on their nose, cheeks, ears etc.
- Wiggle your fingers and toes occasionally to encourage circulation.
- Set reasonable time limits for working outdoors in cold temperatures. Come indoors periodically to warm up and drink hot fluids. Companies should follow Workers Compensation Board guidelines for time limits for working outdoors in cold temperatures. Refer to the following website for an example of a warm-up schedule: http://www.labour.gov.sk.ca/coldconditions
- Wear gloves when handling volatile fuels, as these products may cause immediate frostbite when they come in contact with your bare skin. Cold metal surfaces can do the same. Protect your hands when working with metal tools (wrenches etc.).

Symptoms of Frostbite

Frostbite develops when water in and around cells begins to form ice crystals. As cells freeze, blood can no longer circulate through the affected tissue and eventually the tissue freezes solid.

- Numbness: Be alert for numbness or pain in fingers, toes, nose, cheeks or ears. If the weather remains the same and the pain or numbness subsides, the condition of the affected area is getting worse, not better. Warm any cold area of your body as soon as you detect numbness.
- Frostnip: Skin is pale, numb and cold but is still soft and easily moved; it is not true frostbite. White or gray patchy skin develops on the face (ears, tip of the nose, cheeks), fingers or toes.
- Superficial frostbite: Skin does not move easily over the knuckles or toes; skin becomes hard and waxy and a dent will remain if you push on it.
- Deep frostbite: The affected area becomes frozen solid.

Treatment

Address frostnip and superficial frostbite as soon as possible to prevent increasing tissue damage. Major tissue damage can occur if a frozen area is incorrectly warmed. Never thaw frostbitten tissue if it is likely to refreeze, as this causes permanent tissue damage. Transport the victim to a medical facility for thawing procedures.

- Frostnip and superficial frostbite may be treated in the field; deep frostbite should be treated only at a medical centre. Deep frostbite should be taken as seriously as a severe burn.
- Warm the frozen part(s) against a warm part of the body. For example hold fingers under the armpits.
- Do not rub affected areas with anything. Rubbing will cause trauma within the frozen tissue as the ice crystals rub against cells.

- Never thaw the frostbitten area with direct heat (e.g., fire, heating pad, chemical hot packs).
- Protect the thawed areas with sterile dressings, especially between affected fingers and toes. Keep the victim warm to promote good circulation and elevate the feet.
- Do not break any blisters that may form. This will help prevent infection, which commonly accompanies frostbite injuries. Seek medical attention as soon as possible if blisters form.
- For large frostbitten areas: Thaw the affected area rapidly in a tub of warm water 37°-39°C. This temperature is important and must be maintained. Suspend the affected limb in the water so that it does not touch the sides of the tub. If the ears or face are affected and cannot be submerged, use hot compresses maintained at this temperature. This procedure is painful and should be done in a medical facility whenever possible.

PDAC 9.9.6 Immersion Foot

Immersion foot (also known as trench foot) results when blood vessels in the feet constrict because of prolonged exposure to cold, wet conditions, often when temperatures are in the -1° to 5°C range. It is a non-freezing injury due to poor blood circulation that causes nerve and muscle injury when insufficient oxygen reaches the tissues. If ignored, immersion foot may eventually develop into wet gangrene, which is difficult to treat. Although immersion foot usually develops when the victim works long hours in wet leather boots and socks, it can also develop from continuously wearing sweat-soaked socks in boots. You need not be working in mountain snowfields or streams to develop immersion foot.

Risks and Hazards

Some of the risks and hazards of immersion foot include:

- Sore feet, blisters and ulcers caused by prolonged exposure to cold, wet conditions Permanent muscle, nerve damage and even gangrene and potential amputation may result from severe immersion foot.

Prevention and Preparation

It may only take about 12 hours to develop immersion foot, therefore prevention is important.

- Dry socks: Keep a good supply of dry socks on hand and change them during the day if work requires your feet to get wet.
- Boots: Wear appropriate boots. Make sure boots and socks are not too tight – avoid constricting blood flow to your feet.
- Wear appropriate layered clothing to stay warm so your body does not automatically reduce blood flow to extremities in an effort to keep your core organs warm.
- Put on dry boots and socks when you return from work.
- Make sure your feet are dry and warm at night – never sleep in cold wet socks.

Symptoms

- Feet become swollen, cold and pale; they feel numb or tingling.
- In extreme cases the feet become cold, swollen and the skin appears mottled and bluish (cyanosis).

- When feet are warmed they become red and there is a painful pounding as the blood pulses through the feet. It may take 24 hours before the pain sets in.

Treatment

- Warm your feet slowly at room temperature, if possible. Elevate feet to reduce the swelling and avoid walking.
- Ibuprofen may help reduce swelling and pain, although pain may be so severe that medication does not help.

PDAC 10.0 Wildlife

Introduction

Wildlife may present a danger to field employees ranging from nuisance level to life-threatening. Depending on the location, the major risks may be large mammals, reptiles or insects and include potential attacks, bites or the diseases that result from bites. In addition to safety issues, many animals that may be encountered are endangered species and are protected by legislation. All field employees have a responsibility to avoid disturbing the environment, including animals, as much as possible.

Definitions

- Food conditioned – Animals that learn to associate human activity with a meal are referred to as food conditioned animals. They can become aggressive in their pursuit of human food and cause property damage or human injury (e.g., bears, monkeys).
- Human habituated – An animal that is repeatedly exposed to humans at close range without negative experience learns to tolerate them at these distances.

PDAC 10.1 Risks and Hazards

Risks and Hazards related to wildlife include the following:

- Death and/or injuries caused by animal attacks (bears, crocodiles, snakes, dogs, monkeys)
- Camp invasions by bears caused by poor choice of camp location, lack of preparation (no bear deterrents, firearms, electric fencing, bear guards), poor camp maintenance and inadequate food and waste handling (available attractants)
- Snakebite (tissue damage from venom) caused by not following safe traversing procedures, lack of training; increased risk of tissue damage due to improper treatment for snakebite, panic of the victim
- Anaphylactic shock caused by stings from insects (bees, wasps, ants) to people with allergies
- Diseases caused by insect bites: examples include malaria, dengue fever, Chagas disease, Lyme disease, yellow fever, various forms of encephalitis, plague
- Diseases caused by animal bites such as tetanus, rabies; diseases caused by contact with animal waste products such as Hantaviral disease, histoplasmosis, leptospirosis

- Insect and rodent infestations caused by poor kitchen cleanliness, poor housekeeping practices
- Damage to property (invasion of camp) caused by not following SOPs, inadequate food and waste handling resulting in available attractants
- Vehicle collisions with large animals caused by driving in hazardous areas, at high risk times, at too high a speed

PDAC 10.3 Bears

Bears encounters may be a threat to the safety of field employees and to company property. All employees working in bear country should receive bear safety training that is relevant to the project location. Employees need to know (1) how to maintain camps to prevent attracting bears, how to avoid bear encounters and understand bear behaviour – especially workers who traverse, (3) details of the bear response plans, and (4) contact information for the local government wildlife agency. Wildlife officials should be able to provide local knowledge regarding bears and provide assistance with the removal of a troublesome bear to avoid destroying it.

Employees who traverse should learn about preferred bear habitats, bear behaviour, how to minimize contact with them, and how to react during an encounter. Anyone traversing or working at drill sites should always carry at least two types of bear deterrents – pepper spray and loud noise-making devices – and be trained to use them correctly. Where bear safety concerns are highest, employees should traverse in pairs or threes and in sight of each other. Where there is a perceived threat to life, companies should hire trained bear guards, or qualified field employees may be advised to carry firearms on traverse. In these circumstances discuss the situation with experienced personnel and comply with all regulations with respect to firearms purchase, use of company (or permitted personal) firearms, and required training.

General bear safety information has been compiled from numerous sources. The PDAC extends special thanks and recognition to Andy McMullen, BEARWISE, 14 Tees Court, Yellowknife, NT X1A 3L5 Canada, bearwise@theedge.ca. As Chair of the Safety In Bear Country Society, he has granted permission for the PDAC to use material from the Safety In Bear Country series of instructional videos (in DVD format) produced by the Society. In addition, the following websites are especially informative:

- http://www.enr.gov.nt.ca/_live/pages/wpPages/Safety_in_Grizzly_and_Black_Bear_Country.aspx http://safety.eas.ualberta.ca/node/13
- http://www.environmentyukon.gov.yk.ca/pdf/howyoucanstaysafe.pdf
- http://www.amebc.ca/documents/resources-and-publications/publications/current/safety%20guidelines-web.pdf

PDAC 10.3.1 Precautions and Preventions

Where bears are a risk:

- Seek local knowledge from wildlife officials, elders and others with expertise regarding bears in the project area.

- Use the observations and conclusions of risk assessments when choosing project or camp site locations and traverse routes. See section 10.3.4 Tips for Camp Site Location.
- Develop site specific bear response plans appropriate for the local species of bears. Plans should address various scenarios including when a bear is sighted on traverse, near camp and if a bear enters camp. Training sessions should include drills both in daylight and at night to address potential bear emergencies (see section 10.3.7 Bear Response Plans).
- Adhere to SOPs, especially regarding camp cleanliness, food handling and waste management. Minimize bear attractants.
- Trained bear guards: In high risk areas it is advisable to hire trained bear guards to protect traversing employees and company property. Trained bear guards are usually local people who have completed a training program that covers firearms safety and the use of appropriate deterrents in response to recognized bear behaviours. If trained bear guards are not available in the project area, training programs can be arranged through BEARWISE (bearwise@theedge.ca).
- Bear safety training is essential for every employee, including all contractors' employees.
  - Employees should receive a bear safety course from a wildlife official or competent person prior to beginning project work. Refresher training is advised for long time employees.
  - Train employees regarding the appropriate distances to use various bear deterrents.
  - If firearms are present in camp, it is advisable to hold firearms practice for employees authorized to use them. In Canada, a Possession and Acquisition Licence (PAL) is required to use a firearm.
  - Videos by the Safety In Bear Country Society are available for training sessions. They are available through the distributor's website: https://www.distributionaccess.com
    - *Staying Safe in Bear Country,* Safety in Bear Country Society, Revised Edition 2008. This program presents the accumulated knowledge of many bear specialists. It shows various bear behaviours that field workers should recognize and how to react during various bear encounters. Field employees, supervisors and managers who work on projects in bear country should be familiar with the content of this program. Available in English and French.
    - *Working in Bear Country*, Safety in Bear Country Society, 2001. This program is designed to be shown in conjunction with Staying Safe in Bear Country for a target audience of industry managers and supervisors. The program stresses the need for good planning regarding communication, camp location, site food preparation and waste management, along with bear deterrents, warning systems and bear response plans. Available in English.
    - *Polar Bears: A Guide to Safety*, Safety in Bear Country Society, 2006. This program presents information about typical polar bear habitats, how to avoid

encounters, and appropriate responses to polar bear encounters should one occur. Available in English, French and Inuktitut.

PDAC 10.3.2 Types of Bears

All species of bears have an extremely keen sense of smell, good eyesight, and excellent hearing. They can run faster than any person and can swim very well.

- Polar bears (Ursus maritimus) inhabit much of the land and ice bordering the Arctic Ocean and Hudson Bay. They are common in parts of the Arctic Islands and they occasionally range as far as 150 km inland. They are outstanding swimmers and may weigh up to 800 kg. Unlike other bears, polar bears are predominately carnivorous and their preferred diet is ringed and bearded seals. People in the Arctic may encounter polar bears in any season and need to be careful all year round. Unlike other bears, there is no time when all polar bears are in winter dens. While many retreat temporarily to a den to conserve energy or escape stormy weather, it is only the pregnant females who disappear for most of the winter. Polar bears frequently hunt and travel in the evening and at night. Do not let your guard down in polar bear country as it is always possible to encounter them. When companies work in polar bear country they should hire trained bear guards; traversing employees should work in pairs or groups of three where one person continuously stands armed guard. Information regarding polar bears has been compiled from the Safety in Bear Country Society video Polar Bears: A Guide to Safety and following websites:
  - http://dsp-psd.pwgsc.gc.ca/Collection/R62-342-2001E.pdf
  - http://polar.nrcan.gc.ca/about/manual/ch2/16_e.php
  - http://icwdm.org/handbook/carnivor/PolarBears.asp
  - http://www.nunavutparks.com/english/visitor-information/polar-bear-saftey.html

PDAC 10.3.3 Bear Habitats and Signs

If you work in bear country, keep your eyes open and be prepared for bears encounter. Bears have preferred feeding areas and travel routes; they are always moving in search of food.

Preferred habitats for polar bears include:

- Ice suitable for catching seals: Where wind and ocean currents create pressure ridges, cracks or leads, seals can find breathing holes and polar bears can find seals.
- Coastline and beaches on the mainland and Arctic islands are favoured when the annual ice melts and disappears. Females with cubs move from the land toward the coast and onto remnant ice to hunt seals. Polar bears stay on the ice close to the seals as long as they can. Then they move from the ice as it melts onto land (or farther north on the permanent ice). Bears often drift into shore on ice. They hide among large beach boulders, vegetation, driftwood and remnant icebergs.
- On land the most common place to encounter bears is along their travel routes: beaches peninsulas and shore islands, or valley passes. Bears can approach from the sea.
- Drifting in on pieces of ice they can turn up unexpectedly anywhere on shore.

- In autumn, polar bears move to where the ocean freezes earliest, the calm water of fjords and large bays where rivers empty into the sea. As soon as the ice is thick enough to support them they move back onto it to hunt.

Bear Signs

Learn to recognize bear signs. They may indicate if a bear is in the immediate area or has recently passed through.

- Bear tracks: Be able to identify the species, especially where their ranges overlap. Learn to tell how recently the tracks were made. Look for evidence of cubs – smaller tracks – and note if there may be more than one cub.
- Bear scat: It will reflect the present diet, which changes somewhat throughout the year. Scat will be black and runny and may contain hair if derived from meat; it will be more fibrous if derived from vegetation and may contain lots of berries or seeds.
- Dug up areas: Grizzlies often dig up colonies of ground squirrels, insects and roots. Black bears and grizzlies pull apart logs and stumps to search for food.
- Carcasses: Do not approach carrion, gut piles or animal carcasses, especially if they are partially covered with dirt or leaves. They may be a food cache for a nearby bear.
- Daybeds: Do not approach a daybed or resting place. Bears often rest in the middle of the day in cool places by streams or near recent kills. A daybed may appear as flattened vegetation or a dug out area. They often rest on sandbars by salmon streams.
- Marks on trees: Look for claw marks, rubbed or scraped areas on tree trunks. Bears rub against trees and leave hair behind, which can be rather high up on the trunk if they stand on their hind legs to rub their back.
- Den areas: Seek local knowledge to avoid known den areas. Bears are a hazard if disturbed when in their den, especially a mother with cubs.
  - Polar bears are unlike other bears, as there is no time when they are all in winter dens. While many retreat temporarily to a den to conserve energy or escape stormy weather it's only the pregnant females who disappear for most of the winter. After the annual ice melts and bears are on land, they may briefly rest on or in remnant snow banks and dig earth dens.

PDAC 10.3.4 Tips for Project or Camp Site Locations

Avoid bear problems when setting up a project site or temporary camp.

- Check with knowledgeable people (e.g., local wildlife officers) to avoid setting up camp where bears are known to cause problems.
- Do not locate a project in preferred seasonal bear habitat and on their travel routes.
- Try to choose a site with good visibility in order to see an approaching bear.
- Choose a site where noise (such as a rushing stream) does not block the sounds of your camp to an approaching bear.
- Look elsewhere for a camp site if you observe signs of bears (e.g., droppings, tracks or day beds).

- People in any camp site should (1) never sleep in the open without a tent, and (2) always use a flashlight at night when going to and from latrines or between buildings or tents.
- Bears often forage at night.
- In polar bear country, try to camp inland on a high point of land (always away from the shore) where you can easily observe the surrounding area. On land, the most common place to encounter polar bears is along their travel routes, beaches, peninsulas, near shore islands or valley passes. Avoid camping in the following places:
  - Peninsulas or points of land jutting into the ocean. Remnant ice often runs aground on peninsulas providing the bears with access both to ice and land. The peninsulas make easy travel routes and they may swim between points of land and near shore islands.
  - Coastal shorelines and beaches: In spring many bears move to areas along the coast where ice is more stable. As ice melts some bears seek out the last remaining ice in sheltered bays and inlets. If ice is drifting onshore, bears may be on it. They are forced onto land when the ice disappears.
  - Any place where rocks, vegetation, a hill or other land feature might provide a hiding place for a bear
- Additional information is available on the following websites:
  - http://www.environmentyukon.gov.yk.ca/pdf/howyoucanstaysafe.pdf
  - http://www.absc.usgs.gov/research/brownbears/safety/safeconduct.htm

The project or camp layout can help minimize bear problems. Depending on the jurisdiction, there may be a required setback distance from riparian habitat.

- Environment Yukon publication Guidelines for Industrial Activity in Bear Country provides many recommendations, including a camp layout and the optimum distance between sleeping quarters and cooking facilities, latrine and incineration facilities. Refer to the following website:
  - http://www.environmentyukon.gov.yk.ca/mapspublications/documents/Guidelines_for_Industrial_Activity_in_Bear_Country.pdf
- Set up tents in a line or a semi-circle, never in a circle, square or other closed configuration. If it becomes necessary to deter or shoot an invading bear, you do not want a tent in the line of fire.
- Use as few tents as possible. Fewer, larger tents offer more safety than many smaller ones. Leave sufficient space between tents so a bear can easily escape without getting tangled in support ropes.
- Surround established camps with trip wire fences with motion detectors or electric bear fences in polar bear country and anywhere there is a major risk from bears. See section 10.3.6 Bear Warning Systems for Camps.
- Where bears are a problem, tent frames, steps and other camp structures should have skirting to prevent creating a hiding place for bears (and other wildlife such as wolverines). All exits should have adjacent windows so you can check for bears before

leaving. In high risk areas, buildings and tents should have a window on each side and large buildings should have two exits.

- Remove vegetation near camp that might hide a bear. Try to eliminate blind corners when arranging tents and buildings.
- For fly camps, set up a tripwire fence with an alarm if you see or suspect bears to be in the area. These noise-makers should wake you if a bear attempts to enter camp at night.
- Keep winter camps well lit, especially in the Arctic. Keep bear spray and a good flashlight in each tent.

PDAC 10.3.5 Food Handling and Waste Management

Control the smells of food and waste products to minimize attracting bears. All bears have a very keen sense of smell; they will seek out and find carelessly stored food and incompletely burned garbage. Camps must be kept clean, whether they are established camps or fly camps. Projects should have a policy to never feed any wildlife, as this encourages animals to become human habituated and food conditioned.

Guidelines for Food Handling and Storage

Follow these guidelines for projects and camps:

- Restrict food to the kitchen and eating areas; no food should be allowed in sleeping or work areas. Food should be stored to prevent easy access by bears. In a very small camp, food should be stored in bear proof containers.
- Set up the cooking area separate from the sleeping area. The space between the locations should be open with clear visibility to prevent bear encounters when walking between them. When possible, 50 m is recommended.
- Prepare only enough food that can be consumed at one meal. Store any leftover food in sealed, metal or plastic containers and eat the leftovers as soon as possible. If you lack stronger containers in a fly camp, several layers of airtight very heavy plastic bags may work if they are carefully sealed.
- Use non-greasy foods whenever possible (bears seek out greasy foods). Use or incinerate all leftover grease as soon as possible. If stored, grease must be kept in an airtight container and used as soon as possible. Use common sense and always defrost meat in a refrigerator – not out in the open, on a work surface, or by the barbecue.
- Thoroughly wash all utensils and food preparation and eating surfaces after each meal.
- If a camp will be left unattended during the day, it is very important to prevent bears and other animals from accessing food. Place all food in metal storage drums whenever possible. In addition, strong smelling foods should be carefully sealed in layers of resealable plastic bags. Consider using a “Critter Gitter”, an infrared motion detection device that emits a very loud noise and flashing lights to scare off animals that enter the designated detection area. Mount it so the food is in the detection area (see section 10.3.6).
- For fly camps, suspend food stores (caches) between trees when possible. Food should hang at least 4 m off the ground and at least 100 m from the sleeping tent.

- Wrap lunch food carefully to prevent odours. Any leftover lunch food in daypacks should be removed and disposed of properly each day.
- Keep food, other than well sealed food in survival kits, out of vehicle, boats and helicopters.
- Do not sleep in clothes that have been worn while cooking. Store them in the cooking area if possible, not in your sleeping tent.
- Store all items with odours away from sleeping tents. This includes toothpaste, lip balm, shaving cream, soaps and shampoos, all cosmetics, petroleum products, sunscreen, insect repellent etc.
- If fishing from a boat, use a container to hold the fish. Clean fish far away from camp and dispose of fish guts where a lake is deep. Thoroughly scrub canoes or boats if fish have come in contact with them. Bears will demolish a canoe and pop every section of an inflatable boat in search of fish if they detect the smell of slime and fish remains.

Guidelines for Waste Management

Proper waste management is fundamental to camp safety, as garbage smells attract bears from great distances. All waste odours create hazards for people, for company property and for the bears.

- Follow all applicable regulations and secure required permits regarding garbage and waste disposal.
- Burn garbage daily, preferably after each meal, but do not burn it in the evening when lingering smells might attract bears while people sleep.
- If garbage is not completely burned to ash, store the residue in airtight containers and keep it in an appropriate area protected from bears. Remove it to a proper disposal site.
- Incinerators: If burning is permissible, most regions require the use of an incinerator rather than a burn barrel for the job. Use a commercial garbage incinerator that complies with local regulations. (An incinerator is different from a burn barrel, as the barrel cannot burn garbage sufficiently to remove odours that attract bears.) Keep spare parts for the incinerator on hand for repairs to prevent a build up of garbage.
- Where permitted, incinerate all garbage completely to ash and cool it; then remove it to an off site facility or bury it at least one metre deep and 200 metres away from camp. Incompletely burned garbage retains smells and attracts bears even when buried. In open areas it is advisable for the burning site to be visible from camp in order to monitor it.
- Burn barrels: A burn barrel, an oil drum punched full of holes to allow some extra airflow for a hot fire, may be acceptable for a very small, temporary camp, but this method requires a lot of attention and fuel to thoroughly burn garbage. Always cover the top of a burn barrel with a wire mesh lid to prevent sparks from starting a forest fire and stop animals and the wind from removing garbage. Check local regulations.
- Burn barrels require the use a slow burning fuel (such as diesel) with lots of air to create a hot incinerating fire. Quick burning fuels do not burn garbage thoroughly; they scorch the garbage and spread the smells. The smells from any fire that smoulders will attract bears.

- Grey water – the water left over from dishwashing, showers and washing machines – should be carefully treated to remove odours. Where regulations permit, use dolomite lime in the sumps in preference to a solution containing bleach solution. Do not allow grease or fine food particles to accumulate in sumps; use grease traps to recover the waste and then incinerate it. Cover sumps with plywood to minimize access and odours. It is recommended to fence in large sumps (required in some jurisdictions). Large permanent camps should treat grey water with approved waste treatment systems. In small camps with no grey water disposal system, strain food bits out of dishwater. Place them with garbage and pour dishwater into a proper location and treat it with dolomite lime to remove odours.
- Proper maintenance of sewage and latrine systems is necessary to control odours. Use dolomite lime and earth regularly in latrines. Burn all tampons and sanitary napkins in a very hot fire.
- Wash all bottles to eliminate odours and dispose of them as permitted (i.e., fly out unburned garbage).
- Recycling cans: Storing pop cans for recycling is not advisable in bear country as their smell is a strong attractant. It is better to squash them … burn them …and then recycle or dispose of them according to local regulations.
- Drink boxes create a lot of garbage that attracts bears. Try to find an alternative.

PDAC 10.3.6 Bear Warning Systems for Camps

To increase camp safety, professionally designed bear warning systems are recommended for use at all projects in polar bear habitat and at sites where bears may pose a significant risk. Electric fences are a bear deterrent, whereas trip wire fences, infrared motion detection devices and dogs are bear detection systems.

- To be effective, any alarm system must be properly installed and maintained and each alarm that sounds must be checked out. Even with a warning system fence for protection, a camp should not be located in an area with high bear traffic.
- Erect the warning system the first day to discourage curious bears, especially in polar bear country.
- A warning system will not necessarily deter a bear; it is designed to warn people of their presence and give people time to assess the situation and act accordingly.
- Do not develop a false sense of security just because the camp has a warning system. It is still extremely important to keep the camp free of attracting odours and operate in ways that minimize potential contact with bears.
- Use warning systems together with bear deterrents. When a bear is spotted approaching camp, use an appropriate deterrent as soon as possible to prevent it coming closer and possibly obtaining food (see section 10.3.9).

Electric fencing for camps

Portable or permanent electric fences can be designed to surround part of or an entire camp as a bear deterrent. Depending on the camp size and layout, it may be advisable to have two or more fenced areas. Fences can be powered by solar panels, batteries or from a generator. Construct them so they are properly grounded and check the perimeter frequently to maintain the fence.

Post warning signs at critical places to remind employees of potential electric shock. The following website has information about electric fencing and bear safety: http://www.bearsmart.com/becoming-bear-smart/community/electric-fencing

Trip wire fences

These fences work well as a detection system (not as a deterrent) for fly camps or small camps that are moved frequently. Set the fence up 10 m away from all sides of the camp or a bear can grab items near a tent. This distance allows time to respond to the warning. Trip wire detection fences sound an alarm when it is set off – by any animal. Fences must be reset manually once they are tripped. Do not become complacent and ignore false alarms. Information about this item is available at the following website:
http://www.margosupplies.com/public/canadian1/bear_deterrents/bear_trip_wire/bear_trip_wire.ht m

Infrared or motion detectors

Infrared or motion detectors systems can be used to set off alarms and lights. As animals other than bears can set them off, each alarm that sounds must be checked out to guarantee continued safety. The “Critter Gitter” is an infrared motion detection system that works for small camps.

Information about this item is available at the following website:
http://www.margosupplies.com/public/canadian1/bear_dets.htm

Dogs

If dogs are considered for use as bear detectors, they must be trained for that job and respond to their handler or master under all circumstances. They must be chained within the camp and not be allowed to roam or they may bring an angry bear into camp. Even trained bear dogs may not provide sufficient warning if they are asleep or unresponsive for some reason. While dogs may eat leftover food, do not allow dog food leftovers to remain on their plate or allow them to bury food as the odours will attract bears. Bear dogs are not pets. Pet dogs in camp will not provide the necessary warning protection if a bear approaches. Furthermore, people have been injured when rescuing their pet dog during a bear encounter.

PDAC 10.3.7 Bear Response Plans

Projects and camps need bear response plans that address potential situations. It may be advisable to discuss bear response plans with wildlife officials. Everyone has the responsibility to prevent a bear becoming human habituated and food conditioned. Essential parts of bear response plans include but are not limited to the following measures:

- Train employee to respond correctly to bear encounters.
- Post contact information for the area wildlife officer in order to request assistance should it become necessary to have a bear removed (one persistently returns or enters camp).
- Maintain warning and detection systems and deterrent equipment. Monitor and report any bear activity near camp.
- Compile and report bear problems to wildlife officers.
- Deter and, if necessary, destroy a bear while remaining in compliance with wildlife regulations.

- Create different alarms for bears and for fire. People must respond differently.

Bear response plans should cover various emergency scenarios. Develop plans for:

- When a bear is seen in the distance from camp: Use an appropriate deterrent as soon as possible. Adverse conditioning must be done every time a bear is sighted near camp to try to prevent it from becoming human habituated and/or food conditioned. The closer it gets to food the more difficult it will be to deter it. Any bear that has received a food reward in the past will be hard to deter and any fed bear is dangerous. Plan for the possibility that a bear in the distance may return.
- When a bear attempts to enter camp: Bears that are scared away from camps frequently return.
  - Everyone must be familiar with the plans, which must cover both day and night situations. All employees should understand what is expected of them under various circumstances.
  - Decide at what distance from camp attempts will be made to direct or haze (harass) a bear to go away. Consider what tactics to use and in which order.
- When a bear successfully enters camp during the day and during the night:
  - Know which deterrents to use for each situation when a bear is sighted (distance, or in camp) and which deterrents are appropriate for a specified distance.
  - Discuss plans of action in the event that a bear enters a camp building or tent, including the kitchen and dining structure.
  - Decide who will shoot the bear when there is a threat to life. Discuss what tactics to use if someone is attacked.
- Develop plans for bear encounters while traversing.
  - Know how to react in open areas when a bear is sighted in the distance.
  - Know how to react to close encounters that may occur in dense brush, forests, berry patches, shorelines etc.

PDAC 10.3.8 Bear Behaviour

It is important to learn about bear behaviour so you can interpret a bear's behaviour when you encounter one. The better you understand and recognize bear behaviours and their motivations, the better your chance of lowering your risk during an encounter.

Interactive behaviours between bears are basically the same as when they encounter humans.

- Bears have a dominance hierarchy with large males ranking at the top and juveniles at the bottom. Juveniles engage in aggressive play and develop skills that will help them during bear interactions in later life.
- When faced with one of their own species, each bear will quickly assess the situation.
- Most encounters conclude with the bears increasing their distance from one another, but low stress interactions have the potential to escalate if one bear ignores another's warning or continues to crowd another's personal space. The extent of this space and level of defense can vary with each individual bear or its species.
- When a bear detects a human it will usually leave in order to avoid an encounter. Most of the time, you will never know a bear detected your presence.

Bear Behaviour – Recognizing Signs of Stress

The following information is adapted with permission from the video Staying Safe in Bear Country, produced by the Safety in Bear Country Society, and from How You Can Stay Safe in Bear Country, an Environment Yukon publication.

Signs of Stress

Bears use the same behaviours to indicate their level of stress, whether relating to another bear or to a human. The following signs reflect the degree the bear feels threatened:

Subtle signs of stress:

- Pause in activity – a bear stops eating and looks at you – the bear is checking you out
- Yawning – mouth open and tongue rolling
- Change in body posture or orientation, such as assuming a stiff-legged stance

Obvious signs of stress:

- Huffing Moaning
- Teeth-popping noises

Signs of high stress or aggression:

- Salivating
- Roaring and open-mouthed jawing
- Paw swatting
- Guttural sounds
- Charging – which usually stops before contact

Note: Bears that stands on their hind legs and sniff the air are curious and assessing the situation and they will not charge in this position.

Defensive and Non-Defensive Bear Behaviour

Usually, when a bear encounters a human it will leave the area. However, if a bear approaches a human, it is necessary to assess why the bear is approaching and whether the bear is displaying defensive or non-defensive behaviour.

Defensive Bears

In an encounter, a bear may react defensively, perceiving you as a threat – to itself, its cubs, or its food. Whatever the cause, a defensive bear will likely appear agitated or stressed. The closer you are when a bear becomes aware of you, the more likely it will react in a defensive manner – and the less time you will have to react. Though most defensive interactions with bears stop short of contact, they do sometimes result in attacks. With grizzlies, defensive attacks almost always stem from surprising a bear at close range when it is feeding on a carcass or protecting its young. On the rare occasions when a black bear attacks defensively, it usually involves a mother defending her young; black bears typically respond to a threat by fleeing.

Non-Defensive Bears

A bear may approach and take an interest in you for non-defensive reasons. The non-defensive approaches can appear similar to each other – and should not be confused with defensive behaviours.

- Curiosity: The bear displays a slow, hesitant approach with ears cocked forward and its head and nose raised to investigate what you are.
- Food conditioned: The bear might be after your food. Food conditioned bears may be bold and come right into camp looking for food.
- Dominance: The bear might approach to test its dominance.
- Predation: Rarely, the bear might see you as potential prey. Unlike a curious bear, one that is predatory will be intensely focused on you – as a potential meal – with its head up and ears erect. Its approach is confident and persistent. Predatory bears, especially ones that have been food conditioned, have been known to break into structures and attack people.

PDAC 10.3.9 Bear Deterrents

Deterrents include noise makers, bear pepper spray and firearms that shoot both non-lethal and lethal ammunition. Do not become complacent because the camp has a warning system, or because you carry bear deterrents and have a firearm for backup protection when working. It is still mandatory to keep a clean camp and remain alert while traversing, drilling or carrying out project work.

- Know the capabilities and the limitations of the available deterrents. Keep a variety of deterrents in each camp so no one is dependent on one type. Carry several types while traversing.
- Deterrents must be used at the right time and in the right manner for maximum effect.
- Always carry at least two types of bear deterrents – including pepper spray – when traversing. When traversing in polar bear country, there should always be a person with a loaded firearm backing up anyone who might be forced to use a non-lethal deterrent on a polar bear.
- Transporting bear deterrents: Place orders well in advance to get bear spray and other deterrents to a remote destination. Always transport bear pepper spray, compressed air canister type horns and all explosive deterrents as “dangerous goods” products when using aircraft (refer to section 16.9 Transportation of “Dangerous Goods”). Do not ever consider hiding them in your luggage or pack.
- The following website has tables that compare and review deterrent methods: http://www.extension.org/pages/Polar_Bear_Damage_Management

Noise Makers

Most, but not all, bears react to noisemakers and will leave. Any loud noise may alert a bear to your presence, and the human voice or metallic sounds are often very effective.

- Shouting and clapping hands is a standard method to make noise.
- Cans containing rocks: Shaking of a can partly full of rocks can produce a good racket. This combined with shouting and clapping may produce enough noise to alert a bear of your approach.

- Bang your hammer on a metal clipboard.
- Bear bells are commonly worn by hikers but most experts feel they do not make sufficient noise to warn a bear in advance. Don't count on them.
- Banging pots and pans together can be effective to scare off curious black bears that try to enter a camp.
- Air horns produce a very loud noise and are recommended when working in dense vegetation to warn of your impending presence when you are still a long way from a bear. Some air horns can be blown using your mouth to produce sound, some can be pressurized using a bicycle tire pump, and some air horns come with compressed air canisters, which must be transported as "dangerous goods" in aircraft. Some air horns may not be reliable in cold temperatures.
- Explosive deterrents are launched from a 12-gauge shotgun or specialized launchers (pencil or pistol launchers). These deterrents have ranges from 15-90 m (50-300 ft). Take the wind into account as it may cause deterrents to drift. Do not launch a deterrent so it lands behind the bear or the noise may scare it in your direction.
  - Bear bangers are designed to be shot up to 30 m away where the cartridge explodes. Bear bangers should have an expiry date stamped on the box or the shell. Inspect the shells for leakage and discolouration and replace them even before the expiry date if they do not look right. If they are shot with a pencil launcher they must match with the same firing mechanism (see launchers below). Store them in a cool dry place.
  - Shell crackers have a range of 60-80 m. Only use shell crackers when a bear is more than 65 m away to be sure it explodes in front of the bear. Use a 12-gauge shotgun. A PAL is required to use a shotgun in Canada.
  - Screamers and whistle crackers produce high pitched noises. Some give off a bright light, which is useful for spotting a bear at night. They can travel up to 60 m.
  - Launchers: Pistol launchers for bear bangers are more versatile than pencil launchers. They can fire multiple rounds and are much faster to reload. Pencil launchers: It is necessary to match the type of firing mechanism of a pencil launcher (rim fire or centre fire) with matching cartridges (bangers and flares). A centre fire launcher will not normally launch a rim fire cartridge and vice versa, so don't get caught with a mismatched launcher and bear banger at a bad time. If using pencil launchers, buy only one type of launcher and cartridges so no mix ups occur.
- Motor noises from snowmobiles, ATVs, or a helicopter engine may intimidate a bear to leave the area. Start the engines and rev them. If necessary, it may be permissible to gently "push" a bear away from camp at a fast walking pace using a helicopter, but not for long distances (no more than 10 minutes or 3 kilometres). A bear may easily become overheated or overstressed. Stop if a bear breaks into a run and monitor it from a distance. Inquire about this practice with local wildlife officials to determine if it is permitted.
- Warning shots: Firing a warning shot is the least effective method to deter a distant bear, as it may not hear much noise. Make sure the bear knows where you are before firing or you may scare it in your direction. Make sure no people are in the vicinity of

the bear and shoot in the air to the side of it. Keep track of your shots; you may need your ammunition to shoot to kill the bear.

Bear Pepper Spray

Bear spray is a tested and proven bear deterrent and should be carried by employees when working where they may encounter bears. Pepper spray contains capsaicin, which is the active ingredient that produces a burning sensation to the eyes, nose and lungs. Bear spray must be immediately accessible during an unexpected bear encounter so carry it in a holster on your belt or upper body. Bear spray is no use when it is buried in a pack! Check the expiry date; cans may leak propellant and lose pressure so an unused can that feels light is no good.

- The EPA (Environmental Protection Agency in the USA) rates pepper spray bear deterrents according to some minimum standards.
  - Choose a bear pepper spray product with an oil based formula; it will adhere to the bear's face better than water based products.
  - The canister should contain enough spray to do the job. The EPA suggests at least 6 seconds worth of spray as a minimum discharge time.
  - The pepper spray should spray a distance of at least 7.5 m.
- Be familiar with the specific manufacturer's directions for using bear spray. Some manufacturers advise firing a short blast of spray when a charging bear is about 15 m away. This creates a cloud of spray and a hissing noise that may deter the bear. If the bear continues charging, fire again for 3 seconds directly into the face of the bear at very close range (2-3 m).
- Practice. Many people have mistakenly sprayed themselves by holding the can backwards. Get to know the product you carry. Practice: remove bear spray from the holster, remove the safety clip and take aim, but do not test fire the pepper spray. It is advisable to save bear spray for a bear encounter. For practice, you can test fire cans that have passed their expiry date or purchase inert cans (without the capsaicin ingredient). If a regular can of bear spray is used for practice, make sure the can is emptied so no one faces a bear with a half empty can.
- Use bear spray only in the path and face of an attacking bear. It will not act as a deterrent if applied to objects such as tents, clothing or food containers. In fact, there is evidence that discharging pepper spray into the air or onto objects may actually attract grizzlies. The spray residue is long lasting.
- A blast of bear spray does not project as far in wet and/or windy weather. Try to adjust the aim of the spray for any cross wind. Rain may wash it out of the air. Wind may blow it back onto you.
- Bear pepper spray does not fire as far in cold temperatures. Keep bear spray inside your jacket in cold temperatures. It has only been tested to low temperatures between -12°C and -21°C.
- Each person should have their own supply of bear pepper spray. For fly camps or traverses where bears are very common, the team should have more than one can per person. It may take several cans to deter a very aggressive bear or one that repeatedly attacks.
- Keep pepper spray immediately available at all times in the cooking tent or building.

- Purchase bear spray in the country where you will use it. Do not try to transport it between the USA and Canada – it is possible but difficult to do.
- Transporting bear pepper spray:
  - Aircraft: A pilot must know about all types of deterrents that are transported on the charter aircraft. Bear spray must never be transported in the passenger compartment of any aircraft; it would incapacitate the pilot if it were discharged. Bear spray and other explosive deterrents must be stowed in the cargo hold, cargo pods, or secured in a float compartment.
  - Boats: Transport bear spray outside the cabin of a boat.
  - Vehicles: Transport bear spray in a proper container made for that purpose. They can be purchased or made (e.g., an ammunition box with an airtight seal). Place it where it cannot be discharged by mistake, preferably in a separate compartment or container on a roof rack etc.
- First aid: If someone is inadvertently exposed to bear pepper spray, immediately remove any contact lenses (throw them away) and flush the eyes using lots of water for 15 minutes or until the burning sensation is gone. Contact lens saline solution is said to work well for flushing the eyes. Wash skin with mild soap and water. Be familiar with the first aid, storage and other recommendations on the bear pepper spray MSDS sheet.
- Refer to the following websites for additional information about bear pepper spray: http://www.bearsmart.com/becoming-bear-smart/home/bear-deterrents http://www.absc.usgs.gov/research/brownbears/pepperspray/pepperspray.htm

Firearms

Use of Firearms

A mineral exploration company has the responsibility to exercise full control over the transportation and use of firearms by employees. It is necessary to have safe operating procedures (SOPs) regarding firearms when they are present at any project site or field camp. While the purpose of firearms in camps is for protection from wildlife, try to avoid putting an employee at risk if it becomes necessary to destroy a bear. Trained bear guards or the local government wildlife agency should deal with and/or dispatch a troublesome bear.

- Follow all company SOPs and jurisdictional legislation regarding firearms (refer to section
- 18.2.2 Firearms Regulations and Policies). Develop SOPs to address the use of personal firearms on site, as required.
- In Canada, only people who have a Possession and Acquisition Licence (PAL) and who are both competent and confident should have permission to use a firearm. Keep in mind that people may be overly confident unless they have had sufficient firearms training plus a lot of practice. Even then, faced with an attacking bear some people may panic.
- Employees responsible for using firearms for protection against bears should have extra firearms training. They should also mentally rehearse situations that might develop and practice for speed and accuracy.

- Make sure that people in camp understand what is expected of them when a bear is sighted, has entered camp, or must be shot – especially at night. See section 10.3.7 Bear Response Plans.
- Firearms must be fully functioning and kept in good condition. Any gun that is not absolutely dependable is a liability to the person using it and others whose safety depends upon the shooter. Keep firearms clean and stored to prevent condensation and ice forming in the barrel in cold climates.
- Everyone must know where the firearms are kept and who may use them.
- Store firearms unloaded and inoperable in a locked container. Store ammunition locked separately but available. In Canada, when there is an immediate wildlife threat, it may be permissible to store the firearm temporarily unlocked and out in the open, as long as it is unloaded and ammunition is not readily accessible. The firearm must be under the immediate control of a qualified person at all times. Immediate control means within an arm's length of the qualified person.
- It may be advisable when companies purchase guns for use in camps to purchase all the same type and use the same ammunition to prevent mix ups during a bear encounter.

Types of firearms appropriate to deter bears

- 12-gauge shotgun: Use a short-barrelled, pump action 12-gauge shotgun with a smooth bore slug barrel with no choke (no narrowing of the barrel at the muzzle). This type can be used to fire rubber slugs, bean bags, and whistle cracker shells to attempt to scare a bear away, as well as slugs to kill the bear. 12-gauge shotguns fire slugs that will kill a bear at a close range of less than 30 m.
- Rifles: Use high powered rifles .30-06 or higher calibre. A rifle has a greater effective killing range, which sometimes results in bears needlessly being killed.
- Handguns are not recommended.

Non-lethal projectiles

Several types of non-lethal projectiles can be used as part of adverse conditioning to cause a bear pain but not injure it; this gives the bear a chance to leave before it is necessary to shoot to kill. They require a 12-gauge shotgun.

- Rubber slugs: Use them when a bear is between 30 and 40 m away. Aim to hit the large muscles at the rear of the bear; do not aim at the front to prevent eye damage.
- Bean bags: Use them for ranges from 9 to 30 m. Use an open choked shotgun.
- When to use non-lethal projectiles:
  - Use the appropriate deterrent for the distance between the shooter and the bear. Accuracy is important.
  - Make sure the bear knows your location before firing and that it has a clear path to escape.
  - Make sure to have an experienced backup person with a loaded firearm.

When it is Necessary to Shoot a Bear

Know the wildlife regulations for the jurisdiction, as shooting a bear may only be allowed when life (not property) is immediately threatened. Some regions permit destroying a bear that is persistently destroying property. Shooting a bear is the least desirable solution to a bear problem. Whenever possible, contact the local government wildlife agency to remove or dispatch a problem bear.

If you must shoot a bear as a last resort, shoot to kill with the first shot. The closer the bear is to you (10 to 15 m away) the better your chances of killing it immediately.

- If the bear is facing you, aim behind the head at the back of the neck between the shoulders.
- If the bear is broadside, aim for the front shoulder, which may knock the bear down and disable it.
- Do not aim for the head, as the bullet may glance off the skull. Do not stop firing until the bear is dead.
- Report the kill to the appropriate authorities.

Deterrents Use – Effective Range

- The PDAC acknowledges and thanks Andy McMullen, BEARWISE, for granting permission to use his Deterrents Use - Effective Range chart. Training and knowledge regarding the ranges of each deterrent will help the person make a sensible decision when choosing which deterrent to use during a bear encounter.

PDAC 10.3.10 Guidelines for Bear Encounters

Use your knowledge of bear behaviour and carefully observe the bear during an encounter to determine how you should react. The bear may just be curious, it may be annoyed and threatened by your presence, or it may regard you as prey.

Tips for Avoiding Bear Encounters on Traverses

To avoid encounters, stay alert, make noise and know when and where to expect bears. Use utmost caution if you must traverse through prime bear habitat. Do not become totally focused on the traverse route and outcrops.

- Keep track of wind direction. If the wind is at your back, your smell will be carried ahead of you and bears may sense your presence and leave. With the wind in your face, they will not smell you coming so be vigilant. Check behind frequently to make sure you are not being followed.
- If you are dropped off by helicopter, it is important to scan the area for bears before landing. If possible, check out the traverse route for bears as well. Note: Although you may not see bears when you fly over the landing and traverse route, that does not mean there are none in the area. Stay alert for signs of bears and be prepared for encounters throughout the day.
- Use binoculars in open areas to scan in all directions. They are useful in the barrens, on avalanche slopes, in alpine areas etc. Watch for bears realizing that you will probably see only part of a bear rather than all of it.
- Announce your presence; make lots of noise (see section 10.3.9.1 Noise makers).
- Watch for bear signs and listen for sounds in the surrounding bush that might indicate the presence of a bear.

- Use extra caution if you must traverse along rushing streams, through dense brush or near berry patches. Bears may not hear you coming so continue to make lots of loud noise.
- While traversing, make a mental note of available trees to climb, but do not depend on one for safety.
- Never come between any female bear and her cubs. Female grizzlies with cubs will charge or attack from a much greater distance than will a female black bear.
- Never approach any fresh kill, carrion or loosely piled dirt and branches (possible remains of a bear kill). Watch out, especially if scavenging birds like ravens are around. Bears act aggressively around their kills.
- Never approach a bear to photograph it.
- Do not imitate the vocalizations or postures made by a bear.
- Calmly prepare your deterrent as soon as an encounter occurs. The closer the encounter when a bear discovers you, the more likely it will charge or attack – especially grizzlies and polar bears. See section 10.3.9.
- Juvenile bears frequently test a situation during an encounter. Stand your ground with them, if possible.
- Increase your distance from a bear even if it seems unconcerned; it may be a human habituated or food conditioned bear. If you come closer it may provoke an aggressive response.
- A bear encounter is not classed as an attack unless the bear makes physical contact with the person.

Bear Encounters – how you should react

When you encounter a bear the safest response is to keep calm and do not run from a bear; the act of running seems to encourage a bear to chase. Do not run for a tree (or a safe shelter) unless you know you can make it to the tree and climb high enough to escape the pursuing bear. When you run, you can no longer see what the bear is doing.

When you encounter a bear that is not aware of your presence:

- Try to move away without getting its attention. Make a wide detour and try to leave undetected.
- Watch for any change in its behaviour. Be careful not to startle it.
- If you see young bears on the ground or in a tree or hear bear vocalizations, be extremely cautious and go back the way you came as quietly as possible.

When you encounter a bear that knows you are there:

- Identify yourself as human by talking calmly in a low voice and waving your arms slowly. Do not shout or jump about, as this might provoke an aggressive response.
- Move away slowly and make no sudden movements. Do not run, as it might trigger a chase.
- A bear will usually leave.

If the bear starts to approach:

- Stand your ground. Stay calm.

- Prepare to use your deterrents.
- Determine what kind of approach the bear is making.

Encounters – when bears react defensively

If the bear is making a defensive approach toward you:

- Try to appear non-threatening; your goal is to avoid being seen as a threat.
- Talk in a calm voice and let the bear know you mean no harm. A defensive bear is stressed by your presence. When it no longer feels threatened, it may simply retreat.
- When the bear stops advancing toward you, start slowly moving away from it. If the bear continues to advance, your best strategy is to:
  - Stand your ground! Most defensive charges stop short.
  - Do not shout or throw anything. Once it knows there is nothing to fear the bear should calm down and stop its approach.
  - When the bear is no longer advancing, start slowly moving away – still reassuring it in a calm voice.
  - If the defensive bear advances again, STOP and stand your ground once more!
- If it keeps coming closer, stand your ground, keep talking, and use your deterrent. If the bear seems intent on attack, use your bear pepper spray when it is about 3 m away.
- If the bear attacks, wait as long as you can and then fall straight to the ground in the prone position.
- Prone position: Drop to the ground and lie face down on your stomach.
  - Keep your pack on for added protection. Clasp your hands together over the back of your neck to protect this vital area.
  - Stick your elbows out, spread your legs apart and dig your toes into the ground to help maintain this stable position to make it more difficult for a bear to roll your body over. Do not struggle or make noise.
  - Resist any attempt to roll you over with the strength of your legs. If the bear flips you over, roll back onto your stomach so you are face down again.
- Fetal or cannonball position: Crouch on the ground with your legs drawn up to your chest and your hands clasped around the back of your neck. Most bear authorities advise using the prone position, as your face is better protected and it is much harder for a bear to roll you over and expose your vital organs and face.
- When the attack stops, lie still and wait for the bear to leave. Moving too soon may provoke another assault.

Encounters – when bears react non-defensively

If a bear makes a non-defensive approaches toward you, it will show little stress. Its head and ears will be up. Try to determine its motive (curious, food conditioned, testing its dominance, or predatory). Bears may quickly turn from curious to aggressive when surprised at close range. Your response needs to be assertive:

- Talk to the bear in a firm voice. Stay calm.

- Move out of the bear's path (in case it is testing its dominance); it may simply want to continue on its path. Watch it carefully if you move aside to give it room to pass.
- If the bear follows you:
  - Stop and stand your ground.
  - If the bear follows and stays focused on you, you are in a dangerous situation. It is time to become aggressive. Shout! Stare the bear in the eye. Move aggressively to intimidate the bear by making yourself as large and threatening as possible to let it know you will fight. Stand on a log or rock and use your deterrent. Fire a noise maker that lands in front of the bear.
  - Stamp your feet and take a step or two towards the bear. Stand on a rock or log. Threaten the bear with anything you can. Use your deterrent (bear spray) and any weapons within reach (rock hammer, mattock, rocks, sticks etc.).
  - If the bear attacks, fight back for your life with all your might! At this point, you're dealing with a predatory bear intent on eating you. Be aggressive and make as much noise as possible. Concentrate on the bear's face, eyes and nose. Do not give up! Use and do anything that will help you dominate and drive the bear away; this action may save your life. You may be fighting for your life!
    - Black and Grizzly Bears
      - Play Dead if it is a defensive attack.
      - Fight if it is a non-defensive attack.
    - Polar Bears
      - Always fight if you are attacked.
- Information regarding bear encounters and attacks can be found on the following websites:
  - http://www.bearsmart.com/becoming-bear-smart/play/bear-encounters
  - http://www.environmentyukon.gov.yk.ca/pdf/howyoucanstaysafe.pdf

PDAC 10.4 Other Large Mammals

Some large mammals may be attracted to a project site by the smells of food or garbage, the presence of dogs, or they may just be curious. Never feed wildlife or make food easily available to them through sloppy camp practices.

PDAC 10.4.1 North and South America

Wolves and Coyotes

Prevention and Preparation

Wolves are a more significant threat than coyotes but both species deserve respect. Wolves and coyotes are carnivores and will attack a camp dog to kill and eat it. They have an excellent sense of smell so food and garbage are attractants.

- Wolves fear people, but if they become human habituated they are hard to scare off. If they become food conditioned, they may approach a work site and expect to receive food. This is thought to have happened in northern Saskatchewan where a mineral exploration employee was allegedly killed by wolves in November of 2005.

- Never feed wolves.
- Keep a clean project or camp site. Do not provide access to garbage. Thoroughly burn it, if permitted. Do not bury garbage as they will dig it up.
- Do not approach a wolf den or cubs. Leave immediately if you come upon a kill site.
- An aggressive wolf will hold its tail high, raise its hackles and perhaps bark or howl.

If approached by wolves or coyotes, follow the same reaction guidelines as for a cougar. Try not to allow wolves or coyotes to approach within 100 m.

- Use adverse conditioning techniques immediately when they approach a project or camp site. Try to make them afraid of humans. Make threatening moves: shout and wave sticks, throw rocks, and make noise – an air horn works well to scare them away.
- Appear as large as possible and try to intimidate them.
- Make eye contact and back away slowly if they stand their ground.DO NOT run, crouch down, or turn your back on the animals.
- If you are with a group, everyone should act in unison to create the impression of power. Bear spray will work as a deterrent, if available.

Caribou and Musk Oxen

Prevention and Preparation

If a project is located near a caribou migration path or herds of musk oxen:

- Develop written SOPs regarding the use of vehicles, aircraft, drills, and employee activities when caribou or musk oxen are sighted or are migrating through the project area.
- Musk oxen: Single bulls may charge. Musk oxen will form a protective circle around calves when threatened. Back away slowly if you see a musk ox rubbing its foreleg on a gland on its nose, as this is a sign that it is preparing to attack.

PDAC 11.0 Surveying Safety: Geophysical, Geochemical and Line Cutting

Introduction

Many detailed ground geophysical or geochemical surveys are contracted out to specialists, often with a mineral exploration company geologist onsite to monitor the contractor's work. An exploration company should check the contractor's safety record, including their safety program, incident statistics, and Workers' Compensation Board certification or compliance history before committing to a contract. The contract should contain clauses outlining health and safety principles and practices to an acceptable level. It is also prudent to check their insurance coverage. The exploration company must give reasonable information to the contractor regarding site hazards and environmental issues, which may require a site visit by the contractor before work commences. The contractor should provide a supervisor who is responsible for compliance with the authorities having jurisdiction (AHJs) such as occupational health and safety (OHS) legislation and Mines Acts and Regulations. Ideally, the contractor should be familiar with the area, especially if exploration work is undertaken in a new area or country. Otherwise, more review detail than normal is required for local health, safety and environmental conditions.

The type of work involving chainsaws and cutting grid lines is often given to employees or contractors who are local to the project – for example, Aboriginal people. Such employees or contractors may be familiar with chainsaws but not in the industrial setting and not with strict health and safety considerations. Companies and project managers need to develop education systems to educate such local employees on safe practices rather than assuming that, because they have used chainsaws in their everyday life, they do so safely. Given the high level of comfort of such people with the bush or field environment, appreciation of their bush skills, as well as safety requirements of the workplace, need to be handled with sensitivity.

PDAC 11.1 General Risks and Hazards Associated with All Surveys

Most of the risks and hazards encountered while surveying are associated with the local terrain, weather and climate, the means of transportation used to access the survey area, and the degree of remoteness where the survey takes place. These risks and hazards are covered in the relevant chapters of the PDAC Health and Safety Toolkit, particularly in Chapter 6 Safe Traversing Practices. Cross references are cited throughout this chapter when referring to general risks and hazards. The risks and hazards specific to geophysical and geochemical surveys or line cutting are addressed in the appropriate section of this chapter.

Depending on the type of survey, individuals may need to be physically capable of carrying heavy loads, as some geophysical survey equipment is very heavy, as is the cumulative weight of geochemical samples collected during a day's work. Slips, trip, falls and back strains are common injuries and may be associated with specific terrain (refer to Chapter 6, section 6.4 Traversing in Specific Terrain). The most serious injuries are usually caused by transportation related accidents so it is important to follow the safety guidelines in the relevant transportation chapters. Also, heavy loads should be lifted and carried in a safe manner to avoid back injuries.

PDAC 11.1.1 Essential Safety Guidelines for All Surveys

Employees who conduct surveys should be trained to perform their work safely. New or inexperienced employees should be teamed with experienced employees who are familiar with the terrain, climate and equipment. Before experienced personnel begin work in unfamiliar terrain or a new region, they should receive training to become familiar with risks and hazards of the terrain, climate and location.

Contractors should provide trained survey crews with written safe operating procedures (SOPs) that address the specific hazards of survey work. Refer to chapter 6, section 6.3.1, Development of Safe Operating Procedures, for detailed information regarding safety procedures that should be in place. Some practices should be carried out each day before a crew starts work. SOPs should cover, but not be limited to, the following topics:

- **Training**: Survey employees should be trained for the work they carry out and be familiar with the manufacturer's safe operating procedures (SOPs) and guidelines in the instruction manuals that accompany the survey equipment and tools they use.
- **Tracking system**: Develop a tracking system to record where employees are working each day. Record the planned survey routes or work sites on a centrally located map

or white board at the camp or base. Location updates including changes in plans should be called in and recorded.

- **Communications**: Develop a communication call-in system to maintain contact with employees. Employees should carry functioning communications equipment appropriate for the area. For additional information, refer to Chapter 19 Communications.
- **Emergency response plans** (ERPs): Survey crews should develop ERPs that address site specific risks and hazards and potential injuries associated with specific surveys, terrain and the degree of remoteness. When a contractor's employees are based at a project site, the ERP for survey crews should be integrated with the exploration project ERPs. For additional information, refer to Chapter 3, Emergency Response.
- **Tool and equipment check**: Before departing for work, each survey crew should check their equipment. They should have: (a) all tools, fully charged communication and navigation equipment with spare batteries; (b) required personal protective equipment (PPE) including bear spray, as appropriate; (c) suitable clothing for the weather and potential changes; and (d) appropriate survival kits and first aid kits. If conditions are dry, carry fire suppressant materials when using tools or survey equipment that could start a fire (e.g., chainsaw, small generator or electrical equipment).
- **Transportation**: Crews should perform an inspection check of their mode of transportation to make sure it is in good working order and all equipment is present. Refer to the appropriate inspection and equipment sections in chapters 13 Vehicles; 14 All-Terrain Vehicles; 15 Snowmobiles; and 17 Boats, Canoes and Inflatables. When using air support, refer to chapter 16 Aircraft and follow the SOPs regarding aircraft, the pilot's orders, and hold special briefings as required.
- **Supervision**: Workers should receive appropriate supervision in the field while performing surveys.
- **Working alone**: Follow the regulations of the authorities having jurisdiction (AHJs) to protect the health and safety of workers. Develop and implement the required SOPs if it is necessary for employees to work alone. Refer to section 2.1.1 Working Alone vs. the "Buddy System".

PDAC 11.1.2 General Safety Tips

- Weather related risks: Be fully prepared for the local weather and climate. Carry a suitable survival kit, extra water and food, etc. Wear appropriate clothing and carry rain gear and extra clothing in case you become stranded and must spend a night away from camp. Lightning can be a serious risk depending on the location and especially when carrying out electrical surveys. Be prepared and follow lightning safety precautions including the 30-30 rule (see below, bullet point number 5, in section 11.2.2). For additional information, refer to Chapter 8, Survival, and sections 9.2 Lightning, 9.9.3 Hypothermia, and 9.10.3 Hyperthermia.
- Personal protective equipment (PPE): Required PPE will vary depending on the risks and hazards of each type of survey and the terrain. Safety glasses should be required for most surveys. It is usually advisable to wear high visibility vests. Hearing protection may be required (e.g., when using a chainsaw). Wear gloves to protect hands from

cuts and infections. Refer to section 4.2 Hazard Control and Personal Protective Equipment.

- Footwear: Wear leather boots that provide good ankle support and traction appropriate for the terrain. It is advisable to wear waterproof boots when working in extremely wet areas and heavy, insulating boots during very cold weather. As stable footing is very important, appropriate high quality boots may be considered PPE by some companies. Refer to section 6.3.5 Clothing for information regarding footwear.
- Footing and balance: Carrying heavy equipment or samples hinders good balance. Be vigilant when traversing cut lines and/or climbing over logs or debris. Because some surveys are carried out along straight lines, it may not be possible to avoid difficult and sometimes dangerous terrain (e.g., cliffs, swamps). While trees and brush are usually cut down to ground level, stubs or "pungies" may remain if the ground was snow-covered when the lines were cut. It is easy to trip over them and get cut or impaled, especially when carrying a heavy pack or surveying equipment.
- Snow and ice: Follow all appropriate precautions when working on snow and ice. Refer to section 6.4 Traversing in Specific Terrain and Chapter 15 Snowmobiles for information regarding appropriate safety equipment and routines. Section 15.11 contains important information about self rescue after falling through ice.
- Be critically aware of fire risks. Carry appropriate fire extinguishing equipment, including: a fire extinguisher, extinguishing powder, water and/or a small shovel when using gasoline powered machinery (e.g., chainsaws, generators, brush cutters, power augers). Keep the exhaust area clear of vegetation and place hot machinery on bare rock so it will not start a fire. Always observe fire bans.
- Wildlife and insects: Where bears are a hazard, be trained in bear safety procedures and carry appropriate deterrents including bear pepper spray. Be aware of potential fauna at ground level. Watch out for signs of bees or wasps which often build nests in the ground. Do not place your hands where they might be bitten by a venomous snake or stung by scorpions or insects. When working in insect infested areas and using insect repellent, avoid applying it to your eyes and mouth. Do not overuse repellent as it is absorbed through the skin. Be vigilant when wearing head nets as they restrict your range of vision. Follow medical advice regarding the use of anti-malarial medications and avoid mosquito bites when working where malaria and other serious insect-borne diseases are present. For detailed information, refer to the relevant sections in Chapter 10 Wildlife, section 12.8.4 Protection from Insect Bites, and information regarding relevant diseases in sections 12.8.5 and 18.6.5.
- Audio entertainment equipment: In general, it is not good practice to allow employees to wear personal electronic music devices with headphones or earplugs (including iPods) when working. Headphones or earplugs interfere with the ability to clearly hear directions via radio communication, noise due to machine malfunctions and dangerous wildlife, etc.
- Survey completion: When a survey is completed remove all equipment, including wires. Fill in holes if they present a future tripping hazard to workers or to animals.

PDAC 11.2 Geophysical Survey Safety

Exploration programs often involve airborne and/or ground geophysical surveys to assess economic potential or define the features of ore deposits. When geophysical surveys are conducted with fixed wing aircraft or helicopter support, employees should follow the SOPs and guidelines in Chapter 16 Aircraft.

These guidelines cannot address safety issues for airborne geophysical surveys in any detail. In general, safety regarding airborne surveys relies on the safe practices of charter airlines and pilots. It is important for survey employees to communicate their survey requirements and never push pilots to fly when conditions are not safe. Employees or equipment operators should always speak up if they have a question regarding safety or a procedure that potentially affects safety.

The companies involved in airborne geophysics have developed their own safety guidelines. They are available on the International Airborne Geophysics Safety Association (IAGSA) website at: http://www.iagsa.ca/Contract_Annex990325.pdf

Occasionally borehole geophysical surveys are carried out in conjunction with drill programs. When these surveys are performed, employees should also follow the relevant guidelines found in Chapter 20 Drilling Sites.

Section 11.2 of this chapter primarily covers safety information specifically related to ground geophysical surveys. All geophysical survey crews should be familiar with the general guidelines in sections 11.1.1 and 11.1.2 and relevant information in Chapter 6 Safe Traversing Practices.

PDAC 11.2.1 Specific Risks and Hazards Associated with Geophysical Surveys

- Slips, trips and falls caused by rough terrain, slippery surfaces, balance problems from carrying heavy equipment or backpacks
- Electric shock caused by poor communication with the operator, not following SOPs, wet ground, lightning storms
- Injuries or death caused by accidents when travelling by vehicles, ATVs, snowmobiles, boats or aircraft
- Impact injuries and cuts caused by the misuse of tools such as mattocks, shovels, mechanical augers, post hole drills
- Back strains and injuries caused by carrying heavy survey equipment, carrying heavy backpacks, improper lifting techniques
- Fires caused by short circuits in electrical wires or equipment such as generators, explosives, improper fuelling procedures or spills, carrying insufficient fire extinguishing materials
- Hypothermia caused by working in cold weather conditions, effects of wind chill, wearing inadequate clothing, dehydration, exhaustion
- Water-related risks include drowning and cold water immersion hypothermia caused by falling into water during dangerous stream crossings, breaking through ice
- Health risks from diseases and infections caused by contact with contaminated water or soils containing parasites, viruses and bacteria

PDAC 11.2.2 Field Safety Tips for Geophysical Surveys

Electrical Surveys Methods

The most hazardous geophysical surveys are those that employ electric current, which includes induced polarization (IP) surveys and electromagnetic (EM) surveys. The set up for both is similar, as long lengths of wire are laid down in a designated area and readings are taken when the wire is pulsed with electricity from a generator.

IP surveys have potentially more serious risk of injury than other geophysical surveys due to the use of high voltage electric current. Surface electromagnetic (EM) surveys, also known as ground pulse electromagnetic or fixed loop EM surveys, use lower voltages and therefore do not usually present the same degree of risk of electrocution to the operators. Even so, all employees who participate in surveys using electricity should receive thorough training in the safe use of survey equipment. It is imperative that all employees who operate transmitters are fully aware of the hazards associated with the use of high voltage equipment.

Companies that conduct electrical surveys should develop and implement specific SOPs in addition to the general guidelines recommended in section 11.1.1.

The following guidelines apply to both IP and EM surveys:

- Emergency response plans (ERPs)
  - All field personnel should be familiar with first aid for electrical burns and how to respond to a co-worker who may be electrocuted.
  - Take appropriate fire precautions as the equipment used in electrical surveys can cause a fire if the equipment malfunctions or overheats. Wires may become hot due to poor contact with electrodes or if they become detached and lie in direct contact with the ground. Fire extinguishing equipment must be present where a transmitter uses a motor generator.
- Safety procedures for survey layouts
  - If working in a populated area, post the survey site, date and time at central locations to notify the public (e.g., post office, community centre, grocery store). Hire “sentries”, as required, to supervise all electrical equipment, especially exposed wires and electrodes. Curious children and people are highly vulnerable to serious injury.
  - Place “High Voltage” signs on any unsupervised geophysical electrode sites that carry high voltage or currents exceeding the milli-ampere range. Place signs in populated areas where electrodes are out of sight and use sentries, as needed.
  - When pulling electrical wires and cables across terrain, it is advisable to pull it by hand or use a snowmobile or 4-wheel ATV (rather than a motor bike). Before pulling, carefully check the wire or cable to be sure it has no kinks or knots and very few splices, as these may catch on roots etc. Do not drag wire. If the cable breaks while being pulled, it will stretch first and then whip back at the driver when it breaks.
  - Place wire where it will not harm people or animals. Place it on the ground with sufficient slack so it stays on the ground. Make sure wires are placed so domestic animals will not be harmed.

  - It is advisable to bury cables and wires where they cross trails or paths, especially if they are heavily travelled routes. Bury them out of sight and anchor them solidly on either side of the route. When crossing a paved road, secure wire to the asphalt with fencing staples or other secure means in at least three places. If burying is not possible, it is imperative that wires or cables are solidly anchored on each side of the trail, path or road. In all situations, wire should be secured and flagged on both sides of a trail, path or road for 6 metres with flags placed every 0.5 metres. In addition, the wire should be marked with flagging where it crosses roads or paths to provide additional visibility in case it still rises up. If an animal, person or vehicle contacts and lifts or drags the cable or wire, it will tighten and rise up across a road or path unless it is solidly anchored. A raised wire can seriously injure or even decapitate someone passing on bicycle, snow machine, ATV etc.
  - Contractors should maintain a record of the amount and location of the wire deployed and removed. When a survey is completed, inspect the wire insulation for breaks and damage when picking up wire. Repair damage or replace the wire as necessary. Using damaged wires increases the likelihood of someone receiving an electric shock.
- Safety procedures for handling wires that may carry electric current
  - Do not hold the ends of a transmission wire in each hand, as your body will complete a circuit if the current is turned on.
  - Do not touch any exposed metal of any potentially energized transmission wire. Follow correct safe methods when making temporary field splices.
  - Beware of wet wires. It is possible to receive an electric shock if there are breaks in the wire's plastic casing where the wire passes through a puddle of water.
- Radio communication protocol
  - Develop a very clear radio protocol to indicate “power on” and “power off” to avoid shock and the potential electrocution of a worker handling the wires. The generator operator must never apply electrical current to grounded wires or ungrounded loops of wire unless he or she notifies the rest of the crew and receives confirmation that they know the system will be energized. “Confirmation” means a clear, positive verbal response usually sent over a radio. An arm wave and/or two clicks of the radio microphone do not qualify as confirmation, as they are both signals that can be easily misunderstood.
- Additional safety tips for electrical survey methods
  - Be sure the transmitter power is off except when actual measurements are being made. Always verify that the power is off before you remove or connect electrodes, change personnel on a task, or attempt any field repairs. Do not move a generator while it is turned on.
  - Inspect the transmitter and generator for damage and loose components each day before work. If IP or loop wire must remain in place beyond the time required for the survey, they should be monitored regularly to make sure they remain in a safe position on the ground. Where IP wires or loops are not safe, corrective action should be carried out immediately. Keep records of any inspections of the IP wires or loops noting their condition, the condition of posted signs and other safety concerns.

- Watch your footing and take care when lifting geophysical equipment because it is often very heavy. Use correct lifting procedures found in section 4.3 of chapter 4, Lifting and Back Protection.
- In addition to regular PPE, it may be advisable to wear nonconductive electric shock resistant boots. Avoid wearing steel toed boots, as they are more conductive than regular leather boots.

Ground Magnetic Surveys

Although most magnetic surveys can be done by one person, it is not advisable for surveyors to work completely alone. It is much better to work in pairs along parallel lines within shouting distance of each other in case problems develop.

- To avoid falls that may result in serious injury or damage to equipment, try to make the magnetometer as streamlined as possible (e.g., taping cables). By preventing tangles, the equipment is less likely to get hung up on vegetation during survey traverses.
- The check-in schedule should take into account the fact that the radio will probably be turned off to diminish noise. It is advisable to develop and adhere to a suitable check-in schedule with either an end-of-line or a designated time for the check-in.
- To counteract noise, carry metal objects in exactly the same place every day (e.g., keep the can of bear spray on your right hip and the pen in your left pocket). While surveyors try to carry as little metal as possible, it is still essential to carry PPE. If working in bear country – do not leave your bear deterrents behind.

Gravity Surveys

Survey crews with several people carry out this type of survey. As precise determinations of all coordinates including elevation are essential, two surveys are usually done at the same time – the precise surveyed location as well as the gravity measurement.

- Follow company and site specific SOPs for the type of terrain and transportation used.
- Pay attention to fire prevention if a car battery or a small generator is used for a power source at the GPS base station.

PDAC 14.0 All-Terrain Vehicles (ATVs and Quads)

Introduction

Definition: All-Terrain Vehicles (ATVs) are a class of multi-wheeled vehicles; the most common types are 3- and 4-wheel machines. 4-wheel ATVs may be referred to as “quads”. Some, like the Argo, come with 6 or 8 wheels and are amphibious.

Handling an ATV is very different from other vehicles, including 2-wheel motor bikes. Operating an ATV is “rider active” where the rider must use his or her body movements to help control the machine. The all-terrain design creates a higher centre of gravity and makes these machines more susceptible to overturning, particularly on corners or at high speeds. ATVs should not be operated without adequate instruction from a certified or experienced instructor. As ATVs are designed for off-road use and are permitted on public roads in only a few regions, riders should be familiar with local ATV regulations. The use of ATVs is increasing as they allow access to areas that might otherwise be too remote or too costly to reach. They provide a convenient means of carrying equipment, supplies and samples, and may even replace pack animals in some places. However, they are not the safest off-road vehicle and they should only be used when necessary. When off-road conditions are suitable for their use, it is advisable to use four-wheel drive vehicles and side by side utility vehicles, which are generally safer than ATVs.

ATVs have considerable impact on the environment due to their large knobby tires and ability to negotiate rough terrain. Fragile ecosystems are easily impacted when new trails are created or ATVs get bogged down or stuck, whether they are in desert regions, wetlands, alpine areas or forests. Thin soils are easily broken by driving over the surfaces so that ruts and gouges rapidly expand in size. Refer to the Prospectors & Developers Association of Canada (PDAC) Environmental Stewardship Toolkit on the e3 Plus website at www.pdac.ca/e3plus and search the appropriate type of terrain (arid, wetland, alpine) for information regarding how to mitigate the environmental impact of exploration activities.

PDAC 14.1 Risks and Hazards

Serious injury or death may result when an ATV is not operated according to the manufacturer's instructions. Specific risks and hazards include but are not limited to:

- Serious injuries to the body (especially the head and back) caused by collisions, overturning, or lifting an ATV
- Crashes, flips, or collisions may be caused by:
  - Riding too fast for trail conditions, turning corners too fast
  - Lack of training and lack of skill to handle difficult terrain or obstacles
  - Overloading racks or trailers
  - Towing trailers too fast for ground conditions
  - Encountering other vehicles at blind corners or on narrow trails
  - Wildlife encounters
  - Encountering trees fallen across the trail
- Stranding caused by mechanical breakdown, running out of gas or oil
- Getting lost caused by lack of appropriate navigation equipment, lack of training Capsizing during a stream crossing caused by riding too fast or deep water
- Hypothermia caused by riding in cold or wet conditions with inadequate clothing Burns caused by hot engine parts
- Driver distraction can quickly turn into an incident. Stay Focused!

PDAC 14.3 Safe Operating Guidelines for ATVs

The following guidelines for safe ATV operation specifically apply to 4-wheel machines, although the same principles apply to all ATVs and to 2-wheel motor bikes. These guidelines may be used in conjunction with a manufacturer's operator manual to develop site specific safe operating procedures (SOPs).

- Use 4-wheel ATVs with 4-wheel drive, as these are suitable for field work. Never use 3- wheel ATVs as they are less stable than 4-wheel ATVs. 3-wheel ATVs may be illegal in some jurisdictions.
- Avoid the use of motorized 2-wheel bikes for field work. Choose a 4-wheel ATV rather than a 2-wheel motor bike. If a 2-wheel motor bike is used, the rider should be very experienced using the bike off-road in the specific terrain.
- Comply with the ATV manufacturer's safe operating procedures in the manufacturer's operator manual. Most manufacturers supply comprehensive operation and maintenance procedures. Some manufacturers also supply safety videos for their machines.
- Obey the laws of the country, province, territory, state or municipality that apply to ATVs.
    - ATVs are designed for off-road use only; in many regions it is illegal to operate them on paved roads, as their handling and control is adversely affected. Do not ride ATVs on public roads or on railroad tracks and right of ways where prohibited. Some jurisdictions list the highways where ATVs are allowed to operate on the shoulder portion.
    - Each ATV should carry valid registration and insurance documents, as required.
    - Operators may be required to carry a valid driver's license even if the ATV is not operated on a road. Companies may choose to specify that riders carry a valid driver's license. It may be advisable to obtain an international driver's license in some countries. Know the laws and regulations of the jurisdiction where you work.
    - Develop SOPs that address riding ATVs on slopes >5° if the manufacturer has not provided them in the operator's manual. Depending on the jurisdiction, Workers' Compensation Boards may require a company to develop SOPs for such terrain.
- Riders should wear appropriate personal protective gear: Wear a Canadian Standards Association (CSA), Department of Transport (DOT) or Snell approved helmet equipped with a visor or goggles or safety glasses – especially if vegetation might hit your face. Wear additional protective gear that includes leather boots, gloves, long pants and a long-sleeved shirt or jacket. Some PPE items may be mandatory in some jurisdictions.
- Carry and use required and recommended safety equipment for ATVs.
    - Carry a first aid kit, a survival kit, a tire repair kit, a tool kit with appropriate spare parts, a copy of the operator manual and appropriate communication equipment for the area (radio, satellite phone, mobile/cell phone). Depending on the location, it may be necessary to carry extra water and food, an axe, towing rope and signal flares.
    - At sites with heavy equipment where increased visibility is required, attach a bright coloured antenna flag mounted on a whip rod between 1.2 m to 2.4 m long and clamped onto the back of the ATV. Riders should wear high visibility reflective vests. Note: Do not use a whip in forested areas where it might catch on branches and whip back and hit the driver.
- Develop an emergency response plan (ERP). Include procedures that address breakdowns, an overdue ATV, an injured rider and other potential incidents.

- Each project should establish a communication schedule with routine check-in times. Employees should adhere to the check-in schedule and inform the person in charge of changes in plans.
- Inform the person in charge of the planned route and estimated time of return. Record the information on a map. The person in charge of the tracking system should be familiar with the ERP and know what to do if you do not return as expected.
- New riders should receive training to operate and maintain ATVs. They should receive a copy of the ATV manufacturer's operator manual. New riders should read and understand the manual and be able to make minor repairs, as ATVs break down frequently. Keep a copy with the machine.
- Use ATV racks to carry all equipment, including backpacks. When a rider wears a backpack, it significantly changes the centre of gravity of the machine. Avoid overloading the racks.
- Always maintain a safe speed and keep the ATV under control. Obey any regulatory signs. Ride at the appropriate speed for your experience, your range of visibility, the terrain, weather and light conditions, and potential oncoming traffic. All of these factors play a role in determining the safe operating speed limit. Ride to reduce risk and avoid accidents.
- Stay on established trails. Consider the impact of ATVs on the environment. It may be illegal to use ATVs in environmentally sensitive areas. Know the laws.
- Travel using the "buddy system" whenever possible, especially on long traverses, but do not team two inexperienced operators together. Travel with separate ATVs for safety. If it is necessary to work alone, follow the guidelines in section 2.1.1. Working Alone vs. the "Buddy System". It is advisable to carry a satellite phone, which is the most dependable means of communications, especially in a remote area.
- Obtain permission to cross private land. Leave gates as they are found.
- Carry a passenger only if the ATV is designed for two people. The operator should use extra caution as the passenger's weight will affect the stability of the machine. A passenger should wear all required PPE and be instructed where to correctly position their feet on the footrests. Most ATVs are designed for a single rider only.
- ATVs should not be used for chasing or harassing wildlife. Provincial and territorial legislation prohibits these actions.
- Do not ride an ATV if you have consumed alcohol or if you have taken medication or drugs that might affect your ability to ride.
- Companies should consider establishing guidelines regarding the use of company owned or leased ATVs for recreational purposes.
- ATVs are generally not recommended for use in winter on snow. If they are used, the rider should have all relevant training and be aware of hazards associated with ice (refer to Chapter 15. Snowmobiles).
- Be aware of the hazards along your regular path (fences, wires). Mark them with flagging tape if they are not be obvious.
- It is not advisable to ride ATVs at night. If it is unavoidable, ride with the headlights turned on and wear reflective clothing. See and be seen. Ride slowly.

- ATV riders should not wear headsets and listen to Ipods or other audio entertainment devices.

PDAC 14.4 Equipment Lists for ATVs

Each ATV operator should wear personal protective equipment (PPE) and protective clothing. The equipment that should be carried depends on (1) the travelling distance to the work site, (2) the terrain, and (3) the time of year. Unless the trip is very short (i.e., less than 3 km), ATVs should carry repair tools, spare parts and emergency equipment because an ATV can travel farther in one hour than the operator may be able to walk in a day. Use the extensive equipment lists to help determine appropriate equipment for field or work site circumstances.

Personal Equipment

The following items are recommended or may be required in some jurisdictions for operators and passengers:

- Helmet (CSA approved, see section 14.7 Safety Precautions)
- Eye protection (visor and/or goggles)
- Boots
- Long sleeved jacket or shirt Long pants
- Gloves

Equipment List for ATVs

The items in bold should be considered essential.

- Communication equipment (radio, mobile/cell phone, satellite phone, as appropriate)
- Compass and maps, Global Positioning System unit (GPS) and extra batteries
- Operator manual
- Spare ignition key
- Tools, including manufacturer’s tool kit
- Tire inflation pump and repair kit
- **Spare parts** (e.g., spark plugs, headlight bulbs)
- Electrical tape, mechanical wire, duct tape
- First aid kit
- Water
- **Winch** (depending on location)
- Waterproof matches
- Knife
- Axe or saw
- Small shovel
- Survival kit
- Flashlight and extra batteries
- Written copy of the site ERP

- Log book
- Work gloves
- Fire extinguisher (as required)
- Bear spray, as required

Extra Equipment to Consider for Long Traverses

(Refer to Chapter 8. Survival for additional recommendations)

- Extra clothing
- Extra fuel and oil
- Block and tackle
- Extra batteries (as required)
- Large metal cup
- Food
- Large space blanket (1 per person)
- Signal mirror
- Tow strap
- 15 metres rope
- Emergency candle, sterno cans
- Lighter, additional fire making equipment
- Flares
- Batteries (as required)

PDAC 14.5 Inspection, Maintenance and Fuelling Guidelines

Only use ATVs in good repair. Report all defects to a supervisor and have them repaired before a trip. Never operate an ATV with a fuel leak. Be prepared for breakdowns as these happen frequently in rough country. Record all inspections in the vehicle log book. While a daily inspection should be done, when ATVs are only used for very short trips it may be reasonable to perform thorough inspections less frequently.

Pre-ride Inspection

Inspect the vehicle before you set out each day. Use a two part inspection process – before and after – starting the engine.

Before starting the engine, inspect the following:

- Equipment: Make sure the appropriate required and recommended equipment is present and functioning (e.g., tire repair kit, radio, operator manual, first aid kit, survival kit, log book).
- Tires: Incorrect tire pressure can significantly affect ATV handling. Check the air pressure and the condition of the tires. Make sure they are free of cuts and gouges etc.
- To inflate tires: Always follow the directions in the operator manual. The air pressure and tire circumference should be equal on both sides of the machine for safe handling.

ATV tires are designed for low pressure so use a manual tire pump and a low pressure gauge rather than a high pressure system to control inflation. Tires go flat if not seated correctly. See photo below.

- Wheels: Make sure the wheel lug nuts are tight, the axle nuts are tight, and the cotter pins are secure. Rock each wheel to check for worn wheel bearings and loose lug nuts. There should be no free play.
- Oil and fuel: Check the oil level, fuel level and filters according to the recommended procedures in the manual. Check for leaks. Check that the air filter is not damaged or blocked. Check the fuel filter as recommended. Start each trip with a full fuel tank. Know the range to expect from the fuel tank for the conditions where the ATV will operate and carry extra fuel and oil, as required.
- Brake fluid: Check the fluid level in the reservoir in ATVs that use brake fluid.
- Radiator (if equipped): Check the coolant level. Maintain the correct ratio of water and coolant.
- Chain or drive shaft and chassis: Check that the chain is properly adjusted, adequately lubricated, and is not worn. Chains stretch with age and use and it is imperative to keep them tight. Check for oil leaks if your machine has a drive shaft. Check for and remove any build-up of debris around the drive shaft, chain housing, cables, steering linkages and wheels. Look and feel for loose parts when the engine is off. Test the handlebars and footrests for looseness or excessive play. Check the major fasteners with a wrench at regular intervals. Some new ATVs have drive belts similar to those on snowmobiles.
- Check the shock absorbers.
- Foot shifter: Make certain that the foot shifter is correctly attached and in the right position. If there is a pull start rope, make sure it is not cut or frayed.

After starting the engine, inspect the following:

- Controls: Check that the throttle operates smoothly with the handlebars in all positions. Lights: Make certain all lights are clean, undamaged and working.
- Brakes: Check that all hand, foot, and parking brakes operate properly. Make sure they do not grab or pull the ATV to one side when applied.
- Switches: Make certain all switches work properly. Make sure the engine stop switch turns the engine off smoothly.

Maintenance Guidelines

Periodic maintenance is essential due to the rough terrain where ATVs are used. Also, it is advisable to do an inspection following each trip to check for damage and attend to repairs at that time. Correct small problems before they become serious.

- Follow the maintenance schedule and procedures outlined in the manufacturer’s operator manual.
- Maintain records of servicing, repairs and modifications to ATVs in the vehicle log book and elsewhere, as required.
- Shut off the ATV while repairs are carried out.
- Follow the instructions carefully when cleaning the air and fuel filters.

- Lubricate cables, chain and pivot points frequently with the correct lubricant according to the manufacturer's specifications. It may be advisable to use a graphite lubricant, as oil based lubricants allow grit to adhere and restrict the cable movement. Contain all lubricants during maintenance procedures.
- Brakes may need frequent cleaning and adjustment if the ATV is exposed to a lot of dust or mud.
- Service the ATV as required and at the end of the field season before storage.

Fuelling Procedures

- Fuel at a designated fuel site whenever possible. Fuel an ATV on the ground – not in the back of a pickup with a vinyl bed liner (see the last bullet below).
- Fuel only in an open well-ventilated area with the engine stopped.
- Do not fuel a machine near another machine with its engine running.
- Do not smoke. Do not allow open flames or sparks in a fuelling area. Use the correct fuel.
- Check the fuel level with a dipstick or flashlight – never use a lighted match, as fuel fumes are explosive.
- Do not overfill the tank. Close the tank cap securely when fuelling is completed.
- Clean up any fuel spills completely using spill kit materials as required. Dispose of contaminated materials in appropriately marked containers.
- Portable containers for fuel must be CSA approved. When filling portable containers, always place them on the ground outside a pickup bed, an enclosed vehicle or a trailer so the containers are properly grounded. The vinyl bed liners in pickups prevent proper grounding. Fuel flowing into a container or fuel tank can create static electricity and it is possible to generate a spark and cause fuel vapors to explode if the container (or ATV) is not grounded. Only fill the containers to 95% capacity, as fuel expands as it warms. Mark containers with a line to indicate "full". If possible, store fuel containers in a cool location out of direct sunlight.

PDAC 14.6 Training for ATV Operators

Training helps reduce risks that result in accidents. As a minimum, companies should make certain that employees who ride ATVs have the necessary training and skills to safely operate them. Experienced operators should complete a refresher training course every five years. Employees who are trained but have not ridden an ATV within two years should receive refresher training before operating an ATV again. Companies should keep records of training received by employees, which is a requirement of Workers' Compensation Boards.

Training should take into consideration the need for site specific topics that address the local terrain, weather and specific hazards where employees work, as well as loading procedures, mechanical trouble-shooting and basic repairs. Training should cover the fundamental risks and hazards inherent to the ATV – large tires, high centre of gravity, fixed rear axle, rider exposure – and how to prevent accidents through the use of PPE, safe riding skills and safe operating procedures (SOPs). Most manufacturers provide operator manuals that include safe riding methods. Material in this chapter can be adapted as topics for safety meetings. All riders should be familiar with the operator manual of the machine they use.

Training programs are available from Canada Safety Council (CSC) certified instructors and training is best done by CSC certified ATV instructors. Information is available at the following website: http://safety-council.org/training/atv-rider-course/

Training should provide riders with the following:

- A thorough understanding of ATV features and capabilities:
  - Include hands-on practice performing manoeuvring skills
    - Inspection routines, troubleshooting and minor repairs
  - If more than one type of ATV is on site, operators should be aware of the variation in controls, braking systems, transmissions, and the handling and performance of each type.
- The ability to assess risks:
  - Recognize that ATVs are dangerous vehicles, especially when combined with youthful machismo, speed and inexperience
  - Recognize their personal skill level and the degree of physical strength required to handle an ATV
  - Recognize how various terrain and weather conditions will affect their ability to ride the ATV safely
- An understanding of how ATV safety procedures integrate with company, project or field camp SOPs and ERPs, communications procedures, survival procedures and other safety procedures.

New Riders

- New riders should learn to operate an ATV in a restricted area.
- Supervisors or trained employees should assess the competency of all new riders before granting permission to travel alone to work sites.
- New riders should be assigned to travel with experienced riders.

PDAC 14.7 Safety Precautions

General Prevention and Preparation

- Be alert to weather conditions and possible changes when planning a traverse. A firm trail in the morning may become an impassable trail later in the day.
- Follow the project tracking and communication procedures. Leave your itinerary and estimated time of return on a map with someone in charge who knows how to respond if you do not return. Carry communication equipment to notify the project or camp of changes in plans. Carry a written copy of the project ERP.
- Be especially alert to dangerous situations at the end of the workday when you are tired. Avoid travelling alone. Use the “buddy system” with separate ATVs whenever possible. Ride within your ability.

Personal Protective Equipment (PPE)

PPE is often subject to occupational health and safety (OHS) governmental or institutional "Standards", which vary between countries. When not subject to Canadian Standards, a company should apply a good Standard to the equipment they supply to their employees as a measure to promote health and safety.

- Helmets: Wear the correct helmet and fasten the chinstrap securely. Full face helmets offer the best protection. Helmets should be in good condition – no dents or cracks – and the inner foam padding should be in good shape. The following website has extensive information about ATV helmets: http://4wheeldrive.about.com/cs/beginningatv/a/atvriderhelmets.htm
  - Use ATV helmets that comply with federal standards. Helmets should have a certification sticker from at least one of the following:
    - Snell Memorial Foundation M2005 Standard (highest testing standard)
    - US DOT sticker Standard FMVSS 218
    - Meet or exceed Standard D230 of the Canadian Standards Association (CSA)
    - British Safety Institution Standard BS5361
    - Australian Standard AS/NZS 1698:2006
  - Helmet replacement: Replace any helmet that has been worn in an accident and damaged. Consider replacing helmets after five years, as their safety features deteriorate over time and they do not offer the same protection as when new. Helmets are stamped with the month and date of production. Replace a helmet immediately if it is damaged or shows signs of wear.
  - Table 1 on the following website summarizes Canadian provincial and territorial ATV legislation regarding age restrictions and helmet requirements: http://www.cps.ca/english/statements/IP/IP04-01.htm#TABLE%201
- Goggles or a visor should be worn to protect your eyes from whipping branches, insects and dust etc. Goggles should be free of scratches, shatterproof, and well ventilated so they do not fog up. Accidents can happen when something hits a rider in the face or eyes.
- Boots: Your feet are at risk because of the vehicle design. Wear leather boots and place your feet on the footrests close to the machine and keep them there at all times. Point feet inwards so they do not catch on rocks, stumps or branches.
- Clothing: Wear long pants and a long-sleeved shirt or jacket to protect your skin in an accident and from whipping branches. Do not wear loose clothing such as long scarves, which may get caught in moving parts of the ATV or on vegetation.
- Gloves: Wear comfortable gloves to protect your hands from trail hazards and for warmth.

Speed

- Ride at a safe speed appropriate for the current operating conditions, the type of machine, your ability and trail visibility. Be able to stop within the distance you can see.

- A “safe speed” may differ day to day and even during the day depending on ground, weather and visibility conditions.
- Excessive speed is dangerous and contributes to most accidents, as a rider cannot respond quickly enough to unexpected situations.
- Rapid acceleration may cause the front wheels to lift off the ground and the ATV to flip backwards (with you underneath).
- Go slowly to maintain control when going downhill.
- Slow down when travelling in rough terrain, confined areas with limited visibility, or where you might expect to encounter traffic or wildlife.
- Operate ATVs at a very slow speed within camp.

Terrain

- Learn to identify terrain that is unsafe for operating ATVs. Some hills are too steep. Some ground is too soft – or too wet – or too rough. Remember, ATVs have limitations. Know them and consider walking when ground conditions become too demanding. Use good judgement and avoid risky situations.
- Look ahead to watch for hazards and changing terrain conditions. Note the quality of the ground surface; observe upcoming obstacles as you approach them. These include ruts, holes, protruding rock surfaces, overhanging tree branches, wildlife, oncoming traffic, streams, swampy or muddy ground, and fallen trees.
- When approaching unknown terrain, reduce your speed so you can completely stop the ATV in less than the distance you can see. If terrain is very rough or steep, scout the route on foot in advance.
- Get to know the terrain you frequently travel and keep to planned routes. Don’t take spontaneous short cuts.

PDAC 14.8 Basic Safe Riding Skills

PDAC 14.8.1 Correct Riding Posture

- Ride with your head and eyes up and look well ahead at the path you will take. Keep both hands on the handlebars at all times.
- Keep your knees in near the gas tank.
- Keep your feet on the footrest and point your toes inwards.

PDAC 14.8.2 ATV Controls

Refer to the specific ATV operator manual for information and guidance specific to the ATV model.

- Know the location and operation of all controls. These include hand brakes, foot brake, parking brake, ignition switch, engine stop switch, starter (pull, kick, or electric), throttle, choke, shifter, clutch (if present), reverse gear (if present), lights on/off switch, fuel supply valve etc. Be able to locate and use the controls without searching for them. Your actions should be automatic.
- Know how to start the ATV correctly. Follow procedures outlined in the operator manual.

- Manual and fully automatic transmissions require different starting procedures.
- Know how to start a flooded engine. Know emergency starting procedures.
- If the ATV is equipped with a winch, follow instructions in the operator manual and use the correct accessory equipment. Wear PPE and make sure no one sits on an ATV or stands in the path of a potentially whipping winch cable during the winching process.

Shifting Gears

- Learn to shift correctly. Shifting procedures differ between various machines and whether the ATV has a manual or fully automatic transmission. Refer to the operator manual.
- Learn how to prevent a stall if the ATV has a manual clutch. This includes learning to recognize the sound of the ATV engine in order to shift gears efficiently and smoothly.
- Release the throttle before shifting gears so the ATV remains stable and the front wheels do not lift off the ground.
- If the ATV has a reverse gear, carefully follow the procedures outlined in the operator manual. The improper use of reverse may result in serious injury and/or damage to the ATV.

Braking

- Follow braking instructions in the operator manual. Know how the braking system works and use the correct braking techniques to prevent mishaps.
- Release the throttle before applying the brakes.
- Apply the hand brakes and foot brakes equally, if equipped. Shift to a lower gear, which allows the engine to slow the ATV.
- Brake while travelling in a straight line. Brake before entering a turn. Never brake while swerving to avoid an object. The ATV may overturn more easily if you brake while cornering or swerving, or apply too much braking force.
- Brake gently if the ground is slippery.
- If you unintentionally lock the wheels when braking, briefly release the brakes and reapply them more gradually.
- Never use your feet to slow the vehicle or brace against a rollover. Always keep your feet on the foot rests.

Parking

- Park completely off a trail and in a safe place when you stop.
- Park on flat ground. Avoid parking on soft or sloping ground, as the ATV may overturn.
- Set the parking brake or place the shifter in “park” if the ATV has a fully automatic transmission.
- If there is no parking brake, shift into a low gear when the motor is turned off to keep the machine from rolling.
- Chock the wheels if it is necessary to park on sloping ground.

PDAC 14.8.3 Loads

Any load on an ATV – rider, passenger, backpacks, samples or equipment on racks – raises the centre of gravity. This makes the ATV less stable, more difficult to handle and easier to roll over.

- Do not overload ATV racks. Loads should not exceed the manufacturer's weight limits. Distribute the load between the front and rear racks according to the guidelines in the operator manual. Poorly distributed loads make the ATV very difficult to control.
- Thoroughly secure all loads to the racks. Loads should not extend beyond the ATV where they might catch on rocks or vegetation. Do not place sharp objects on the front rack.
- Do not place loads so they obscure the rider's ability to see the trail and safely ride.
- Place all backpacks on racks. Riders (and passengers) should not wear a backpack so they can dismount quickly in an emergency.

PDAC 14.8.5 Transporting ATVs

Use appropriate means to transport ATVs, such as flatbed trailers or pickup trucks. Use caution when loading and unloading them and use a winch whenever possible.

- Depending on the terrain, it may be possible to back a pickup truck or trailer into the side of a bank if the height is right. An ATV can then be ridden carefully onto the truck bed or trailer.
- It is safer to load and unload ATVs using a trailer rather than a pickup truck, as the ramp angle is lower.
- Loading ramps must be secure. Ramps should have cleats or brackets so they can be securely attached to the truck or trailer and then secured with straps. Use proper ramps that have side boards to assist the tires staying on the ramp. Ramps should provide good traction (e.g., metal ramps with perforations, plywood ramps with cross-wise lath). It is very easy for an ATV to slide off when ramps are wet or muddy. Using wooden planks as ramps to load ATVs is not acceptable as they cannot be securely fastened and it is very easy to flip an ATV during loading, which may result in a serious crush injury or even death.
- Inspect the trailer: wheels, tires, floor, welds, anchor hooks, electrical hook-ups etc.
- Make sure additional cargo is secured on the truck or trailer and will not shift en route and damage the ATV.
- Loading
  - Choose a flat unobstructed site to load the ATV onto the truck or trailer.
  - Keep the ATV under control at all times to prevent it from rolling and hitting the back window or slipping off the ramps.
  - Remove all cargo from ATVs before loading them onto a truck or trailer.
  - Check that the wheels are centred over the ramps and use low gear or 4-wheel drive.
  - Winch the ATV onto the carrier. If this is not possible, ride the ATV slowly and carefully up the ramp and onto the truck or trailer.
  - Check that the ATV is centred on the trailer or bed of the truck.
  - Check that the ATV is in gear, the parking brake set, and the fuel line is shut off.

  - Secure the front and back of the ATV to the vehicle with approved straps, harnesses, blocks and/or chains that are in good condition to prevent the ATV from shifting while en route or being ejected during an accident.
- Unloading
  - Winch an ATV down the ramps. Never ride it backwards down the ramps off a trailer or pickup truck.
  - If this is not possible, keep your hands on the controls and roll it out to the ramps. Walk on the ground while controlling the brake as you move the ATV down the ramps.

PDAC 14.9 Safe Riding Strategies

Follow the riding instructions in the manufacturer's ATV operator manual for negotiating turns, slopes and obstacles. Safe operation of ATVs requires the rider to be "rider active" and shift their body when turning, going uphill and downhill and riding over obstacles etc. Correct body actions should become automatic.

PDAC 14.9.1 General Strategies

- Ride within your ability. Choose another route if there is any doubt whether you can safely cross specific terrain or an obstacle.
- Keep your eyes up and continuously scan for approaching hazards. Modify your speed, your riding techniques and your path of travel to accommodate hazards.
- Always be able to stop within the distance you can see. This is very important when climbing hills or riding in unfamiliar terrain.
- Don't tailgate. If the route is dusty, leave extra space to maintain good visibility in order to assess approaching trail conditions and traffic. Remember that ATV models built before 2004 do not have brake lights.
- Never put your feet down to try to stabilize an ATV. You may injure your foot or leg. Always dismount on the uphill side if the ATV is about to tip over.
- Do not stand on the foot pedals while travelling on flat terrain.
- When travelling in confined areas, watch out for branches that might hit your head or body. Watch out for situations where you might wedge your hands or handlebars against a tree or rock. Do not use a whip and antenna flag in confined areas.
- Avoid rider fatigue. Wear suitable clothing for the weather, eat enough food to keep up your endurance and drink plenty of water to avoid dehydration. Take rest breaks. Know your limits and do not exceed them.
- Yield the right-of-way when you encounter uphill traffic.
- If you encounter mud, do not spin the tires as you will dig in the ATV and get covered in mud. Each day, clean out any mud build-up from the engine and chain etc.
- Stay on existing paths and trails. Do not take shortcuts. Preserve the environment; ATVs are capable of doing severe damage to the land.
- It is not advisable to use an ATV on snow. It is usually better practice to use a snowmobile – they have a lower environmental impact and are designed to operate under cold conditions. When circumstances allow for ATV use in winter conditions,

riders should follow the applicable training and basic safe operating guidelines for snowmobiles and working on ice (refer to Chapter 15. Snowmobiles).

- Use ATVs only where they will not adversely impact the environment. In snow, they are noted for digging up the path when wheels are spun to regain traction. This is likely to happen when riding on soft snow; therefore ATVs are best ridden on firm snow.
- Follow the SOPs and measure the ice thickness before crossing any frozen lakes or streams to make sure it will support your weight plus all your equipment. Continue to measure the ice thickness on a regular basis, as the thickness can change rapidly and unpredictably.
- Be trained to recognize and treat hypothermia and other cold injuries.

- To cross a road or railroad tracks, come to a full stop in a place with clear visibility. Never assume that you are seen by drivers on a road; they are looking for other vehicles, not for ATVs. Check carefully in both directions. Cross at 90°. It is not advisable to ride along railroad tracks or railway right of ways – it is often illegal to do so.
- If you encounter horseback riders or pack horses on a trail, yield the right of way to them and shut off the engine so the horses are not frightened by the noise.
- If you are an experienced rider but unfamiliar with a particular ATV, make a test run to become familiar with its controls and handling features.

PDAC 14.9.2 Tips for Crossing Obstacles

Refer to the operator manual for specific manoeuvring instructions. Avoid crossing obstacles (and ruts) unless it is safe to do so. Some are too large to attempt. Be especially careful to shift your body to maintain stability if only two wheels on one side of the ATV cross the obstacle. General tips include:

- Cross obstacles and ruts as close to 90º as possible.
- Adjust the speed to maintain momentum.
- Stand on the footrests. Hold the handgrips firmly while keeping your knees and elbows flexed.
- Move your body weight slightly to the rear as the front wheels rise up over the obstacle.
- As the rear wheels contact the obstacle, move your body weight forward and centre yourself on the ATV.

PDAC 14.9.3 Tips for Turning

Follow the specific turning techniques recommended in the operator manual. Some models have a solid rear axle and some have unlocked differentials. Know your machine and the techniques required for safe turning.

- Slow down before entering a turn.
- Turn the handlebars and look in the direction of the turn.
- Move your body weight forward and lean to the inside of the turn.
- If the ATV begins to roll during a turn, lean your body farther into the turn. Gradually reduce speed and widen the turn if possible.

- Avoid sharp turns when carrying loads or pulling a trailer – go slowly. Do not brake while swerving to avoid an obstacle.

PDAC 14.10 Utility Vehicles

Utility vehicles, such as Mules, Bobcat, Rhinos, Argos, may replace ATVs in some locations. They are generally safer than ATVs as they are driven like a truck rather than ridden like an ATV or snowmobile. They are useful for carrying more people and/or cargo between locations, but they have limitations. For example, many models cannot cover the same rough terrain or steep slopes as ATVs. Some are amphibious. Safe operating procedures that apply to ATVs should be applied to the operation of utility vehicles. Some special features should be noted:

- Utility vehicles are not designed to be driven on public streets, roads or highways. If the authorities having jurisdiction (AHJs) where the company operates permits them to be licensed and driven on public roads, the company should develop SOPs that specifically address this use of utility vehicles.
- Read the manufacturer's operator manual and be familiar with all danger and warning decals on the vehicle before driving it. Follow the SOPs in the manufacturer's operator manual.
- Some utility vehicles may require certified training, depending on company SOPs and/or jurisdictional legislation.
- Be familiar with the transmission features of the utility vehicle.
  - Some utility vehicles have gear shifts and can be manually downshifted to slow the vehicle as it is driven downhill.
  - Some utility vehicles are designed with a direction handle to go forward or reverse and the operator must control the vehicle speed when going downhill by pressing both the brake and the accelerator pedals. With this type of transmission, the direction handle can be changed from forward to reverse only when the vehicle is stopped and the engine is idling.
- Utility vehicles may be fitted with rollover protection (ROP) and seat belts. Drivers and passengers should wear seat belts when underway unless driving on ice.
- Wear a PFD if using an amphibious vehicle for transportation over water. Use caution when driving them in water, as they may (1) ride very low in water, (2) be challenging to manoeuvre, and (3) be easily swamped in choppy water.
- Perform daily routine inspections like those for ATVs.
- Follow the manufacturer's directions for the operation of the vehicle's accessories, such as the winch. If the vehicle is equipped with special mud tires, make sure they are installed according to the manufacturer's directions.
- Use caution when encountering obstacles in the route. Try to remove them or go around instead of driving over them.

PDAC 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.

PDAC 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

PDAC 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):

- 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.
- 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.
- 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.)
- 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.
- 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.
- 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.
- 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.

- 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.
- 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.
- Maintain a safe speed and keep the snowmobile under control.
- Obtain permission to cross private land. Leave gates as they are found.
- 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.
- Snowmobiles should not be used for chasing or harassing wildlife; provincial and territorial legislation prohibits these actions.
- 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.
- Companies should consider establishing guidelines regarding the use of company owned or leased snowmobiles for recreational purposes.
- 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.

PDAC 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

PDAC 15.5 Inspections, Maintenance and Fuelling Guidelines

PDAC 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.

PDAC 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.

PDAC 15.5.3 Fueling 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.

PDAC 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 .

- 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.
- 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.
- Each rider should understand how snowmobile SOPs integrate with company and project/camp ERPs, communication procedures, survival and other safety procedures.

PDAC 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.

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.

PDAC 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.

PDAC 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.

PDAC 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.

PDAC 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.

PDAC 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

PDAC 15.9 Safe Riding Strategies

PDAC 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&P ageId=11036

PDAC 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.

PDAC 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.

PDAC 16.0 Aircraft

Introduction

The mineral exploration industry commonly relies on aircraft to access remote exploration sites. Various types of fixed wing aircraft and helicopters are used depending on availability and what is most appropriate for the job. Mineral exploration often requires operating aircraft in a wide variety of remote and challenging conditions. Aircraft related accidents, particularly those involving helicopters, have accounted for more fatalities than any other type of accident in exploration.

- Some fatalities could have been prevented if safe operating procedures (SOPs) had been followed. Four ways to reduce the likelihood of aircraft related incidents and potential fatalities are carefully select charter aircraft companies and pilots; (2) do not accept unsafe practices by pilots or pressure pilots towards such practices; (3) thoroughly train all employees at any project serviced by aircraft to work safely in and around aircraft; and (4) provide refresher training for those who use charter aircraft on casual basis.

PDAC 16.1 Risks and Hazards

All Aircraft

- Crashes resulting in injury or death caused by pilot fatigue, bad weather, overloading, inadequate maintenance
- Drowning caused by inability to escape a submerged or overturned aircraft after a crash in water
- Death, dismemberment, severe injury, impact injury caused by contact with rotor blades or a propeller. This is particularly hazardous when mooring a float plane or when entering or exiting a helicopter during a toe-in landing
- Stranding caused by an accident, bad weather, mechanical problems, communication breakdown
- Pilot fatigue caused by difficult working conditions, stressful sling work, pressure by the company or contractor to complete a job
- Damage to property, aircraft caused by careless handling of freight, prop wash Hearing loss caused by lack of hearing protection
- Burns caused by contact with cowling around engines, areas near exhaust discharge, pitot tubes
- Accidental fires caused by prop wash, downdraft from rotor blades, fuel spills

Helicopters have additional risks and hazards

- Being struck by rotor blades or tail rotor, caused by unsafe movement through hummocky ground, wind causing blades to dip, toe-in landings
- Risks associated with slinging – see section 16.12 Slinging
- Injury or damage caused by people or equipment contacting main or tail rotor while loading
- Damage to main or tail rotor blades caused by coming into contact with trees or shrubs in tight landing spaces, which may result in potential stranding
- Falling out caused by flying with doors removed during some surveys

PDAC 16.3 Aircraft Charters

Accidents and incidents involving aircraft (helicopter and fixed wing) are the principal cause of fatalities in the mineral exploration industry. Given that about 75% of accidents are caused by pilot error and 20% by equipment malfunction, it is imperative to use the safest pilots and aircraft possible. All companies registered in Canada that operate aircraft are required to have a Safety Management System (SMS) in place. No matter where in the world an aircraft is chartered, the presence or lack of a SMS will be an indication of a company's regard for safety.

Guidelines for Chartering Aircraft and Hiring Pilots

- Use only registered charter airline companies with good safety records that are in compliance with jurisdictional regulations – preferably one that has been audited. Request to review the company SMS documents and safety records and try to review audit information.
- There are consultants throughout the world that specialize in safety performance audits of charter aircraft companies. When planning an exploration program with extensive air support, the cost of performing an audit is only a small portion of the total expense.
- Obtain references for air charter companies and pilots from other companies that have used them. Preference should be given to pilots who have flown satisfactorily for the company before and whose competence can be effectively assessed.
- Discuss the charter company and aircraft selection process with someone who is familiar with the charter company under consideration and who has experience with the type of aircraft and terrain.
- Charter aircraft that are appropriate for project requirements e.g., ferrying employees to and from the site and/or traverse routes, capability to cover the required area, transporting equipment, flying required surveys or slinging required loads (e.g., equipment or drills). Make sure the aircraft landing requirements are fully discussed and understood.
- Specify the requirements for complete survival kits, training and emergency procedures when requesting proposals for aircraft charters.
- Make sure the aircraft landing requirements are fully discussed and understood.
- Hire experienced pilots. The Prospectors & Developers Association of Canada (PDAC) suggests that an exploration company stipulate that a pilot have a minimum of 1600 hours flying in the same type of aircraft. As an additional requirement for helicopter pilots, stipulate that a pilot has in excess of 800 hours experience in similar terrain and 300 hours of experience using unprepared landing sites. Also, the pilot should have flown a minimum of 300 hours as pilot in command during the last 12 months, and also have recent training and experience in slinging the particular type of work that will be required at the site. Some major mining companies require even more experience than outlined here.
- When helicopter slinging is required:
  - Helicopter: Tender documents and/or the helicopter contract should specify a type of helicopter capable of moving the drill components or any other required sling loads on site. Therefore, it is necessary to identify the drill equipment and accurate weights of component parts in the tender document. Helicopter specifications can

be checked for lifting capacity, range, fuel capacity and other attributes to determine the best machine for a specific purpose but it is always advisable to discuss these requirements with experts.

- Drill sites: Drill moves using helicopters require special pilot expertise such as long-lining ability and knowledge of how drillers work. Tender documents should specify that the pilot has recent experience and certification regarding drill moves and with the same type of machine. Specify a licensed aircraft maintenance engineer with sling expertise, as this person is responsible for the good condition of the sling equipment.

- It is recommended that a helicopter aircraft maintenance engineer be present at all projects where a contract helicopter is based. Discuss pilot and engineer rotations before the project starts.

PDAC 16.4 Safe Operating Guidelines for All Aircraft

Follow strict safety rules when working around all aircraft. Propellers and rotor blades are invisible when engines are running; it is easy to become distracted and walk into them.

- At the start up of the season or project, include an aircraft safety induction as part of the general safety induction meeting. The pilot should provide a full briefing at the aircraft for all personnel working on a site with aircraft support. It is advisable to repeat aircraft safety briefings at least monthly, but they must be repeated whenever a new pilot begins work, new personnel arrive on site, a new aircraft is used, or whenever an incident occurs involving aircraft. Employees and passengers should pay attention to all safety briefings.
  - Hold full safety briefings before all flights for passengers who regularly fly (e.g., air support for traversing) until they are fully familiar with procedures. Less extensive briefings can be held once workers are well trained. Hold periodic refresher training.
  - Brief passengers before all flights when there is a change or potential change in regular routine or there are unusual situations (e.g., hover manoeuvres).
  - Hold full pre-flight briefing any time there are visitors or persons who do not regularly fly on the aircraft.
  - All critical safety instructions and briefings should be in the local language, where relevant.
- In many jurisdictions there are limits to the number of hours a pilot may fly in a given time period. Know these limits and do not request a pilot to exceed them. These regulations are intended to combat pilot fatigue, which is an important factor in many aircraft incidents and accidents. Transport Canada regulations permit 8 flight hours and 14 hours maximum duty time in a 24 hour period. http://www.tc.gc.ca/CivilAviation/Regserv/Affairs/cars/Part7/Standards/720.htm
  - As a guideline, the International Airborne Geophysics Safety Association recommends the following hours, which are available on the following website: http://www.iagsa.ca/Contract_Annex990325.pdf
    - Maximum flight hours

    - 40 hours in any 7 consecutive day period
    - 70 hours in any 14 consecutive day period
    - 120 hours in any 30 consecutive day period
    - 1200 hours in any calendar year
  - Hours should be reduced if slinging or low level surveys are performed.
- Plan flights schedules to comply with certifications of the pilot and aircraft. If using VFR (Visual Flight Rules) aircraft, always plan to have flights completed in daylight with a safety margin. This usually means planning flights during daylight hours that begin no earlier than 45 minutes after sunrise and are completed 45 minutes before sunset.
- Develop a written emergency response plan (ERP) with procedures that address potential aircraft emergencies. Train all passengers and employees to know what to do and in what order for potential aircraft emergencies. Hold a drill to test the plans. Passengers should be fully familiar with relevant parts of section 16.15 Emergency Procedures.
- Pilots should file a written record of the passengers on board, the route and destination for every flight.
- Aircraft are required to carry safety and survival equipment for each passenger. All passengers should know the location and nature of this equipment; the location may differ between aircraft – even in the same type of aircraft. In addition, each passenger should carry basic personal survival items suited to local conditions distributed in their pockets.
- All passengers must be transported in anchored seats with seat belts fastened. Wear hearing protection (ear muffs) whenever possible. Carry and use disposable earplugs for additional protection.
- The pilot or co-pilot is required to supervise the embarking and disembarking of passengers. This is usually done when the engines are shut down.
- When boarding or disembarking, never walk in the direction of the propellers of fixed wing aircraft or in the direction of the tail rotor of a helicopter.
- Stand well back from all aircraft during landing or docking procedures. Never touch or stand within the arc of a stationary propeller. The engine's ignition circuits may be live and spontaneous ignition in piston engines can occur.
- Never overload an aircraft. Follow safe loading procedures. Plan for the increased weight of samples. Make an extra trip if necessary. (See section 16.8 Safe Loading Guidelines.)
- Notify the pilot of any dangerous goods cargo. Plan ahead as it may be difficult to ship some supplies to remote sites, depending on available air carriers. See section 16.9 Transportation of Dangerous Goods.
- All employees are required to maintain vigilant, safe behaviour and refrain from all types of horseplay in and around aircraft at all times.
- No smoking within 30 metres of aircraft or fuel storage areas.
- In the event of a crash, stay in the vicinity of the aircraft. In the event of a hard landing, do not leave a helicopter until the rotor blades stop completely or the pilot gives

permission. Know where the exit is relative to your seat (situational awareness) so you can find the exit even if you are upside down, under water or the cabin is dark and smoky.

- Always wear clothing appropriate for the climate and weather when you fly. Keep essential survival items in your pockets, if permitted. You may not be able to retrieve heavy clothing and packs from the cargo compartment in an emergency. In winter in the Arctic, dress in layers, wear boots and carry a parka, mitts and hat in the passenger compartment. In summer, carry a warm jacket and bug repellent.
- When ferrying crews to a destination, distribute the food and equipment, including survival kits, as equally as possible between flights. Then, if something prevents the completion of all flights, the risk is reduced for any group that may be stranded without food, water and shelter.

.PDAC 16.5 Pilot Fatigue

Fatigue is cumulative and affects pilots in insidious ways; their attitude toward flying changes so that personal safety standards decline and they take risks they would not normally take. Fatigue and tiredness are not identical. A person may feel tired after a long day of work, but after a number of long hard work days one may feel the cumulative effect of the work as fatigue. Piloting any aircraft is stressful work and may result in fatigue. Piloting helicopters is usually considered more stressful than piloting fixed wing aircraft – and slinging operations are rated as twice as stressful as normal helicopter flying.

Symptoms of pilot fatigue are difficult to pinpoint but they may include:

- Decreased mental alertness.
- Emotional responses to minor irritants that become unpredictable.
- Tuning out visual and auditory cues that would normally serve as warning signals to the pilot.
- Pilots may exhibit distracted attention, slow reaction time or missed cues, grouchiness and irritability, atypical behaviour and/or isolation.
- Fatigue often leads to mistakes, which in turn leads to incidents, sometimes with tragic consequences.

The following contribute to fatigue:

- Long working hours without enough sleep.
- Pushing the limits – of the aircraft, load capacity, the weather and available daylight.
- Slinging difficult loads under marginal conditions – even when not actually pushing the limits.
- While “fatigue” is most frequently an issue raised with reference to pilots, it is not limited to pilots. Field employees who undergo long stretches of work without a break and/or who endure stressful project situations may develop fatigue and be more liable to unsafe actions around aircraft.

PDAC 16.7 Helicopters

Helicopters present a number of unique hazards by nature of their design and use. They are more susceptible to mechanical failure than fixed wing aircraft. Although they are particularly useful, never take safety for granted at any time, especially when accessing rugged terrain and/or flying in poor weather conditions where visibility is limited.

In addition to those listed in section 16.4 Safe Operating Guidelines for All Aircraft, the following guidelines apply to helicopters.

PDAC 16.7.1 Safe Operating Guidelines for Helicopters

- Avoid using piston engine helicopters.
- Passenger safety briefings should stress the additional hazards associated with helicopters.
- Never approach or exit a helicopter without the pilot's direct permission or signal. Pilots frequently do stability testing and shift the helicopter slightly before final landing. Establish a protocol with the pilot to signal that it is safe to approach or exit a helicopter. Also, establish a signal protocol that indicates it is safe for the pilot to lift off after all passengers have disembarked, unloaded gear and are well clear. This is particularly important when passengers disembark while the machine is under power.
- Approach a helicopter by moving toward the front of it and in full view of the pilot. Try to keep eye contact with the pilot. Take care not to walk into the radio antenna or pitot tubes. Exit by moving away at the front of the helicopter. You may have to approach or exit to the side if it lands facing high ground or if it has a low blade clearance at the front (e.g., Sikorsky S-76). Never enter or exit toward the rear of a helicopter, as the tail rotor is invisible when the machine is running. See also # 6 and 7 below.
- Always approach or exit in a crouching position to give your head more clearance from the rotor blades. Hold on to your hat or hard hat if it is not secured with a chinstrap. Do not reach up for your hat or chase it if it blows away.
- Never walk in the direction of the tail rotor. If you walk into the tail rotor it will kill you! Inform the pilot before exiting if it is necessary to remove gear from the cargo compartment. Do this carefully and make sure to close the cargo compartment door correctly when finished. Then, return to the front in full view of the pilot and move away at the FRONT of the helicopter. Never go under the tail boom to get from one side of the helicopter to the other. Walk only around the front of the helicopter.
- Always approach and exit using the downhill side if the helicopter is on a slope. The rotor blades will be much closer to the ground on the uphill side and they can hit your head. Be alert to this risk when moving through uneven or hummocky ground within the range of the main rotor blade. Passengers in rear seats should all exit from the same door on the downhill side of the helicopter. A front passenger who must exit on the uphill side should first retrieve gear stowed in the cargo compartment while staying close to the helicopter, and then move around the front and away from the machine on the downhill side.
- Do not approach or exit when the rotor blades are moving slowly. Blades will dip as the motor slows, and they can also dip unpredictably when it is windy.
- Establish a signal protocol between the pilot and all passengers to use when exiting and unloading gear. When exiting a helicopter that will take off immediately, move at

least 10 metres away with your gear and crouch down in a safe place. Make eye contact with the pilot and signal that you are secure. Remain there during liftoff. This is very important when passengers are disembarking while the helicopter is under power.

- Do not approach a helicopter when visibility is reduced with blowing sand, dust or snow from the downdraft of the rotors. Wait until visibility is clear or until the helicopter has shut down.
- Do not distract the pilot or upset the balance of the machine with sudden or unpredictable movements during takeoff, landing or other manoeuvres. Nevertheless, if you notice a hazard while flying, be sure to point it out to the pilot. Do not assume the pilot has seen it.
- Carry all long items horizontally (e.g., poles, oars, tools) when loading and unloading. Two people should carry long items – one at each end – to prevent contact with the rotors. Never carry them vertically or over your shoulder as they may hit the main rotor blades. Do not toss items from person to person.
- Stow small articles: Place hats, vests, sample bags, maps and clipboards etc., into a pack before boarding so they cannot be blown or sucked into the rotors or engine. Never chase something that blows away – you may be killed.
- Never throw anything out of a helicopter. It may contact the rotor blades or be sucked into the jet engines.
- Passengers should not ride in a helicopter during slinging procedures.

Note: Stay alert and constantly remind yourself to keep your distance from the rotor blades.

PDAC 16.7.2 Additional Safety Guidelines for Helicopters

- Do not rush while working around aircraft. The tendency to hurry during loading and unloading procedures greatly increases the chances of injury. This is especially true when the machine is running and rotors are turning.
- Always plan who will do which job when loading and unloading a helicopter. Who will communicate with the pilot? Who will hold the door? Who will carry which items? How will the items be carried? This helps prevent confusion and accidents, as it is very noisy and windy around a helicopter with its rotors turning.
- When boarding or exiting a helicopter under power, keep a good grip on the door handle or door frame until both feet are safely inside the helicopter or on the ground.
- When exiting, refasten seat belts so they don't flap around inside the bubble or hang out the door. Close the door carefully.
- Do not touch a helicopter or the load before it has completely landed, as it is usually charged with static electricity.
- Stow field gear, samples and packs in the cargo compartment. Plan for the increased load at the end of the day due to the weight of samples.
- Close doors and cargo compartments carefully and completely. If the helicopter is unfamiliar, ask the pilot to demonstrate how to open and close the doors with minimum effort. Practice when the helicopter is shut down.

- Securely stow all items within the bubble. Unsecured, small heavy items can cause a lot of damage during turbulence or a hard landing. They may slide and jam the controls.
- Never place items against the bubble as they may damage the surface or obstruct the pilot's view.
- Extra caution is required during some surveys such as when a helicopter door is removed. When working on such a survey, do not unfasten your seat belt until the pilot gives permission.
- When traversing or working off site, use hand-held FM radios for communication between the pilot and other parties on traverse. Supply the pilot with a frequency so field parties can communicate with the pilot from the ground. At least one FM radio per group working in any one location should be provided. Compact satellite phones capable of communicating with the project site can be used if the project site has the capability of contacting the pilot by radio.
- Carry a fluorescent orange helicopter cloth and signalling mirror to attract the pilot's attention in case radio communication fails. The cloth is useful to indicate wind direction to the pilot, but then pack it away securely to prevent it being sucked into the rotors.
- Protect your eyes from dust produced by the downdraft during arrival or departure. Wear safety glasses or goggles.

General safety around helicopter landing sites

- Stand back at least 15 m from the landing pad during arrival or departure, preferably upwind and in view of the pilot. Remember – a helicopter can move in any direction including backwards.
- Weigh down or remove all lightweight materials, especially plywood, foam mattresses and tarpaulins that might be blown around by helicopter downdraft. A heavily loaded helicopter has a powerful downdraft that can send sheets of plywood, styrofoam or plastic sailing into the air.
- Locate all fires at least 100 m from a helipad so turbulence created by flying activity will not blow embers about and create a brush fire.
- Designate any required parking area for vehicles or ATVs etc., and set it well back from the landing site. Remove light weight material (e.g., empty cans, rubbish) from the back of pickup trucks to prevent objects being blown about by the downdraft from helicopter blades.
- In some forested areas, few landing sites are available and it is imperative that a ground party carries an axe or saw to create or improve landing sites. Fly the traverse route prior to drop off to check for potential landing sites, as well as rivers that cannot be crossed, predatory wildlife and hazardous terrain. Communicate and plan with the pilot regarding when and where you expect to end the traverse so that a suitable pick up point is located. Mark it on the maps (yours and the pilot's).

PDAC 16.7.3 Guidelines for Hover and Toe-in Manoeuvres

The following guidelines are adapted with permission from "Toe-in Pick-up Guidelines" in the Canadian Mineral Exploration Health & Safety Annual Report 2008 issued jointly by AME BC (Association for Mineral Exploration British Columbia) and PDAC.

- Hover Manoeuvre: Any passenger entry or exit from a helicopter that is required to be under power in order to maintain a stable altitude
- Toe-in Manoeuvre: A passenger entry or exit when any skid is in partial contact with the ground

Exploration employees and helicopter pilots should strive to avoid hover and toe-in manoeuvres whenever possible. Field crews should always look for flat landing spots throughout the entire field season so the pilot can make a conventional, full skid landing. They are much riskier than regular landings, as it is critical for the pilot to maintain stability of the helicopter at all times. A hover or toe-in manoeuvre accident has a higher potential to become a fatal accident. The noise of the helicopter under high power is stressful for both the pilot and passengers. Passengers must remain calm and never rush or move rapidly when they embark or disembark from a helicopter under power.

- Factors that contribute to the safety of helicopter toe-in manoeuvres include: the type of helicopter, terrain, altitude, wind direction, the number of passengers and the loads to be removed or placed on board.
- Hover manoeuvres including toe-in pick ups and landings must only be done with experienced field crews who have developed a solid working relationship with a pilot experienced in making these manoeuvres.
- Hover manoeuvres including toe-in pick ups and landings should be discussed during the safety induction at the beginning of the season. If a pilot does not mention these manoeuvres at the safety induction or when the pilot starts work, the field crew should ask if they are part of the pilot's repertoire. Field crews should not assume a pilot will make toe-in landings and pick ups whenever they find it more convenient than searching for or preparing a good flat landing site.
- Entry and exit procedures for hover and toe-in manoeuvres should be practiced on the ground with the engine off before they are performed in the field.
- If a hover manoeuvre or a toe-in landing or pick up is anticipated during the day, the pilot and field crew should review and discuss the procedures prior to embarking on the flight and/or again prior to disembarking from the helicopter. The pilot should hold a drill before every trip when there is potential for a hover manoeuvre and especially for a toe-in manoeuvre.
- Establish the order of disembarkation or embarkation and sit in the helicopter accordingly. This order is usually determined by the weight of each passenger.
- As the pilot must keep both hands on the controls, he often indicates by radio contact or by eye contact and a nod that he is ready to have passengers board. Establish this procedure with the pilot beforehand.

Hover and Toe-in Landings (exits)

- Passengers should not participate in any hover exit when the skids are more than 0.6 metres off the ground.

- When disembarking, be especially careful not to make any unexpected movements that suddenly transfer weight onto or off a skid during the manoeuvre. All movements and weight transfers must be slow, smooth, efficient and controlled.
- After stepping carefully and smoothly off a skid, crouch at a predetermined distance while the helicopter takes off.
- When it is necessary to retrieve cargo from a compartment on the pilot's side of the helicopter, never duck under the tail boom. Only cross carefully in front of the pilot so you are always in view. Avoid this move if at all possible.
- Never walk upslope after disembarking from a helicopter in a hover or toe-in landing.

Toe-in Pick Ups

- A toe-in pick up location must be approved by the pilot – preferably by radio. If you are not in radio contact and the pilot does not land, it is because the pilot does not like your choice of pick up point. The pilot will go and find a good landing spot and you will have to walk to it.
- Before being picked up by the helicopter, all passengers should assemble with all gear in a location where it will be safe to board the helicopter. This position must be at a level no farther uphill than the level where the helicopter door will be so each person can walk carefully to the helicopter on a level or upslope path. Everyone must avoid the possibility of contact with the helicopter rotors.
- Each person must be able to make eye contact with the pilot. "See the pilot see you".
- Usually this will be 90º to the length of the machine on the side opposite the pilot.
- The crew must assume a crouched position with hat removed and all gear arranged ready to board. When the pilot signals (usually a nod), one person at a time will move slowly and deliberately to board the helicopter. The order that people board the helicopter should be determined through discussion with the pilot prior to the manoeuvre, which probably means prior to being originally dropped off.
- When loading packs etc., carry items at or below waist level to avoid contact with rotors.
- The pilot can direct a passenger on board to assist by arranging seat belts and lifting or stowing packs in the cabin. The pilot should indicate where to sit to best keep the balance of the helicopter.
- Before boarding, hand in gear to a passenger already on board. Each person must slowly and smoothly step onto the skid and climb into the helicopter without creating a sudden weight shift. All movements and weight transfers must be slow, smooth, efficient and controlled.
- When it is necessary to stow cargo in a compartment on the pilot's side, NEVER duck under the tail boom. Only cross carefully in front of the pilot so you are always in view. Avoid this move whenever possible.
- Make sure all cargo is safely stowed and restrained before take off.

Because the safety of the operation is paramount:

- The pilot makes all decisions regarding the helicopter and its capabilities – no exceptions.

- Every passenger has the right to refuse to participate in a hover or toe-in manoeuvre if they do not feel competent to handle the situation.

PDAC 16.8 Safe Loading Guidelines for All Aircraft

Know the load capabilities of the aircraft. Not only will this depend on the type of aircraft, it will vary with location, elevation and time of year – due to weather, temperature, humidity, the amount of fuel on board, as well as the weight of the passengers and samples (wet or dry).

- Follow these guidelines:
- The pilot must load all aircraft personally or closely supervise the operation.
- He or she must know the weight and size of the cargo to correctly balance the aircraft.
- Loads must be secured so the centre of gravity does not shift during flight and endanger the aircraft.
- Plan for the increased weight of samples at the end of the day. Never urge a pilot to overload the aircraft. Make another trip.
- Notify the pilot of any dangerous goods to be transported in the aircraft. Verify how bear or pepper spray, firearms and flares, explosives and detonators etc., may be transported before any flight (see section 16.9 below).
  - It is recommended that bear spray be placed in hermetically sealed containers. Ammunition cases that seal tightly work well.
  - Transport aerosol bug spray in the cargo compartment.
  - Firearms must be transported unloaded and with the safety on.
  - Explosives and detonators must be transported separately. Make sure any loading ramp is firmly secured before use.
- When loading, take care not to bump or damage the fuselage, floats or rotor blades.
- When loading and unloading fuel drums from fixed wing aircraft, roll them on secured planks with ropes wrapped around the drums for control.
- Use care when loading sharp tools or equipment such as shovels in the helicopter cargo compartment. Often only a thin wall separates the fuel tank and the cargo compartment.

PDAC 16.11 Responsibilities Regarding Aircraft

Exploration companies, contractors and all employees should have a clear understanding of their responsibilities to reduce risks and hazards and help eliminate aircraft incidents and fatalities.

- When companies use the Internal Responsibility System (IRS) approach, everyone follows SOPs, helps identify risks and hazards and contributes to safe aircraft operations. Refer to section 1.2 Internal Responsibility System.

PDAC 16.11.1 Pilots

The pilot is in charge of all aspects of the aircraft. It is his or her duty to safely load the aircraft, brief passengers and conduct a safe flight. The pilot should receive a copy of Section 16.

Aircraft and discuss the contents with the project manager and with employees during the aircraft safety induction meeting.

Responsibilities of the pilot include but are not limited to the following:

- Comply with all flight regulations of the country, province, territory or state (authorities having jurisdiction) and company requirements.
- Do not exceed the allowable duty hours and flight hours for the jurisdiction and/or the exploration company policy. http://www.tc.gc.ca/CivilAviation/Regserv/Affairs/cars/Part7/Standards/720.htm
- Identify and designate (with the project/camp manager) a safe landing strip, dock, helicopter landing site, and safe slinging pick up and drop off locations, as required. Inspect them daily when in use and keep them free of debris and obstacles.
- File flight plans and make sure the person in charge has a written record of passengers and monitors all flights.
- Perform all necessary pre-flight checks on the aircraft.
- Develop an appropriate check-in and tracking system for aircraft with the project or camp manager. It is appropriate for the pilot to report the aircraft position every 30 minutes when flying.
- Brief the passengers on all in-flight safety procedures, equipment and flight conditions, especially for project visitors and employees who fly infrequently. Hold refresher training as required.
- Make sure all passengers know how to access and use all safety and survival equipment.
- Grant permission for passengers to approach or exit the aircraft. Remind passengers of the safe routes, as necessary.
- Inform passengers of any unusual conditions at the time of takeoff, during the flight or when landing.
    - Follow safe operating procedures regarding fuel:
    - Use the correct fuel and make sure it has not passed the expiry date.
    - Maintain safe fuel delivery systems including filtering and water contamination test equipment. Test fuel for the presence of water and reject any fuel where water is present. Check the fuel lines for water each morning.
    - Do not operate fuelling equipment during an electrical storm or high winds.
    - Make sure empty fuel drums are removed and stored away from the landing site.
    - Be familiar with the information regarding safe fuel handling in remote locations on the following website: http://www.tc.gc.ca/civilaviation/publications/tp2228/fueldrum.htm
- Supervise all aspects of loading the aircraft including the placement and securing any permissible external loads. Make sure freight or hand luggage does not block the aisle between crew, passengers and any exit.
- Approve loading of all dangerous or hazardous cargo. The pilot should have training in handling hazardous materials.
- Never indulge in or permit any “horseplay” at any time, for any reason around aircraft.

- Plan with passengers and clearly mark the location of drop off and pick up points on the pilot's copy of the map.
- Brief passengers and make sure passengers are thoroughly trained and capable when hover or toe-in exits may occur.

PDAC 16.11.2 Project Manager or Supervisor

Responsibilities of the project manager for sites serviced by aircraft include but are not limited to:

- Select the correct aircraft for the job and site requirements in consultation with the charter company and/or pilot (see section 16.3). This will reduce the temptation to overload the aircraft. For example, just because an aircraft has four seats, it is not necessarily able to carry four people. Take into account elevation, temperature, fuel, survival gear, weight of samples, as well as the weight of passengers and their gear.
- Make sure all employees receive training at the aircraft induction safety meeting regarding SOPs around aircraft. New employees should receive routine training in aircraft SOPs when they start work. Make sure project visitors receive full aircraft safety briefings.
- Make sure that passengers are (1) aware of their right to refuse to fly if they feel unsafe; and (2) understand their obligation to report what they feel are unsafe aircraft and/or flying practices.
- Develop a written emergency response plan with procedures to address potential aircraft emergencies. Make sure the plan is posted and accessible to employees and that they are trained to implement it, as needed. Test the ERP to make sure it works – hold a practice drill.
- Make sure emergency survival caches are available beyond an arbitrary distance (depends on location, terrain, number in party). The survival kit should be contained in a highly visible, waterproof, sealed bag that can float.
- Set up and maintain safe landing sites in consultation with the pilot.
  - Keep the landing area clear of loose debris.
  - Place an air sock or wind indicator at the landing site. Place secure flagging streamers on radio antennas so they are clearly visible from the air.
  - Regularly inspect aircraft landing strips and make sure no workers or equipment are present when aircraft are expected.
- Oversee fuel storage.
  - The fuel storage area should conform to all regulations of the AHJs (authorities having jurisdiction). Locate the storage area at least 100 metres from living quarters, lakes, rivers and major streams. Store fuel well above high tide and any possible flood levels. It is advisable to have a secondary containment system that is rated for aviation and diesel fuel. Check the specification sheet for rating information.
  - Equip the fuel storage area with fire extinguishers, appropriate spill kits and posted with no smoking signs. At least one 20-lb BC extinguisher should be present.
  - Make sure that adequate supplies of the correct fuel are available and they have not passed the expiry date.

  - Keep an accurate account of the correct fuel in caches in consultation with the pilot or aircraft maintenance engineer.
  - Store fuel drums on their side with the bungs in a horizontal position to prevent water contamination. Store aviation fuel separately from all other fuels. Mark the fuel drums with the company ownership when required.
  - Refer to section 18.4.3 Fuel and Fuel Handling
- Discuss the pilot's flight plan and maintain a log and/or map of the specific remote locations where employees are working in the event communications are lost and rescue is required.
- Remote project environments can be stressful places to work in. Form a stress free working relationship with the pilot and do all that you can to promote well being at a project or camp. Don't come across as telling the pilot how to do their job, but take action if there are any signs that the pilot is under undue stress. Discuss concerns with both the pilot and his or her supervisor, if necessary (see section 16.5 Pilot Fatigue).

PDAC 16.11.3 Passengers

Passengers need to be aware of their responsibilities so they do not jeopardize the safety of a flight.

Responsibilities of the passengers include but are not limited to the following:

- Obey the pilot at all times and follow the project SOPs regarding aircraft.
- Pay attention to all safety briefings. Have situational awareness – know the location of all exits relative to your seat and how to open each one. Be familiar with relevant information in section 16.5 Emergency Procedures.
- Never pressure a pilot to (1) fly beyond allowable flight and duty time limits, (2) fly beyond his or her license limitations, (3) overload the aircraft, (4) fly in bad weather or in unsafe conditions, or (5) use an unsuitable landing strip or water port. Remember that the pilot is in charge of the flight at all times.
- Employees may refuse to fly if they feel the aircraft is unsafe, or if the pilot has flown or may fly in an unsafe manner. Inform a supervisor if any pilot engages in questionable behaviour.
- Employees may refuse to participate in a toe-in manoeuvre if they feel they need more training.
- Wear a seat belt at all times. Wear hearing protection. Wear the headset whenever the pilot is wearing one as it is the only means of communicating with you.
- Know the location and how to access and use the survival and safety equipment on board the aircraft.
- Inform the pilot if you are transporting dangerous goods (e.g., guns, ammunition, bear spray). These items must be correctly packaged and stowed. See section 16.9 Transportation of Dangerous Goods.
- Stow all hand luggage according to the pilot's instructions.
- Never indulge in "horseplay" in or near any aircraft. No one may ride on the skids or on the sling underneath the helicopter. Lifting people by helicopter line or sling may only be done by special emergency crews in the process of a rescue.

- Passengers should wear clothing suitable for the worst weather conditions they may encounter in case of delay, accident or stranding. Carry a suitable personal emergency/survival kit. Do not leave an aircraft without your pack – whether on traverse or at a work site – as something may prevent the aircraft from returning.
- Make sure you have a topographic map of the area and know where you and your co-workers are located when dropped off. Mark it on your map. Do not leave the aircraft unless you know your exact location.
- Discuss with the pilot how he prefers field crew to describe their locations by radio and by ground signalling. Ineffective communication costs valuable helicopter time, can contribute to pilot stress and can become a safety issue with respect to fuel consumption and helicopter range.
- If you suspect that you are off course, do not hesitate to communicate your concern to the pilot. Occasionally pilots get lost, especially in areas with few recognizable physical features and few roads. Indicate any hazard (e.g., birds, other aircraft) you observe to the pilot while in flight; don't assume the pilot has seen it.
- When a helicopter comes in to pick up passengers, someone may be designated to help to indicate wind direction. They should stand with their back to the wind and extend their arms straight out in front pointing in the direction the wind is blowing.
- The following websites provide general information regarding passenger safety on helicopters and float planes:
  - http://www.tc.gc.ca/CivilAviation/systemSafety/brochures/tp4263.htm
  - http://www.tc.gc.ca/CivilAviation/systemSafety/brochures/tp12365.htm

PDAC 16.12 Slinging

Helicopters are often used to move supplies, fuel, project equipment and drills efficiently by slinging. Drill moves and airborne geophysics are special skill slinging operations and pilots who perform these jobs require special training. Slinging is hazardous work and accidents may occur even with experienced pilots. To minimize the hazards and dangers, employees and drill contractors need to develop, be trained in, and adhere to safe operating procedures (SOPs) for slinging.

PDAC 16.12.1 Risks and Hazards

- Death, injury to pilot and/or ground personnel caused by helicopter crash
- Death or injury to people on the slinging route caused by loss of load or snagged sling gear
- Accidents resulting in injury or death caused by:
  - Pilot fatigue
  - Poor visibility (dust, blowing snow, flat light, rain)
  - Improperly secured load
  - Load exceeding lifting capacity of the helicopter
- Stress caused by noise, rotor downwash
- Hearing loss caused by lack of hearing protection Eye injuries caused by blown dust, grit

- Hand injuries caused by crushing or pinching or impact by sling loads Electric shock from grounding effect
- Injuries caused by slips, trips and falls due to poor ground conditions, obstacles, poor housekeeping at sling locations

PDAC 16.12.2 Causes of Slinging Accidents

Employees should be aware of the potential hazards that cause accidents during slinging operations. Pilot fatigue is the root cause of many slinging accidents. 60% of slinging accidents occur during pick up. The following information is compiled with permission from the Transport Canada brochure TP 3042 - Slinging with Safety.

Source: TP 3042 - Singing with Safety, Transport Canada in May 2000. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2008.

Some major hazards are:

- Snagged sling gear
- Obstacles in the operating area such as stumps, drill equipment
- Untidy housekeeping around the drill site and landing site. Debris or loose plywood sheets etc., may be blown violently into the air by the downdraft from the helicopter's rotors.
- Poor surface conditions at the operating site such as snow, soft spots, mud Incorrectly rigged load
- Overloading
- Wind conditions not known beforehand, or variable wind conditions Inappropriate choice of machine for the task
- Inadequate condition and maintenance of slinging equipment

Here is how accidents happen:

- Inadequate planning Inadequate briefings
- Getting pressured into a risky operation Accepting hazards
- Flying when fatigued
- Lack of training for the task
- Unsure of what is required
- Operating in marginal weather conditions Ignoring safe operating procedures (SOPs)
- Becoming distracted and not spotting a hazard
- Poor communication or poor understanding between workers on the ground and the pilot Lack of respect for established procedures
- Ground crew placing themselves in a dangerous position under the load or out of sight of the pilot

PDAC 16.12.3 Safe Slinging Guidelines

It is essential to carefully plan all slinging operations. Numerous factors contribute to safe slinging operations. These include (1) using the correct equipment, (2) careful planning and coordination of all manoeuvres between the pilot and ground crew, (3) accurate communication between pilot and ground crew, and (4) taking time to do the job safely and correctly. Hazards and risks can be reduced by following these guidelines.

- Carry out a risk assessment to identify, assess and eliminate risks. Address the observations and conclusions of the risk assessment and mitigate the risks. Provide protection against risks that cannot be eliminated.
- Make sure the helicopter has the lifting capacity to do the job.
- Make sure the helicopter pick up and drop off locations are large enough for all required manoeuvres and are cleared of all debris and vegetation that might interfere with operations.
- All personnel involved in slinging operations should be fully trained and experienced. All personnel (company employees, contract drillers) should follow safe slinging procedures. All personnel not directly involved with slinging operations must stay well away from the slinging locations and flight paths.
- Consider having individuals authorized to manage and/or connect sling loads formally designated as “load marshalls”. Once they have specific training, the person designated as load marshall shall inspect all loads prior to hooking up, and be the only person allowed to actually hook up, or designate the person that hooks up the load. The load marshall is the only person who communicates with the pilot.
- All ground crew should wear PPE: hard hats secured with chin straps, hearing protection, goggles that strap on securely for eye protection, reflective clothing and boots with good soles – preferably with safety toes, as required. The load marshal should wear fluorescent gloves and fluorescent arm bands.
- Hold briefings for each slinging job so everyone fully understands their responsibilities for the task at hand. Include clear instructions regarding potential emergency situations.
- Plan for site specific emergency response procedures. Define a NO-GO zone where the pilot may drop a load or make an emergency landing. Everyone involved must know where to go and what to do if a load gets snagged, is dropped, or if the helicopter must make an emergency landing.
- Use the correct type of slinging equipment for the job and be sure it is in good working condition.
- Organize the loads taking into account the weight, shape and type of loads.
- Plan flight paths so helicopters do not fly over built up areas, established project areas or where people are working.
- Ground personnel should never place themselves beneath a suspended load under any circumstances.
- Never put pressure on the pilot to complete slinging operations under poor weather conditions or if the pilot and/or drill crew are in a state of fatigue.

Note that exploration companies can often negotiate a training session outside the field season with a helicopter charter company at the air base. Charter companies are usually willing to oblige as their pilots also receive valuable training under controlled conditions. If planning ahead is possible, an exploration company may bring drill company employees as well to take part in the training. Individuals who have taken the training may be designated as “load marshalls”.

PDAC 16.12.4 Planning for Safe Slinging Operations

Include the following factors when planning slinging operations.

Risk Assessment

Conduct a risk assessment to identify, assess, eliminate or mitigate the hazards associated with slinging operations. Here is a partial list:

- Physical hazards such as trees, power lines, cliffs, bodies of water, project living quarters Weather conditions
- Fatigue potential: how rested are the pilot and crew?
- Ground conditions at staging, pick up, drop off and emergency landing sites
- Loose material, debris, temporary unsecured structures at any of the above locations
- Load aspects
  - Weight of items for slinging – “real weight vs. driller’s weight”
  - Lifting capacity of aircraft
  - Potentially difficult loads to sling
  - Potential pinch points, crush or other danger points specific to the loads

Helicopter Performance

- The elevation, air temperature and humidity significantly affect helicopter performance.
- Helicopters operating in mountainous or hot environments have reduced lifting capabilities and must carry lighter loads than when operating at sea level and/or in cool weather.
- Above certain weights, helicopters may not be able to take off vertically. It may be necessary to clear an area ahead of the site for the helicopter to execute a low-level transition to forward flight.

Site

- The pilot and project manager should identify and designate the pick up and drop off slinging sites. Clear the operating area of all stumps, brush, unnecessary equipment and loose materials that might catch on a moving sling load or be blown about by the rotor downdraft.
- Inspect the sling operation sites daily and remove all debris and obstacles to prevent flying debris caused by downdrafts from the helicopter.
- Define the NO-GO area for each operation for emergency manoeuvres.

Communication

It is usually safer to use radio communication between the pilot and groundman. It is highly recommended that radios always be available and used during slinging operations.

- It is advisable to use handheld FM radios fitted with headsets or speaker phones. These provide hearing protection, noise reduction and a boom microphone that enables workers to speak without averting their eyes from the task. Holster radios to protect them from entanglement and allow a worker’s hands to be free.
- Check radios during the briefing to be sure they function.

- The pilot should receive radio communication and hand signals from only one person on the ground.
- Pre-determine the radio calls that are expected from the groundman to the pilot. Choose good clear instructions as the background helicopter noise makes directions difficult to understand by either person. For example, mutually select radio calls when lowering a load like: 10 metres, 5 metres, 2 metres, down. Use clock angles to direct lateral movement of a load: 12 o'clock (forward), 6 o'clock (reverse) etc. Use "clear" only when the groundman or designate has hooked up a load and is clear of the area and wishes to direct the pilot to lift the load.
- Agree upon and be thoroughly familiar with hand signals to use, if necessary. See section 16.14 Commonly Accepted and Known Hand Signals.

Slinging Equipment

The size, safe working load, length of slings, hooks, nets, shackles and "D" rings will vary with the capability of the helicopter and the type of load.

- Slinging equipment is not standardized. Consequently crews involved in slinging require specific training for the equipment in use. Just because an individual has some slinging experience and/or training, it cannot be assumed that they know and understand the correct procedures for specific sling gear in use at the site.
- When a new helicopter arrives at a project, insist that the pilot present and inspect all slinging gear for suitability and condition prior to commencing any slinging operations.
- Make sure the appropriate equipment is available to do the job efficiently (various slings, cable chokers, lifting pods, lanyards etc.). Every item must be in good working condition.
- Clearly identify all slinging equipment for aircraft use only (colour code, if necessary) and store it separately from general purpose slinging equipment. Lifting equipment should be clearly marked with a unique identification number or symbol that indicates the maximum lifting capacity of the item. Store the slinging equipment up off the ground when not in use. Suspend it from the attachment hooks when possible.
- Use a long line (>15 m) for slinging, as it is safer. Avoid the use of a short line (<15 m).
- Maintain a register of all slinging equipment to make sure all items are within the life or test date.
- Wire ropes used for all slings, lanyards and nets should have a designed breaking strength of not less than 6 times the maximum lifting capacity of the helicopter. All items in the load chain must have a breaking strain of at least 4 times the weight of the largest load to be carried.
- Inspect all slinging equipment before initial use and daily for defects and damage for the duration of the slinging work. The inspector must be a designated, competent person.
- Keep a record of inspections.
- Inspect wire rope slings for (1) fatigue failure – small cracks in the wire rope, (2) abrasive wear – worn shiny spots and (3) abusive wear – kinking or bird caging.

- Discard wire rope slings that show severe corrosion, more than 1/3 reduction in the diameter of the outer wire and excessive abusive or abrasive wear. Abusive wear causes serious structural damage to wire rope and will cause the sling to become unsafe long before other factors.
- Use steel wire rope slings and/or fibre net slings in preference to nylon webbing slings.
- Nylon webbing may chafe very rapidly in flight if it is poorly rigged. Rough loads may require wrapping to prevent chafing of nylon webbing if it is used. If so, verify the appropriate wrapping material to prevent it coming loose and being sucked into the engines or rotors.
- Test electrical and emergency mechanical cargo hook release mechanisms daily. Keep all winches, shackles, line slings and hoists under one maintenance testing program.
- Make sure the aircraft hook assembly and operating system adhere to the same planned maintenance requirements as other aircraft components.
- Always insert a swivel between the fixed hook assembly of the helicopter and the external load.
- A shackle or hard eye must form the direct connection between the cargo hook and sling. Soft eyes and rope attachments may bind on the cargo hook and prevent release under normal release conditions or, more dangerously, in case of emergency.
- The pilot should release the long line every time the helicopter lands, even if for a very short time. Something may interrupt the slinging plans and the pilot might take off and forget the line is still attached.
- If a cargo hook has been impacted in any way, it must be inspected prior to continuing or resuming slinging operations.

Loads

- Make sure the cargo weight does not exceed the lifting capacity of the helicopter.
- Take great care when attaching slings to make sure they will not become detached during flight.
- Make sure the entire cargo is held securely by the net so nothing comes loose during flight.
- Properly prepare unusually shaped items for slinging. Follow best procedures when slinging difficult loads such as plywood or boats, as they can “fly” and be very dangerous during slinging if not correctly handled.
- Weigh down light loads (e.g., plywood) with heavy gear to keep the sling from swaying backwards into the tail rotor.
- Before slinging bundles of long timbers such as 2x4s, nail each 2x4 to an adjacent one. Then, no individual 2x4 will slip out of the bundle if the load starts to spin during flight.
- It may be advisable to pad or wrap core boxes with cardboard, canvas or something similar, to prevent them from chafing the sling net. Stack and fasten core boxes together to minimize any load shifting and spillage during flight.
- There are often special hooks for slinging drill rods. Make sure the person hooking up the rods is trained and understands how the hooks operate.

- Centre the weight by placing heavy items in the centre of the cargo net first and lighter items on top. Make the loads as symmetrical as possible. After the net is secure, look for holes where items might slip out. Pad sharp objects, as they could sever the net while in flight.
- Don't place a tarpaulin inside a net to carry many small items. The tarpaulin could potentially slip out and get tangled in the rotors. Small loose items should be placed in boxes with lids and then boxes securely strapped together.
- Place all sling net loops on a lanyard hook, and then attach this lanyard hook to the helicopter hook. If you know the number of loops around the perimeter of the sling net, you can count the loops on the lanyard hook to confirm that they are all attached.
- Never attach cloth straps or ropes directly to a helicopter hook. Attach them to a lanyard hook. Then, attach the lanyard hook to the helicopter hook. If straps or ropes are attached directly to the helicopter hook, they may come off if the load rotates during flight.
- Make sure the lanyard hook-keeper is secured in the closed position before signalling the helicopter to lift.
- Never fly with an empty lanyard and/or long line as they may trail back into the tail rotor during certain manoeuvres. Remove the line and place it inside the helicopter for the return trip or weight it down. They can only be flown if they have at least 10 kg of fixed weight at the hood end of the line.
- When it is necessary to use a very long line attached to a sling (e.g., jungle, mountainous sites with very tall trees), always have a pile of rocks or logs available to use to weigh down the sling for the return trip. Under these circumstances, it may be impossible to detach the sling net or cables for the return trip.

Weather

- Be prepared to stop slinging operations if weather conditions are marginal. Check the wind direction frequently and be alert for changes. Stop slinging operations if electrical storms move into the area. Don't push your luck.
- Radio communication between the pilot and groundman is essential when slinging in snow conditions, as the helicopter can create blowing snow while it hovers. The pilot will have great difficulty seeing hand signals from the groundman. This may also occur when sand or dust obscures visibility.
- Flat light conditions make vertical referencing very difficult. To help the pilot distinguish the horizon, place visual cues or markers outside the pick up area. Use items like large rocks, large orange garbage bags filled with snow, spray paint large areas of snow or rocks. Whatever is used must not be affected by the rotor downwash.

Grounding Effect

- Electrostatic charges are built up by friction between the surfaces of the aircraft and airborne particles. Static shock can be particularly severe when the air is dry and dusty and also when the aircraft flies through heavy rain, snow or ice crystals. It may be advisable to use a grounding hook to touch the load first. A person can be knocked to the ground or even become entangled in the cargo net from a charge of static electricity.

- The person hooking the cargo onto the helicopter load hook should wear lineman gloves for protection from static electric shock. Before attaching the load to the cargo hook, touch the load hook to the sling eye before touching the hook with your hand.
- If bad static conditions exist, have the pilot ground the load first, then pick it up to do final positioning.
- Do not stand in water when touching a cargo hook of a hovering helicopter.

PDAC 16.12.5 Slinging Responsibilities

Responsibilities for safe slinging operations lie with the helicopter company to provide certified sling equipment in good working order, and with the pilot and the groundman/load marshall to carry out safe operations. Other ground workers at the sling location should follow the directions of the load marshall.

Pilot

It is very important for the pilot to be well rested. He or she must not exceed the legal number of flight duty hours. During slinging operations, it is imperative that the pilot feel complete confidence and control after taking into consideration all the external factors affecting the operation. Because slinging operations require such intense concentration by the pilot, everyone must watch for signs of pilot fatigue, which may include inattentiveness, slow reaction time or missed cues, grouchiness and/or atypical behaviour. See section 16.5 Pilot Fatigue.

The pilot's responsibilities include the following:

- With the project manager, designate and inspect the staging area, the sling pick up, drop off, and emergency drop locations.
- Make certain that everyone is thoroughly briefed for the required moves. See section
- Safety Briefings for Special Operations.
- Establish signals for communication – radio and hand – and make sure everyone is familiar with them. See section 16.14 Commonly Accepted and Known Hand Signals.
- Check the release mechanism and sling gear serviceability. If present, the aircraft maintenance engineer may have this responsibility.
  - Check the cargo hook.
  - Check that the release mechanisms physically open – normal and emergency.
  - Inspect all slings, straps, nets etc. Nothing must be worn or frayed and all hooks must have a safety latch.
  - Inspect the position of the helicopter mirror. Follow proper slinging procedures.
- Clarify emergency procedures for everyone to follow in the event of an emergency – both during hook up and during flight.
- Coordinate the makeup of loads with the groundman. Be familiar with and estimate the flying characteristics of each load.
- In the case of a failed or dropped load, halt slinging operations until the root cause of the failure is determined and mitigated.

Groundman (Load Marshall)

A slinging site may use one or more people on the ground. The person in charge is designated as the groundman or load marshall. This person may or may not hook up the load to the helicopter. It is safest if a groundman stands off to one side and coordinates the hook up, which is done by a second trained person.

- The groundman must be fully trained for the job and have a complete understanding of the task to be performed. The groundman responsibilities include the following:
  - Manage activities on the ground and define the positions and responsibilities of the team.
  - Make sure the load is safe. Be familiar with the weight and specific attachment gear required for specific types of loads.
  - Communication: Only the groundman or one designated person may send signals to the pilot. The pilot and groundman must confirm the signals with each other. Use radio communication, whenever possible. Hand signals may be acceptable, depending on visibility conditions.
- It is essential to wear PPE (see # 6 in section 16.12.3). The groundman should also wear reflective arm bands and fluorescent gloves for greater visibility when signalling.
- Communicate the load weight to the pilot each time, as it may be very different from the previous load.
- Place loads so they are free of obstructions before lifting.
- Do not allow the cable to be placed across the skids when attaching the cable to a load.
- Verify that the lanyard hook-keeper is secured in the closed position before signalling the helicopter to lift.
- Never step directly in front of a sling load after hooking it onto the helicopter. Exit forward but to the side to avoid being struck by the load as the helicopter aligns for take-off.
- Stand or crouch in full view of the pilot. Then, keep well away from the flight paths while sling loads are transported.
- Never under any circumstances will a ground crew or driller place themselves beneath a suspended sling load or in the path that a forward moving helicopter is expected to take. Be aware of the area the load would cover if dropped and stay clear of that area.
- Never turn your back on an incoming load.
- Allow the load to settle before removing chokers and slings.
- Use a second groundman when slinging a drill rig and equipment or when slinging a complicated load. This person is required to be familiar with safe slinging procedures and should be equipped with a radio. Only one person, however, may give signals to the pilot.
- Know the emergency procedures for the job. Know where to go and what to do if a load gets snagged, is dropped, or if the helicopter must make an emergency landing.
- Designate and observe the NO-GO zone.
- If the ground crew sees any equipment that may be suspect in any way they must bring it to the attention of the pilot immediately.
- Take time to do the job safely and correctly.

Other ground crew workers

- Only workers who have a specific task related to slinging may be at the site. All others must remain well clear of the operations.
- Every worker at any slinging site must wear PPE including gloves to protect hands. Wear a head set with receiver to hear communications between the pilot and groundman. Do not communicate with the pilot unless designated to do so by the load master.
- Know the emergency procedures for your job – where to go, what to do if a load fails or is dropped, or the helicopter engine fails or makes an emergency landing.

PDAC 16.12.6 Guidelines for Drill Slinging Operations

Be familiar with section 16.12.3 Safe Slinging Guidelines as well as the following guidelines.

- Prior to a field program involving drill slinging operations, make sure the tender document and/or helicopter contract specifies the type of helicopter capable of performing the required drill moves and other slinging procedures. Request specific pilot experience related to drill moves as part of the contract as well as for the aircraft maintenance engineer, who is responsible for maintaining slinging equipment. See section 16.3 Charter Aircraft)
- Only long line sling equipment should be used (minimum 15 metres – maximum 38 metres) unless the geographical and/or windy conditions require more than 38 metres to allow a safer and more stable hovering position for the helicopter. Using long lines will minimize the effect of downwash from the rotors and place the aircraft in cleaner air.
- Short line slinging (<15 metres) does not provide enough manoeuvrability and reaction time for the pilot or ground crew in the event of an emergency load release or engine failure.
- Inspect slinging equipment for damage before use. Use only steel cables as rope may break and whip into the rotor blades. Inspect cargo nets for rips and tears where the contents may come out while in flight.
- Pre-plan drill moves and/or any load preparation with all personnel involved in the operation. Designate a groundman (load marshall) to manage activities on the ground and define positioning and responsibilities for the personnel who are specifically designated to be present in the immediate area of the move sites (tear down and assembly sites). Only the designated groundman should be responsible for two-way radio and hand signal communications with the pilot, unless otherwise assigned.
  - All employees working at the slinging site must wear PPE (see # 6 in Chapter 16, section 16.12.3).
  - Only employees directly working with slinging operations may be present at the sites. This is critically important for safety.
  - Where available, use a competent observer to monitor activities from a distance and who can act as a second load marshall in specific cases.
- The briefing plan prior to any sling load movement must include clear instructions regarding what to do for possible emergency situations. Define a NO-GO AREA on

each drill site or storage area where the pilot may drop the load or make an emergency landing.

- During slinging, ground personnel will not place themselves beneath a suspended load under any circumstances.
- Designated positions should be within sight of the pilot at all times. “If you can’t see the pilot’s eyes, he can’t see you”. Note that different helicopters will have different pilot line- of-sight characteristics. The pilot should review these characteristics with the ground crew prior to all drill moves.
- Communication: It is best to use radio head sets to communicate with pilot. Chatter should be kept to critical conversation only. Keep communication equipment fully operational until the slinging operations are complete. Hand signals (marshalling signals) must be well known and may also be used by the designated load marshall. Remember that only one person sends the signals to the pilot. See section 16.14 Commonly Accepted and Known Hand Signals.
- Establish with the pilot that current weather conditions permit safe operations and under no circumstances should the pilot be badgered into completing the operations under poor weather conditions or if he and/or drill crews are in a state of fatigue.
- Organize the tear down and assembly sites and keep them free of clutter. Secure all materials to prevent flyaway material during slinging.
- The tower is the most challenging and dangerous part of a helicopter supported drill move. The ground crew and pilot should work together to achieve a smooth and safe tower move and re-attachment. The load marshall should try to position him/herself upwind of the approach direction, unless the pilot decides on a different approach for safety reasons.
- Whether positioning the tower vertically or horizontally, the tower should approach the drill at mount or eye level (unless there are different instructions from the pilot pre-move briefing) and not from a height directly overhead.
  - Marshal the pilot to bring the load in a lateral position at eye level to allow easier positioning, less intimidation and a safer environment for the ground crew. The tower should be level with respect to the mount. Mark or weld hanging points on the tower for future moves once the best strapping points are identified (for balance and flight characteristics). Critical for safety: make sure any welds are properly completed.
  - Load stabilization should only be conducted with the approval of the pilot and with the use of straps or rope with sufficient length to allow the ground crew sufficient distance to be protected from an emergency load release. Over use of straps or ropes can be counter productive as the ground crew may in effect work against each other. One or two experienced ground crew should be easily able to stabilize the tower. (The method of strapping used is of prime importance).
  - Fit the drill with a guide (welded guides) to force the base of the tower into the correct alignment.
  - Paint a white or orange line along the tower rest bar and the side of the tower in view of the pilot so he can better gauge proper alignment. This guide line should be cleaned and refreshed, if necessary, before each drill move.

- Pin or bolt all drill rig parts immediately after they are positioned.
- If difficulties or confusion develop that cannot be easily and quickly resolved, the pilot should land the helicopter and participate with the ground personnel to solve the problems or concerns.
- Debrief after every move to identify problems and highlight successful work procedures.

PDAC 16.13 Temporary Landing Sites

Safe operating procedures should be in place for landing fixed wing aircraft that land on lakes and rivers using floats, on unmaintained airstrips and ground such as beaches, eskers or gravel bars using tundra tires; and on frozen lakes and rivers using skis. SOPs should also be in place for helicopters, which may land in many conditions and terrain. Obtain environmental approvals and adhere to regulations of the AHJs when selecting and preparing landing sites. Landing requirements vary according to the type of aircraft.

PDAC 16.13.1 Helicopter Landing Sites

The largest required helicopter determines the required dimensions of the landing site at a project or camp. Always discuss the exact requirements for landing sites with the helicopter contractor so they are fully understood by all parties. Good clearance in all directions is necessary for manoeuvring helicopters and slinging loads. Some terrain requires special construction to provide a safe landing spot. Where a helicopter downdraft creates blowing sand or dust, a raised helicopter landing pad may be a partial solution. Much of the following information is based on the Transport Canada Aviation Safety brochure Safer Temporary Bush Helipads.

- Source: TP 4262 -Safer Temporary Bush Helipads, Transport Canada in April 1999. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2008.

Selecting Temporary Sites

- The landing site surface should be on level, firm and stable ground under both wet and dry conditions. The site should be as level as possible with a slope not more than 3º.
- Understand the difference between the area required for the helicopter skids and the amount of area required for safe landing and takeoff.
- Plan the temporary landing site dimensions to safely accommodate the largest helicopter that will be used. A clearing, including the opening in the tree canopy, should measure at least 35 metres in diameter (more in areas of tall forests or jungle). The landing spot (helipad) should be at least 4 metres square. If the helipad is made of logs etc., they must extend sufficiently beyond the length of the skids and be placed at 90° to the skids for firm support.
- Take into account local prevailing winds and plan the flight access corridors in the direction of prevailing winds. If necessary, clear an access corridor. Consider a clearing beside a lake, river, road, or on a ridge top.

- Stay away from power lines, wires, cables or towers. Avoid obstacles such as cliffs and stands of tall trees that might cause dangerous downdrafts.
- The approach and landing paths should avoid passing over open water and over accommodations.
- Wildlife. Stay away from flight paths or feeding areas of flocking birds such as gulls. Flight paths are usually below 150 metres above ground level and birds are especially active at sunrise and sunset. This problem may occur near waste disposal sites, dumps, migratory waterfowl refuges and agricultural fields during harvest or plowing activities. Bears may also become a problem at landing sites near dumps.
- Choose an area that requires minimal site improvement – one relatively free of stumps, deadfalls, brush, rocks or other hazards.
- When possible, select a low dust area.

Improving a Temporary Site

- Cut down trees that may be a hazard on the approach and departure paths, especially if helicopters will be slinging external loads. Ideally, it is best to provide access with a 15º angle of approach. The angle of approach may not exceed 40º.
- Clear the manoeuvring area (e.g., within at least 15 metres of the landing spot). Remove all hazards such as stumps, brush, deadfalls, large rocks and loose debris. Remaining trees near the landing site must be firmly rooted, show no signs of decay or dead branches that may be blown down by the downdraft from the rotor blades.
- Clear the landing area to the ground surface within 8 metres of the helipad. Nothing must protrude that might contact the tail rotor.
- Provide a wind indicator such as flagging tape streamers or a windsock. Smoke flares may be used when necessary. Firmly secure all markers and flagging to prevent them from blowing into the rotors.
- In areas where dust or sand is a problem, use a binding agent (one permissible under local environmental regulations) in the immediate area of the landing spot.
- Make sure at least one 20-lb large multi-purpose (dry powder type) fire extinguisher is immediately available at the landing site.
- Provide a hazardous materials spill kit and a proper waste disposal container.

Temporary Bush Helipad Construction on Snow or Swampy Ground

- On deep snow or soft swampy ground, construct an evergreen bough mattress at least 15 cm thick and at least 3 m square for the helipad. Tramp the snow down with snowshoes first to make a base.
- Lay a minimum of 6 sturdy logs close together on the bough mattress (maximum of 50-60 cm intervals) and at right angles to the direction of helicopter approach. Ideally the logs should form a solid and continuous landing surface. They should be at least 3 metres long and 10 cm thick. Each helicopter skid must rest across several logs, not along one log.
- Make sure the pad is level to within 5º. Trim off all stubs and knots from the logs so the skids won’t catch on them.

Long-Term/Heavy Duty Bush Helipad Construction on Snow or Swampy Ground

- Construct an evergreen bough mattress larger than for the short-term pad. It should measure at least 30 cm thick and 4 m x 5 m. Tramp the snow with snowshoes to make a base.
- On the bough mattress, lay 2 sturdy logs, each 4-5 m long, about 3 m apart. Lay these logs parallel to the helicopter direction of approach.
- Lay sturdy logs of equal thickness across the first two logs to form a solid and continuous landing surface to maximize the “ground effect”. The logs should be 4-5 m long. Spike these cross-logs together with 30 cm spikes.
- Make sure the pad is level. Trim off all stubs and knots and make sure no spikes protrude.

Hillside Bush Helipad Construction

- Except for leveling considerations, the construction and dimensions should be the same as for level ground helipads.
- Build up the downhill side to make a level helipad. Often, a large log on the downhill side will suffice. On steep slopes, make sure the pad is securely braced so it will not slide or roll under the weight of a fully loaded helicopter.
- Lay the cross-logs on top of the built up braced logs in the same direction as the slope to form a continuous pad. Usually, the helicopter will approach on a course along the side of the hill and land with one side towards the slope and the skids supported by several of the cross-logs. Verify the best direction to place the logs with the helicopter pilot.
- Install a good, highly visible wind indicator. This is very important due to the variable winds that occur around hills and down slopes.

Temporary Rock Hilltop Helipad Construction

- Clear all loose debris from the rock surface and mark the landing spot with conspicuous paint.
- A 3-metre circle around a large letter H is best, but any marking easily seen from the air will suffice.
- A wind indicator is important because of hilltop winds.

Temporary Ice Helipad Construction

- Check carefully for cracks and soft spots on the river, lake or sea ice, especially when the ice is snow-covered.
- Away from a shoreline it is often difficult for pilots to determine their height for landing or hovering. Provide visual references ahead or to one side of the landing spot. Piles of equipment or weighted conspicuous markers such as orange garbage bags filled with snow or streamers can be used.
- All personnel must stand well clear of the helipad during landings, hovers or departures. Blowing snow can obscure the pilot’s visibility and the helicopter could drift across the landing site.

PDAC 16.13.2 Landing Strips

Remote Landing Strips

- Pilots and project managers should verify that the landing strip is long enough to accommodate the aircraft and that the condition of the strip is suitable for use.
- Pilots should fly over a remote unattended landing strip to check for wind direction, wild animals, obstructions and the condition of the runway before committing to land.
- Designated employees on the ground should inspect infrequently used landing strips on foot or by vehicle for obstructions and wild animals before flight arrivals and departures.
- People working on the ground near landing strips should be aware that pilots usually make a pass before landing. Anyone present on a landing strip on foot or in a vehicle should leave it immediately when aircraft approach. Designate an area off to the side for parking vehicles.

Landing on Ice

- Verify the ice is thick enough to handle the fully loaded aircraft. Measure the ice if necessary. Clear snow from the ice and make edges to define the runway.
- If landing on an ice road, set up the strip in an area where the ice road banks are no higher than 2 m to avoid interference problems with the wings when the aircraft turns around. Block off both ends of the runway with vehicles. Keep the vehicle at least 30 metres from the lead-in and another vehicle 500 metres away from the end of the strip to allow for a run-off zone. Do not point the vehicle head lights onto the strip as the white light will wash out the visibility of the strip.
- If permitted, night landings require flares to be set up every 60 metres on both sides of the runway. As a potential alternative to flares, place a roll of toilet paper into a can of diesel fuel. These burn longer and make a more visible light. Position the flares in advance and wait for the aircraft arrival. When the plane arrives, signal to confirm arrival at the correct location. Light the flares.
- Keep the runway secure until the plane has departed.
- For additional information, refer to Best Practice for Building and Working Safely on Ice Covers in Alberta. Website: http://employment.alberta.ca/documents/WHS/WHS-PUB_sh010.pdf

PDAC 16.14 Commonly Accepted and Known Hand Signals

The Transport Canada poster TP 9528 has signals that are generally accepted for marshalling movements and helicopter instructions from ground to pilot. The poster measures 28x43.5 cm and is available in English and French. It can be ordered from the following website: http://www.tc.gc.ca/civilaviation/systemsafety/posters/menu.htm

PDAC 16.15 Emergency Procedures

PDAC 16.15.1 Emergency Guidelines for All Aircraft

Each project should have a written emergency response plan (ERP) that includes emergency procedures in the event of an overdue and/or downed aircraft. Everyone should be familiar with the ERP and with aircraft emergency procedures and routines in the event a crisis develops. Although the pilot is responsible for the safety of the flight, each passenger is also responsible for their own safety. In an emergency situation, a pilot may not be able to provide additional instructions regarding an emergency landing or evacuation. Therefore, you need to know how to get out of the aircraft.

The emergency procedures for fixed wing aircraft and helicopters are compiled from information available on the following Transport Canada websites. In addition, passengers should be familiar with the passenger safety instruction cards in the aircraft.

- Source: TP 12365 – Seaplanes: A passenger's guide. Transport Canada in January 2008. http://www.tc.gc.ca/CivilAviation/systemSafety/brochures/tp12365.htm Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2008.
- Source: TP4263 – Helicopter Passenger. Transport Canada in August 2004. http://www.tc.gc.ca/CivilAviation/systemSafety/brochures/tp4263.htm Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2008.

Preparation for an Emergency

- Pay attention to every safety briefing. Know the location of exits and all emergency equipment including the ELT on board the aircraft. Equipment location varies between aircraft and even between the same type of aircraft. Know the "brace position" for your type of seat belt. See the safety card for details. Ask questions if you do not learn all the information you should know in the briefing or on the card.
- Read the instructions for the operation of the doors and emergency exits. Know the location of and how to use all exits. The method of opening an exit may differ from one aircraft to another and even within the same aircraft. If you have not done so in a general safety induction, ask the pilot if you can practice opening the exit(s) before the engine starts up.
- Locate the exit in relation to your left or right knee. If the exit is on your right while upright then it will still be on your right in the event the aircraft comes to rest inverted. No matter how disorienting an accident, as long as your seat belt is fastened, your relationship to the exit(s) remains the same. Be familiar with your surroundings so you can find your way to an exit – even with your eyes closed.
- If you are flying over water, know the location of your life preserver. Locate it! Know how to reach it, how to put it on and how to inflate it. Float planes are required to carry life preservers or PFDs (personal floatation device) for every occupant. Check with the pilot to see if it should be worn in-flight. If so, wear it, but never inflated it while in the aircraft.

During an Emergency

- Follow any instructions issued by the pilot.

- Do not distract the pilot.
- Check that any loose gear in the cabin is secured.
- Wear a helmet if provided.
- Remove eye glasses and put them in your pocket. Loosen your collar.
- Assume the brace position.
  - Tighten your seat belt.
  - With shoulder straps: tighten and sit upright, knees together, arms folded across your chest
  - Without shoulder straps: bend forward so your chest is on your lap, head on knees, arms folded under thighs

After an Emergency on Land

- Wait for instructions to exit or until rotors stop turning if in a helicopter.
- Assist others to evacuate well clear of the aircraft.
- Remove the first aid kit and other emergency equipment after there is no threat of fire.
- Administer first aid as required.
- Remove ELT, read instructions and activate.
- Set up camp to be as comfortable as possible.
- Make the site as conspicuous as possible from the air.
- Stay near the aircraft – don't wander away from the site.

After an Emergency on Water, follow instructions for underwater egress

In water accidents, float planes tend to come to rest inverted. Helicopters may tip over after an emergency landing on water. The key to your survival is to retain your situational awareness and expeditiously exit the aircraft. It may be advisable to be trained in underwater egress if you frequently fly over water or on float planes. The following actions are recommended once the float plane momentum subsides.

- Stay calm – Think about what you will do next. Wait for significant accident motion to stop.
- Grab your life preserver/PFD – If time permits, put it on, but at least grab it. DO NOT INFLATE IT until after exiting. It is impossible to swim underwater with an inflated life preserver. You may get trapped.
- Open the exit – If sitting next to an exit, find it and grab the exit handle in relation to your left or right knee as previously established. Open the exit. The exit may not open until the cabin is sufficiently flooded and the inside water pressure has equalized. DO NOT RELEASE YOUR SEAT BELT AND SHOULDER HARNESS until you are ready to exit. It is easy to become disoriented if you release your seat belt too early. You may float upwards making it more difficult to get to the exit.
- Release your seat belt/harness – Once the exit is open and you know the exit path, keep hold on a fixed part of the float plane and release your seat belt with the other hand.
- Exit – Proceed in the direction of the nearest exit. If this exit is blocked or jammed, immediately go to the nearest alternate exit. Always exit by placing one hand on a

fixed part of the aircraft and not letting go before grabbing another fixed part (hand over hand). Pull yourself through the exit. Do not let go until you are out. Resist the urge to kick, as you may become entangled in loose wires or debris, or you might kick the person exiting right behind you. If you become stuck, back up to disengage; twist your body 90° and then exit.

- Getting to the surface – Once you have exited a float plane, follow the bubbles to the surface. If you cannot do so, as a last resort inflate your life preserver. Exhale slowly as you rise.
- Inflate your life preserver – Inflate it only when you are clear of the wreckage, since life preservers can easily get caught on wreckage, block an exit, or prevent another passenger from exiting.

PDAC 16.15.2 Ground to Air Emergency Signals

Routine methods for signalling aircraft from the ground include the following:

- Brightly coloured helicopter cloth: Fluorescent orange or red nylon cloth squares at least 2x2 metres. They are highly visible and all field workers who routinely use aircraft should carry one. If you are being searched for, a pilot or searcher is more likely to detect movement even in his/her peripheral vision, so run and wave the cloth(s). Join several together as the larger the coloured area the easier it is to see. Stake them together to the ground during the day. Use them for shelter at night.
- Mirrors: Aimed correctly, the flash of the mirror can be seen for long distances. Any mirror will work, but a mirror is most accurate when it has small sighting hole to use to pinpoint the target. Don't flash a mirror at an aircraft that is very close or landing as it can momentarily blind the pilot. Brunton compass mirrors work well and even a piece of flattened tinfoil may work in an emergency.
- Smoke and Fire: In most daylight, smoke is more visible than fire, unless it is very windy.
- Keep green tree limbs, woody matter available to make lots of smoke when a search plane approaches. Build a fire for a signal on very dull days, at dusk or dawn or at night. The fire needs to be large to be visible, but don't allow it to start a brush or forest fire.
- Pyrotechnic signals: Good signals can produce enough smoke or light to be seen from a long distance. Smoke flares work only in daylight and are effective for aerial searches. Small flares that are fired from pen-like holders are not very effective. Those fired from pistols are brighter and reach a higher altitude. Use red flares to indicate distress and use white flares for illumination. Be very careful not to start a fire with them. See section 8 Survival.
- The following symbols may be used to communicate with aircraft during an emergency. It is good to know them even though they are not used frequently due to the increased use of satellite phones. Create as much colour contrast as possible between the symbol and the background. Symbols should be at least 2.5 metres long – larger is better – and spaced at least 3 metres apart. Symbols 1 to 5 are internationally accepted; symbols 6 to 9 are for use in Canada only.

PDAC 18.0 Camp Set Up and Management

Introduction

Careful planning and a concern for health, safety and the environment are essential for good project management. Field camps or rented accommodations should provide adequate working, eating and sleeping arrangements for field personnel and should be appropriately equipped to encourage employees to work safely and efficiently. At the same time, camps should make as little impact as possible on the environment. Project managers have to allow sufficient time to secure the required permits and permissions before sites are opened. Consider the following factors when selecting a project or camp site:

- Time of residence: Will the camp be in operation for a field season or year round? Duration: Temporary or a permanent establishment
- Size of the camp (at each time of year)
- Accessibility: Transportation access (vehicle, helicopter and fixed wing) may impact the site selection
- Required permits

Acronyms

AHJ – Authority Having Jurisdiction

CPR – Cardio Pulmonary Resuscitation

ELT – Emergency Locator Transmitter

ERP – Emergency Response Plan

GFCI – Ground Fault Circuit Interrupter

GPS – Global Positioning System

kW – Kilowatt

LPG – Liquefied Petroleum Gas

MSDS – Material Safety Data Sheet

OHS – Occupation Health and Safety

PAL – Possession and Acquisition License

PFD – Personal Flotation Device

PLB – Personal Locator Beacon

SOP – Safe Operating Procedure

TDG – Transportation of Dangerous Goods

UV – Ultra Violet

W – Watt

WHMIS – Workplace Hazardous Materials Information System

PDAC 18.1 Risks and Hazards Associated with Exploration Camps

- Non-compliance orders or charges from authorities having jurisdiction (AHJs)
- Slips, trips and falls caused by uneven surfaces, wet or icy ground, obstacles, poor housekeeping, poorly built steps, inadequate lighting
- Back injuries and strains caused by improper lifting and manual handling techniques, slips and falls
- Cuts, lacerations and other injuries caused by the improper use of chainsaws, axes, hammers and other tools, or improper tool maintenance
- Fires caused by improper fuel storage, fuel use, and fuelling practices; faulty heating equipment or failure to turn off equipment; exploding fuel or propane tank; clothes draped above heaters or on electrical wires; failure to extinguish open fires or cooking fires
- Illnesses spread by contaminated water,food or sewage contaminated drinking water Diseases spread by local insects, parasites, vermin and larger animals
- Animal attacks caused by poor choice of camp location inadequate garbage disposal, poor camp hygiene and lack of electric fencing
- Carbon monoxide poisoning caused by poorly maintained heating equipment; inadequate ventilation of core shack, buildings or tents; misuse and/or lack of maintenance of motors and engines; not following procedures when working in confined spaces, inadequately ventilated tents
- Electrocution, electric shock, or burns caused by inadequate or improper wiring, lack of lockout tag out procedures, lack of qualified personnel to install or repair electrical equipment, lack of adequate employee training
- Cuts, burns caused by spilled hot food or liquids, misuse of kitchen equipment, hot equipment (core saws, generators, heating stoves)
- Injuries or occupational illness caused by exposure to hazardous materials
- Firearms accidents caused by improper use, lack of firearms policy or absence of implementation of safe operating procedures (SOPs), using the wrong ammunition
- Damage from floods or landslips caused by poor camp location
- Transportation related risks caused by camp location, lack of training, not enforcing SOPs, travelling at excessive speed for terrain conditions
- Additional risks caused by working around drill sites and or heavy equipment at advanced exploration sites

PDAC 18.2 Jurisdictional Regulations and Company Policies

In most countries and jurisdictions, various acts and regulations apply when establishing exploration and mining camps. Depending on the size of the camp, regulations may require permits for camp construction, access routes, water use and waste disposal etc. Allow sufficient time to contact local authorities having jurisdiction (AHJs), determine the requirements and obtain all necessary permits to be in compliance with regulations prior to establishing a camp.

Examples of required permits include: land use permits, work permits, timber cutting permits, water use permits or licenses, waste disposal or effluent discharge permits and drilling permits.

Access agreements with local aboriginal groups may be required to access land and set up camp, and if the camp is located on or near a watercourse, Department of Fisheries and Oceans (DFO) regulations may apply. In addition, consider the following requirements: various building and electrical codes, health and first aid regulations, spill containment and reporting regulations, as well as transportation of dangerous goods (TDG) and Workplace Hazardous Materials Information System (WHMIS) requirements. Some jurisdictions require notification to the health authorities when opening a camp.

Many jurisdictions have specific requirements for camp personnel e.g., a camp manager may have to hold specific certifications, or there may be specified medical personnel requirements according to camp size. If planning a rotation of personnel in camp, make sure sufficient qualified persons are available for the rotations.

Some jurisdictions have websites that list laws and regulations which require compliance from the mining industry. The jurisdictional Workers' Compensation Board or equivalent authority and the government department that includes mines are sources of information. Two helpful jurisdictional websites:

- http://www.gov.mb.ca/stem/mrd/busdev/exp-guide/camp.html
- http://www.ontario.ca/en/information_bundle/mineral/STEL02_038213?openNav=mylaws

PDAC 18.2.1 Alcohol and Drug Policies

Exploration companies should have a clear and concise policy to address alcohol and drugs at project and camp sites. The policy should conform to regulations of the authorities having jurisdiction (AHJs), including the regional Mines Act and Regulations. Companies should respect the wishes of local communities, especially when working in or near a "dry" community. Refer to section 2.1.3 Alcohol and Drug Policies for references and a suggested list of topics to address. There should be a provision for employees to sign off that they understand the policy and regulations.

PDAC 18.2.2 Firearms Regulations and Policies

Exploration companies should have a firearms policy in place when circumstances may require firearms on site. Only under special circumstances – for the protection of human life from animal attacks – should firearms be kept in camps and/or carried by employees on traverses. In some areas, it may be preferable to have local people (possibly indigenous people) with hunting experience to act as guards where there is a threat of wild animal attack. In countries where firearms are deemed necessary for personal security during exploration work, a company should hire armed personnel to act as guards rather than permit their own employees to carry firearms. The company should carry out a country risk assessment to determine whether the risk to personal safety is worth doing business in the location.

PDAC 18.2.2.1 Risks and Hazards

- Injury or death caused by the unintentional discharge of a firearm.
- Injury or death caused by the intentional misuse or careless use of a firearm.
- Personal injury to the shooter, which may include hearing loss or getting shot from an accidental discharge during a slip or fall, crossing an obstacle, when the firearm is placed upright against an object, or forgetting to unload the firearm.

- Bear attack when a bear is shot and injured but not killed.

PDAC 18.2.2.2 Company Owned Firearms in Canada

By acquiring a firearms business license, it is possible for a company to purchase non-restricted firearms for qualified employees to use in the field for protection from life-threatening attacks by wild animals. To obtain a firearms business license in Canada, the company must submit an application to the Chief Firearms Officer of the province or territory where the firearms will be stored when not in use. Because applications are made through the office of the provincial or territorial Chief Firearms Officer, it is necessary to apply to the correct jurisdiction.

- If after use in the field, the firearms will be stored where the company head office is located, the application should be made in the province or territory where the company head office is located and where it holds a municipal business license.
- If the firearms will be stored in a different province or territory outside of field season, the application should be made to the Chief Firearms Officer of that province or territory, even though the company head office is located in a different jurisdiction.

For inquiries regarding applications for a firearms business license: Telephone the Chief Firearms Office at 1-800-731-4000 and request to speak with the Chief Firearms Officer in charge of firearms business licenses for the appropriate province or territory.

The process to acquire a firearms business license requires an application by a person within the company who assumes responsibility for the firearms and an inspection by a local firearms officer who will determine whether the storage facility, access and the control of the firearms each meet the licensing requirements. Conditions may be placed on the license that (1) firearms are for use in remote areas for the protection of life from wild animals, (2) firearms may be used only by employees working in remote areas who have a Possession and Acquisition License (PAL) and (3) the firearms may be transported throughout Canada to remote work locations.

PDAC 18.2.2.3 Company Firearms Policy

The company firearms policy must conform to all federal, provincial, territorial and local regulations. In Canada, only people who have a valid PAL are permitted to use or handle company owned firearms, except for individuals who are aboriginal, meet specific criteria, and qualify for alternative certification.

A mineral exploration company's firearms policy should cover the following:

- The company has the responsibility to exercise full control over the use, transportation and storage of firearms.
- Authorization for firearms use, transportation and removal from storage must be for qualified employees only. Unqualified employees must not have access to firearms.
- All employees permitted to use firearms must have appropriate training and a license in accordance with the codes, statutes or laws of the local jurisdiction e.g., a Possession and Acquisition License (PAL) in Canada. Employees must adhere to the company policy and safe operating procedures (SOPs) regarding use of firearms.
- A firearms policy should define the following:
  - Who is in charge of firearms.
  - Who is permitted to use the firearms.
  - How access to firearms is controlled.

- Requirements for transportation, storage and care of firearms and ammunition.
- Only non-restricted firearms are permissible in camp.
- The circumstances when firearms may be used.
- The muzzle of the firearm must always be controlled.
- Who is designated to shoot should a bear or other wild animal invade camp.
- Firearms must not be used for hunting.
- Whether or not possession of personal firearms on site is permissible.
- That all restricted firearms and prohibited weapons and devices are prohibited on-site.
- Disciplinary actions for violation of the firearms regulations and policy.
- Contractors working on site are required to follow the company firearms policy.

PDAC 18.2.2.4 Essential Safe Firearms Practices

Essential firearms safe practices include but are not limited to the following:

- Develop and implement company SOPs that comply with federal, provincial, territorial and local regulations regarding the safe use of firearms. See the section regarding SOPs below.
- Training and practice: It is advisable to provide additional firearms practice and training (including target practice) by a certified instructor to employees who possess a PAL before they go on site.
- Notification: In Canada, notify local police authorities when firearms are present in camp.
- Make sure all employees are aware of the firearms policy and regulations. There should be a provision for them to sign off that they understand the policy and regulations.
- Store firearms unloaded, with a trigger lock in place and in a locked container. Store ammunition locked separately. Make sure the correct ammunition is available for the specific firearm.
- When a company secures a firearms business license and purchases firearms for use at camps, it may be advisable to purchase only one type of firearm so that all ammunition can be used in every firearm. This can prevent potential mix ups during an emergency.
- Employees who are permitted to use firearms must (1) know where they are kept, (2) be able to access and unlock the firearms and (3) obtain the correct ammunition in an emergency situation.
- When removed from storage, a firearm must be under the immediate control of a qualified person at all times. Immediate control means within an arm's length of the qualified person.
- A firearm used for predator control may be stored temporarily unlocked and out in the open, as long as it is unloaded and ammunition is not readily accessible.
- Keep firearms in good condition and fully functioning. Any firearm that is not absolutely dependable is a liability to the person using it and for others whose safety depend upon it.

- Keep firearms clean and stored to prevent condensation and ice forming in the barrel in cold climates.
- Where field traverses may expose employees to animal attacks (e.g., polar bears or grizzly bears), it is advisable to hire trained bear guards from local communities and traverse in groups of three with two people recording information and one acting as bear guard.
- Notify the appropriate government wildlife agency to deal with and/or dispatch a troublesome bear if the bear's presence is not an immediate emergency. Although the purpose of firearms in camp is for protection of life from wildlife attacks, except under emergency conditions, it is the job of the wildlife agency rather than a company employee to remove or dispatch a bear.
- Refer to Chapter 10, section 10.3.1 Precautions and Preventions for information regarding trained bear guards. Also refer to section 10.3.9 Bear Deterrents regarding deterrents and appropriate firearms for defence against bears.

Safe operating procedures (SOPs) regarding firearms must include but not be limited to the following:

- It is the responsibility of the exploration manager and the camp manager to make sure everyone in camp adheres to the firearms policy and regulations.
- Follow correct procedures when handling a firearm.
- Follow correct procedures when loading and unloading a firearm.
- Transport firearms safely to and from camp, field traverses and other locations.
  - Address potential transportation of firearms by vehicles, ATVs, snowmobiles, boats or fixed wing aircraft and helicopters.
  - On firearms equipped with a safety, keep the safety in the "on" or locked position, but do not rely on the safety because it is a mechanical devise that may fail.
  - Firearms must be unloaded with the safety on and locked before entry into any means of transportation. Place them in a secure position where they will not be dislodged or stepped on. Firearms must be placed in the cargo compartment of an aircraft or a boat, and are best transported in a vehicle inside the closed and locked cargo compartment.
  - Always make sure that firearms are unloaded before entering camp or any building.
  - Always make sure that firearms are unloaded but with ammunition available while on traverse.
- SOPs should include basic firearms safety practices.
  - Incorporate the Vital Four Firearm ACTS of Firearms Safety and PROVE the firearm safe (below)
  - Be familiar with the different types and models of firearms and the action mechanism of each firearm at the site.
  - Never modify or alter a firearm.
  - Never assume a firearm was unloaded by the previous holder before storage.
- Follow correct procedures when shooting at a specified target, both during practice or in an emergency.

The following information is reproduced from Section 2: Basic Firearm Safety of the Canadian Firearms Safety Course: Student Handbook. These are the most important firearms safety rules – the acts that must be carried out by everyone qualified to use firearms at an exploration project or camp.

The Vital Four Firearm ACTS of Firearms Safety

Assume every firearm is loaded.

- Regard any firearm as a potential danger.

Control the muzzle direction at all times.

- Identify the safest available muzzle direction.
- Keep the firearm pointed in the safest available direction.
- The muzzle of a firearm should not be pointed towards yourself or any other person.

Trigger finger must be kept off the trigger and out of trigger guard.

- Resist the temptation to put your finger on the trigger or inside the trigger guard when you pick up a firearm.
- Accidental discharge is far more likely to occur if your finger is on the trigger or inside the trigger guard.

See that the firearm is unloaded. PROVE it safe.

- Do not handle the firearm unless you can PROVE it safely.
- Check to see that both chamber and magazine are empty. Do this every time you handle a firearm, for any reason.
- Pass or accept only open and unloaded firearms. This is an important habit to develop.

PROVE it safe:

Point the firearm in the safest available direction.

Remove all cartridges.

Observe the chamber.

Verify the feeding path.

Examine the bore.

- The firearm is now unloaded and safe until it leaves the direct control of the person who unloaded and PROVEd it safe.

Additional information is available on the following websites:

- http://laws.justice.gc.ca/en/F-11.6/index.html
- http://www.rcmp-grc.gc.ca/cfp-pcaf/cfo-caf/cfo-caf-eng.htm
- http://www.rcmp-grc.gc.ca/cfp-pcaf/fs-fd/ab-au-eng.htm

PDAC 18.2.3 Workplace Hazardous Materials Information System (WHMIS)

Every camp uses hazardous materials. Some obvious products include propane, diesel, Jet B fuel, hydraulic fluids, some drilling additives and bear spray. Less obvious hazardous products are those used in camp kitchens such as cleaning agents (oven cleaner) and chlorine bleach, chemicals required for water treatment, lime used in privies. Core and sample preparation facilities use hydrochloric acid and other chemicals for mineral testing. These products can potentially cause injuries, occupational illnesses, fires or explosions. The degree of risk depends on the quantity, toxicity, concentration, whether the material is flammable, explosive or under pressure.

Employees have the “right to know” about the potential risks of hazardous materials used on site, and companies are required by law to provide such information and train employees to protect themselves and work safely. This can be accomplished through Workplace Hazardous Materials Information System (WHMIS) training.

WHMIS is the Canadian standardized system that provides specific information about the safe use of hazardous materials or controlled products in the workplace. Controlled products are any products, materials or substances that are regulated by WHMIS legislation. WHMIS legislation is implemented through federal, provincial, and territorial regulations. The WHMIS system includes hazards identification and classification, (2) labelling, (3) material safety data sheets (MSDSs) and (4) employee education programs. Education and training should include a four hour basic WHMIS course taught by a certified WHMIS trainer so all employees receive WHMIS training and certification. Some employees should receive additional site specific WHMIS training, depending on their work and potential exposure to specific controlled products on site.

- Note: Presently, there are plans for WHMIS legislation to adopt the international Globally Harmonized System of Classification and Labelling of Chemicals (GHS) in Canada1. Like WHMIS, the GHS defines and classifies hazards of chemical products and uses labels and MSDS-type sheets to communicate health and safety information. Changes are likely to affect the content and format of labelling and MSDS sheets but not the responsibilities of suppliers, employers and employees. General information about GHS is available at:
  - http://www.ccohs.ca/oshanswers/chemicals/ghs.html

Information regarding various hazardous materials used in mineral exploration and which are commonly found in camps and drill sites is available in section 20.4.7 of Chapter 20 Hazardous Materials and in Chapter 10. Hazardous Material on the e3 Plus Excellence in Environmental Stewardship Toolkit at: http://www.pdac.ca/e3plus/

PDAC 18.2.3.1 Responsibilities of Suppliers, Employers and Employees

Suppliers that sell or import controlled products are required to label the controlled products or containers of controlled products and provide a material safety data sheet (MSDS) with the product.

Employers are required to make sure all hazardous products are labelled and that all MSDS sheets are readily available to employees for reference. Employers are also required to develop, implement and maintain a WHMIS education and training program for workers who are or may be exposed to controlled products at work. Some of this material can be incorporated into induction and safety meetings.

- Education should provide information about how the WHMIS system works, hazard identification and classification, plus how to read, interpret and understand the information on WHMIS labels and MSDSs. The required level of education depends on the specific controlled products, the risk of exposure and the specific work carried out by employees at the site.

- Training has to address specific information and knowledge required to interpret information on labels and MSDSs in order to protect employee health and safety. Training should include information about the use, handling, storage, disposal, and emergency procedures to take if exposed to the controlled products. It may be advisable to develop safe operating procedures (SOPs) that address critical aspects of some controlled products. The degree of training will vary with each site and between employees at the same site depending on an individual's job.

Employees are required to take part in WHMIS training provided by the employer. They should use the training to work safely with the various controlled products on site. They are required to understand the information on labels and MSDSs and report illegible, damaged and/or missing controlled product labels to the employer so they can be replaced.

PDAC 18.2.3.2 WHMIS Hazard Classifications, Symbols and Labels

WHMIS Hazard Classification and Symbols

WHMIS uses eight hazard symbols to indicate which type of hazard(s) must be considered when working with a controlled product. See the following table. Chemicals are divided into groups with similar properties or hazards. Controlled products are divided into six (6) classes of which two classes are split into divisions and subdivisions. Note that many products fall into one or more categories.

Detailed information about WHMIS classification is available at the following websites:

- http://www.ccohs.ca/oshanswers/legisl/whmis_classifi.html#_1_4
- http://www2.worksafebc.com/i/construction/Toolbox/pdfs/TG07-13_WHMIS.pdf

Table 18.1 WHMIS Classifications and Symbols for Hazardous Chemicals

 Compressed Gas	Class A: Compressed Gas Products under pressure For example, oxygen, propane, acetylene, fire extinguishers
 Flammable and Combustible Material	Class B: Flammable and Combustible Material Six Divisions use the same symbol. Flammable gases, liquids, solids and aerosols; Combustible liquids; Reactive Flammable materials: For example: propane, acetylene, gasoline, diesel fuel, paint thinner, spray paint

 Oxidizing Materials	Class C: Oxidizing Materials Materials may not burn, but provide oxygen to a fire: For example: nitric acid, hydrogen peroxide, sodium hypochlorite – bleach
 Immediate and Serious Toxic Effects	Class D, Division 1: Materials Causing Immediate and Serious Toxic Effects For example: sulphuric acid, hydrofluoric acid
 Other Toxic Effects	Class D, Division 2: Materials Causing Other Toxic Effects Immediate irritation or chronic health effects: For example, asbestos fibres, silica dust, acetone, mercury, lead, xylene, sodium hypochlorite – bleach
 Biohazardous Infectious Materials	Class D, Division 3: Biohazardous Infectious Materials Commercial cultures containing infectious organisms: For example: viruses: Hepatitis B; bacteria: salmonella; parasites: Giardia
 Corrosive Materials	Class E – Corrosive Materials Materials that cause burns to skin or eyes: For example: sulphuric acid, nitric acid, sodium hydroxide, hydrofluoric acid, sodium hypochlorite – bleach
 Dangerously Reactive Materials	Class F – Dangerously Reactive Material Products that experience dangerous reactions when subject to heat, pressure, water, shock: For example: sodium hypochlorite – bleach, hydrogen cyanide

WHMIS labels

WHMIS legislation requires specific labels on controlled products. Labels alert employees to the risks and necessary precautions to take when handling a controlled product. Labels must be easy to read and must not be defaced. If a controlled product is missing a supplier label when it is received, the product should not be used until a supplier label and MSDS are received from the supplier. There are three types of WHMIS labels.

Supplier Labels

Controlled products are required to have a supplier label affixed to them. Supplier labels must be bilingual and have a distinctive WHMIS hatched border. Only specific information is permitted on the supplier label:

- Product identifier – name of the product.
- Supplier identification – name of the manufacturer or distributor.
- Hazard symbols – one or more symbols of the applicable WHMIS hazard classes of the controlled product.
- Risk phrases – words that notify users of the main hazards of the product.
- Precautionary measures – PPE, handling, storage, and disposal requirements of the product.
- First aid measures – appropriate first aid emergency measures in case of exposure.
- Reference to the MSDS – a statement that an MSDS is available.

For small containers of less than 100 mL, only the product identifier, supplier identification (hazard symbols), and the reference to the MSDS are required to appear on the supplier label.

An example of a supplier label and information about them is available on the following website:

- http://www2.worksafebc.com/i/construction/Toolbox/pdfs/TG07-38_WHMIS_supplier_label.pdf

Workplace Labels

A workplace label has less detailed information than a supplier label. The WHMIS hatched border, bilingual labelling and hazard symbols are optional. Required information can be written with a permanent marker directly on the container or on a label that is applied to the container.

Workplace labels must appear on a product container when:

- Controlled products are transferred into a secondary container.
- The supplier label is missing or illegible.
- A controlled product is produced and used on site.

Workplace labels must contain the following:

- Product identifier (name).
- Specific safe handling information, including required PPE and protective clothing.
- Reference to the MSDS if an MSDS has been produced by the supplier.

An example of a workplace label and information about them is available on the following website:

- http://www2.worksafebc.com/i/construction/Toolbox/pdfs/TG07-37_WHMIS_workplace_label.pdf

Other Means of Identification

Workplace labels are not always practical. Other ways to identify controlled products may be used on tank cars, piping systems and on reaction or process vessels at a site.

Product identification may include warning signs, symbols, placards or coding systems that use colour, numbers or letters. When these methods are used, employees must be trained to recognize and understand them.

PDAC 18.2.3.3 Material Safety Data Sheets (MSDSs)

A material safety data sheet (MSDS) contains more detailed information than appears on supplier or workplace labels. No controlled product should be accepted upon delivery unless accompanied by an MSDS. However, when only a small amount of a controlled product is purchased, it may be necessary for a company to obtain the MSDS on the internet and print it on site.

Location: Companies and contractors should make sure MSDSs for all controlled products used on site are easily available for access by all employees and subcontractors. Keep up-to-date original MSDS sheets well organized and in a central location. Keep copies of important MSDSs in relevant locations so they are available when needed (e.g., drill shack, kitchen, first aid station, storeroom, core facility, eye wash stations). In addition, it is advisable to keep an electronic copy of each MSDS. Check the file annually and request updated MSDS sheets. Suppliers are required to update MSDS sheets every three years in Canada but it is the responsibility of the employer to request the current MSDS.

Interpretation: Employees should receive instruction in the content and significance of technical information on an MSDS. They should be able to read, locate and interpret the most important and relevant information. Some MSDS sheets are clearly written and easy to understand but many are not. Presently in Canada, there are nine sections of required disclosure information on an MSDS. There is no set format and sections may appear in any order although all nine sections must be present and complete. (GHS uses the term Safety Data Sheet (SDS) and defines a 16-headings format for the disclosure information. Canada presently accepts the GHS format when certain conditions are met.)

- Hazardous ingredients: The ingredients, concentrations and estimates of immediate and severe health effects, Chemical Abstracts Service (CAS) number.
- Preparation Information: Name and telephone number of party responsible for the preparation of the MSDS, date of preparation.
- Product information: Product identifier and product use information; manufacturer’s name, full street address, city, province, postal code and emergency telephone number; supplier’s name, full street address, city, province, postal code and emergency telephone number; Product identification number (PIN).
- Physical data: A physical description: physical state, boiling and freezing points, pH, appearance, specific gravity, smell.
- Fire or explosion data: Conditions of flammability, means of extinction, flash point, hazardous combustion products, explosion data.
- Reactivity data: Reactivity, conditions of chemical instability, names of incompatible substances or classes of substances, conditions of reactivity, hazardous decomposition products.
- Toxicological properties: Route of entry to the body, effects of short and long term health exposure, various types of toxicity.

- Preventative measures: Specific control measures: engineering controls, PPE, safe work procedures, handling, storage and disposal measures, spill procedures.
- First aid measures: Specific first aid measures in case of illness or injury caused by exposure.

Before using a product, workers should be familiar with the MSDS:

- Match the name of the product to the MSDS to verify the product being used.
- Be familiar with the hazards.
- Understand the safe handling, storage and disposal requirements.
- Know what first aid measures to use, if necessary.

Although many countries require MSDS sheets to accompany hazardous products, the format and required information on MSDS sheets are not yet internationally standardized. When exploration companies work in countries that lack MSDS requirements, the company should obtain or compile an MSDS database. The following websites have information about content requirements and writing an MSDS in Canada and other countries.

- Canada:
  - http://www.ccohs.ca/oshanswers/legisl/msdss.html
  - http://www.ccohs.ca/oshanswers/legisl/msds_prep.html
- USA:
  - http://www.msdswriter.com/learn_writer.cfm
- Australia:
  - http://www.safeworkaustralia.gov.au/NR/rdonlyres/6AA1E55D-D444-4909- B18B-812688B49A7F/0/MSDSCodeNOHSC20112003.pdf

As the GHS will eventually standardize the content of MSDSs (SDS under the GHS), this website provides the status of implementation of GHS:

- http://www.unece.org/trans/danger/publi/ghs/implementation_e.html

PDAC 18.2.3.4 Site Specific WHMIS Training Requirements

WHMIS legislation requires employees to receive additional site specific training that covers specific controlled products that the employee works with or work around. The level of training will depend on the likelihood of exposure in the work place. For example, training for specific controlled products on site should include:

- Safe storage, handling use and disposal of controlled products including those that are contained or transferred into any pipes, process or reaction vessels, tank cars or tank trucks etc., if present on site.
- Emergency measures (spills, first aid etc.) required for controlled products if employees are exposed. Depending on the location and level of hazard presented by a controlled product, it may be appropriate to train only a few employees – or all employees in emergency procedures.
- Emergency procedures if there is potential exposure to “fugitive emissions” (emissions of gases or vapors of controlled products from leaking pressurized equipment).

Depending on the level of hazard and the site, it may be appropriate to train all employees in ER procedures (e.g., chlorine gas leak).

Additional WHMIS information is available on the following websites:

- http://www.worksafebc.com/publications/health_and_safety/whmis/assets/pdf/whmis_cor e_full.pdf
- http://www.labour.gov.on.ca/english/hs/pubs/whmis/index.php
- http://www.iapa.ca/main/documents/pdf/2006_whmis_training_requirements.pdf

PDAC 18.4 Camp Management Guidelines

The following sections provide considerations and guidelines that should facilitate camp operations and promote the health and safety of employees.

PDAC 18.4.1 Site Selection and Location

A project or camp manager may or may not have responsibility for choosing the site location except when the initial site is established. Given the opportunity to choose a site, the following sections and sub sections should be considered.

When choosing a new location for either a permanent or temporary camp, be sure the site will comply with local regulations.

- Obtain all required permits from AHJs. See 18.2 Jurisdictional Regulations and Company Policies.
- Permission to use or access private land is always required even though permits may not be necessary. Land access agreements may be required with landowners and all field employees must extend full courtesy to landowners. Follow their directions regarding the use and closure of gates, access through stock grazing lands, use of water sources and private roads. Keep landowners informed of your presence and the methods of transportation that will be used – especially helicopters.
- If possible, check with people who have previously used a site to identify potential problems and confirm its suitability.
- Establish a camp location as near as possible to the work or field area and to any roads or an airstrip. This minimizes travel time and exposure to risks associated with transportation to and from the work site.
- Consult the following publication if establishing a camp in bear country:
  - Guidelines for Industrial Activity in Bear Country:
  - http://www.environmentyukon.gov.yk.ca/mapspublications/documents/Guidelines_for_Industrial_Activity_in_Bear_Country.pdf

Features to consider when selecting a site:

- Camps are generally best located in dry, sunny, well drained site with sufficient elevation to avoid potential flooding or a negative environmental impact on local water resources. The site should be near a fresh water supply and extreme care should be taken not to pollute or contaminate any sources of water. Ideally, camps should be located reasonably close to existing roads to accommodate access.

- The available space should be large enough to operate comfortably and safely for the expected duration of the project. Take into account the need for future expansion of the camp should the project progress.
- Address site hazards such as: limited or confined work areas, the need for special platforms for steep terrain, guard barriers to prevent falls into old open mine works, adequate access and parking space for service vehicles and equipment, aircraft etc., or the need for electric fencing for protection from bears. If helicopter support is planned, be sure that there is adequate space to construct the landing pad an appropriate distance from the living area.
- Determine if there are any overhead or underground power lines, cables, or gas and water pipelines in the immediate area. Contact the appropriate authorities before any excavating or drilling commences to prevent inadvertent contact. Refer to 21.3.4 Working Near Power Lines.

Site Layout and Organization

Design the layout to meet fire, health and safety regulations and codes and other requirements of the authorities having jurisdiction (AHJs). The following are organizational guidelines:

- Locate tents, kitchen area, fuel storage area and the helicopter landing pad with fire prevention in mind.
- Arrange the camp to minimize the risk of encroachment by animals. There should be no “dead ends” where wild animals may become trapped.
- Locate a camp a minimum of 200 m from an airstrip. (Helicopter landing pads may be closer.) Locate an airstrip and a helicopter landing pad so aircraft do not pass over the camp at a low altitude. Conversely, if wind direction is critical, position the camp to prevent aircraft flying over it.
- Locate fuel storage areas at least 100 m away from the camp. See section18.4.3 Fuels and Fuel Handling.
- Tents:
  - Space tents and buildings at least 15 m apart to reduce the potential spread of fire.
  - Arrange tents in a line or a semi-circle, rather than in a full circle or a square to prevent a tent being in the target area should a bear invade the camp. Consider setting up an electric fence around camps where bears are common. Refer to section 10.3 Bears.
  - Ideally, the kitchen area should be at least 20 m downwind from sleeping tents.
- If possible, establish a camp near a river or a lake, but not closer than 50 m, or as specified by AHJs.
- Water requirements: Plan for water requirements. Check that the potable water supply is clean or treated as appropriate. Send water samples to a reputable laboratory for analysis to evaluate its purity with respect to inorganic and organic contaminants and to make sure it meets drinking water standards. See section 18.6.3 Drinking Water Safety.
- Electricity requirements: Larger camps commonly use electrical generators to supply power to the various buildings or tents. The generator should be placed in a convenient location, preferably away from sleeping tents due to noise and exhaust

hazards. Select a generator of appropriate size for the load by assessing the number of lights, appliances, equipment and other sources of power draw. Carefully plan the layout of the electrical distribution system and grounding with reference to local electrical codes. A qualified electrician should complete the installation of camp electrical generation and distribution systems to ensure compliance. See section 18.4.6 Electrical Safety.
- Sanitation and waste management requirements: Plan camp sewage, wastewater requirements and waste disposal facilities appropriate for the size of the camp and that conform to the site permit. See section 18.6.4 Waste Management.

Communications

For detailed information regarding communication requirements and protocols for camps, transportation, traversing and emergencies, refer to Chapter 19. Communications. The following are fundamental when planning a field camp:

- Determine the best communication equipment for the geographic location and terrain, and supply the camp with sufficient equipment, including an independent backup system.
- Designate a communication centre that also functions as a means of tracking the location of all employees.
- Post all important information for communication equipment at the communication centre. This includes:
  - Operating instructions for all communication equipment.
  - The emergency response plans in detail. How and who to contact for various emergencies.
  - How to contact the on site and off site first aid emergency personnel, nearby first aid facilities (other camps) and medical centres
  - Contact list of company headquarters, offices and supervisory personnel
  - List all possible contacts for all possible emergencies, including local regulatory offices, police and helicopter or fixed wing transportation operating in the vicinity.
- Train all employees to use the communication equipment. It is essential that everyone is able to follow the posted instructions.

PDAC 18.4.2 Fire Safety

Fire is the greatest risk in a camp. The consequences of fire may be extremely serious. Should a camp burn, people may be seriously injured or killed or left without shelter, first aid, communications, transportation, food, water and clothing. The abrupt loss of a camp may result in an immediate and serious survival situation, especially in freezing weather.

Based on a risk assessment, determine the needs for mitigation and fire prevention methods. Each camp must have the appropriate firefighting equipment as required by local authorities. Depending on the jurisdiction, it may be advisable to exceed the local requirements.

Fire Safety Practices for Camps

- Arrange camps to reduce the spread of fire. Maintain a safe distance between tents and/or buildings and consider the prevailing wind direction. Make sure appropriate and properly functioning fire extinguishers and smoke detectors are present in permanent structures and tents. Keep a sand-filled bucket beside the entrance of each tent.

- Depending on the size of the camp, place firefighting equipment including fire extinguishers and a fire horn in one or more muster stations in a central location(s). Keep a water hose and pump in place at a water source to fight fires (lakeshore, river bank).
- Place fire extinguishers in a strategic location – near the exit of a tent, cabin or a drill shack. Do not bury fire extinguishers under equipment, clothing or supplies or at the back of a tent or drill shack. Locate extinguishers in the office and kitchen tents, sleeping tents, the incineration site, generator enclosures, drill shack, fuelling locations and fuel storage areas, helicopter landing pad and/or air strip, and in vehicles.
- Fire extinguishers should be the appropriate size to fight a potential fire. Although regulations may require only one 10-lb extinguisher at specific locations, it is recommended to keep two 20-lb extinguishers at fuel storage areas, fuelling areas, drill shacks, and the kitchen.
- Develop an emergency evacuation plan. Develop alternate plans if the location requires them. Post the plans and make sure each person, including visitors, are familiar with the plans. Periodically hold practice fire drills.
- Allocate parking for vehicles so there are two exit routes whenever possible.
- Maintain good housekeeping routines in camps to diminish the risk of fire.
    - Reduce clutter. Do not stack core boxes or other combustible materials against accommodation structures. They provide fuel for potential fires and may block exits and emergency equipment.
    - Incinerate oily rags so it is not necessary to store them. If this is not permitted, store them in a sealable metal container. Keep it closed to exclude oxygen.
    - Keep grass and flammable vegetation cleared away from propane tanks or fuel storage areas.
- Each camp should establish a smoking policy so that smoking is permitted only in areas declared safe for smoking. Smoking should be discouraged in sleeping tents and trailers or caravans. Do not permit smoking in or near:
    - Storage areas for fuels, chemicals, flammable materials such as solvents, paints, lubricants
    - Aircraft and helicopter landing areas
    - Fuelling areas or fuelling procedures for machinery, vehicles, extra fuel container
    - Maintenance areas when servicing: batteries, engines or motors, hydraulic systems etc.
    - Any designated “No Smoking” area

Fire Prevention Practices for Employees

Employees are required to carry out all activities and procedures in a manner that minimizes the risk of fire. Be informed about the local fire hazard rating and carry out work in compliance with any mandated restrictions.

- When open fires are permitted, keep them small and locate them in a safe place. Never leave them unattended. Fires in wooded areas should be built only on mineral soils.
- Scrape away all organic materials before building a fire. Make absolutely certain that organic materials are never left smouldering under any fire. Extinguish all open fires thoroughly with water when they are no longer required. When you are sure a fire is extinguished, add several more buckets of water just to be safe.
- If waste is incinerated, separate and remove all dangerous goods that might explode (e.g., batteries, aerosol cans).
- Turn off cook stoves when not in use. Make sure oil stove heaters are turned down or off whenever you leave camp. Perform regular maintenance on stoves, stovepipes and draft regulators, which will reduce the potential risk of carbon monoxide poisoning.
- Turn off all non-essential propane tanks when you temporarily leave camp.
- Light lanterns outside the tent and bring them inside only when burning properly.
- Use caution when burning mosquito coils. Place them in a metal container when lit and be sure to extinguish them whenever you leave camp.
- Clear brush and grasses from around portable generators, water pumps, compressors or any small motors.
- Use caution and correct procedures when fuelling camp equipment and vehicles. Check with someone who knows how to do the job if you are unfamiliar with the routine.
- Make sure proper safeguards remain in place around I.P. motor generators and transmitters as this equipment is a significant fire hazard.
- When parking a vehicle, make certain the exhaust system does not come in contact with dry flammable materials such as grass. Catalytic converters may become very hot.
- Check for build-up of flammable material such as grass, seedpods, twigs and other organic debris under the vehicle chassis and sump guard, and clean out these areas regularly.

Fire Extinguishers

Fire extinguishers and equipment should meet or exceed Canadian standards. Everyone is required to know the location all firefighting equipment and be trained to use it. Fire extinguishers are labelled with letters, symbols and pictographs according to the class of fire they are designed to fight. Not all fire extinguishers carry pictographs on the label.

All fires require three elements: (1) fuel, which can be solid, liquid or gas, (2) oxygen and (3) heat sufficient to raise the fuel above the temperature of ignition. To extinguish a fire, it is necessary to remove one of the three elements.

Fires are classified according to the material involved in the fire.

- Class A: Ordinary combustible material e.g., wood, cloth, paper, rubber and many plastics. Ordinary combustibles leave an ash when burned. All Class A fires must be extinguished by cooling the material below the temperature of ignition. The burning material must be soaked with an extinguishing substance to prevent re-ignition.

- Class B: Flammable liquids (e.g., gasoline, grease, oil, diesel, kerosene, tar). Class B fires must be extinguished by removing oxygen (smothered) so the vapors cannot reach the source of ignition. Never use water; it causes the fire to spread.
- Class C: Electrical equipment (e.g., wiring, fuse boxes, appliances, circuit breakers, machinery, battery powered equipment). Class C fires of “live” electrical equipment must be extinguished by using an extinguishing substance that does not conduct electricity.
- Never use water, which will increase the likelihood of electric shock or electrocution. Multi-purpose dry chemical fire extinguishers are safe to use but leave a residue that will damage electronic equipment.
- Class D: Combustible metal such as magnesium and other metals and/or metallic dust. The class is rare and the each extinguishing material is designed to fight the specific metal that is burning.
- Class K: Cooking oils such as vegetable fats or animal fats – a classification used only in the restaurant industry although occasionally some camps can experience these fires.

Generally, only three types of fire extinguishers are used in camps:

- Water or foam
- Carbon dioxide (CO_2)
- Dry chemical – regular dry chemical (BC) extinguishers use sodium bicarbonate or potassium bicarbonate, while multi-purpose dry chemical (ABC) extinguishers use monoammonium phosphate

Use the correct fire extinguisher for a fire; otherwise you may be injured or cause the fire to spread. Each fire extinguisher carries a label with symbols of the class or classes of fire it can extinguish. Many fire extinguishers are multi-purpose and carry two or more symbols. Class A and Class B fire extinguishers carry a numerical symbol to indicate the relative effectiveness of the extinguisher. The higher the number, the more effective the fire extinguisher (i.e., bigger). A “2A 10BC” is the minimum acceptable size of multi-purpose fire extinguisher and a larger size is preferable, even in a tent or small office. Size 2A 10BC are adequate for placing in vehicles.

Additional Information

- Class D fires require specialized fire extinguishing material and would not be present at a normal exploration camp.
- Class K fires are those involving restaurant kitchen appliances. Camps might consider supplying class K fire extinguishers for kitchens if deep fat fryers are used. Class K extinguishers use a wet chemical potassium acetate based agent with a low pH that is specifically engineered to extinguish deep fat fryer fires. They are intended to supplement automatic system protection; do not rely solely on a class K extinguisher.
- Halon extinguishers are no longer made and should not be used as they form dangerous gases when used to extinguish a fire. Respiratory PPE is required, especially if a fire is in an enclosed space.
- Fire extinguisher maintenance should include a monthly inspection, recharging as soon as an extinguisher is used, annual servicing to replace damaged parts, and keeping records of inspections and the repairs.

- Recharging fire extinguishers: Report the use of a fire extinguisher to a supervisor immediately so it can be recharged and made serviceable again. Even minimal use may compromise the performance of an extinguisher in the event of a fire. When you grab a fire extinguisher, you count on it being full.

Firefighting Basics

Training: Be trained to operate each fire type of extinguisher and all other firefighting equipment in the camp. You will not have time to learn how to do so in an emergency. Training should include practice extinguishing a fire and it is best to practice extinguishing the types you are most likely to encounter.

- If you encounter a fire, sound the alarm for a fire immediately. Shout loudly.
- Use the correct fire extinguisher. Fight a fire only if it is a small fire and you believe you can put it out quickly.
- Never fight a fire that is burning between you and the exit. First get out and then fight the fire with your back to the exit.
- Never turn your back on a fire as it may flare up or change suddenly.
- In very cold temperatures a water-based extinguisher is not effective, as the water base may freeze. A water-based extinguisher used on an electrical fire may cause electrocution or shock; if used on a class B fire of flammable liquids, it may cause the fire to spread.
- Treat a fire as an electrical fire if there is any suspicion that it may be an electrical fire. Do not use a water extinguisher. Disconnect the power source(s) if it is safe to do so.
- Stand upwind from a fire to fight it. Do not stand downwind as the smoke and flames are dangerous if they contain hazardous chemicals. Also, the smoke and air may become superheated.
- Do not fight fires that involve explosives or chemicals. Evacuate the area if there is any chance of chemicals or explosives associated with a fire.
- Machinery fires burn with great intensity. The air downwind may become superheated and damage lung tissue.
- After extinguishing a fire, watch the area carefully to be sure it does not re-ignite.

Remember the acronym PASS. To use a fire extinguisher properly:

- Pull the pin to unlock the discharge lever.
- Aim low at the near edge and base of the fire.
- Squeeze the lever (or button) to discharge the contents.
- Sweep from side to side while directing the discharge at the base of the fire. Drive the fire toward the far edge. Do not aim at the centre of the fire as the force of the discharge may spread the fire outwards.

Additional information about fire extinguishers and fires is available at:

- http://www.iapa.ca/pdf/FreeDownloads8_fireext.pdf www.fireextinguisher.com

PDAC 18.4.3 Fuels and Fuel Handling

Camps often require a variety of fuels, which are commonly stored in 205-litre (45-gallon) fuel drums or in smaller drums and jerry cans. Camps that require large volumes of fuel supplies sometimes use large capacity above ground storage tanks. Some fuels require special handling, such as propane and acetylene, as they are stored in cylinders under high pressure.

Comply with regulations of the AHJs regarding all aspects of location and placement for fuel storage areas (caches), transportation of fuels, and handling procedures of fuels and waste fuel products. Keep appropriate spill kits where fuel spills may occur.

In Canada as of June 12, 2010, new regulations apply to both aboveground and underground storage tanks for petroleum products with a capacity over 230 litres that are located on federal or aboriginal lands. Storage tank systems must be registered with Environment Canada and meet standards to prevent leaks and spills. For information refer to: www.ec.gc.ca/st-rs

This section contains limited information about fuel storage, handling, and transportation as the subjects are covered in the e3Plus Excellence in Environmental Stewardship Toolkit. Refer to sections 10.1 Fuels and Petroleum Products and 10.2 Propane and Other Liquefied Petroleum Gases on the e3Plus website: http://www.pdac.ca/e3plus

Risks and Hazards

- Environmental damage caused by fuel or oil spills is the greatest risk.
- Fire and/or explosion caused by: misting fuel coming in contact with an open flame, static discharge
- Burns or chemical burn injuries caused by fires, explosions or skin contact with fuels Inhalation injuries caused by the toxic, corrosive, or asphyxiant properties of some compressed gases
- Impact injuries caused by mechanical failure of compressed gas cylinders. If cylinders are knocked over and the regulator is sheared off the contents may diffuse and/or the cylinder may become a missile and cause great damage.
- Carbon monoxide poisoning caused by incomplete combustion of fuels in heating stoves, generators, saws or appliances where there is insufficient ventilation.

Fuel Storage Tips

Correct storage is essential to prevent fires, environmental damage and wasted fuel. In addition to outdoor fuel storage requirements, AHJs may require fireproof cabinets and ventilation, and they may prescribe minimum distances between storage facilities for certain products.

- Fuel drums and tanks:
  - Store all flammable and combustible liquids safely in accurately labelled containers that conform to WHMIS regulations (e.g., fuels and propane). Refer to 18.2.3 Workplace Hazardous Materials Information System.
  - Store each type of fuel in a separate cache; it is important not to mix different types of fuels, especially aviation fuels.
  - Store full factory sealed fuel drums by lying on the side with both bungs horizontal in the 9 o'clock and 3 o'clock position, which prevents air and moisture from entering. This is mandatory for aviation fuel drums and recommended for diesel.

- Fuel drums should be stored in a secondary containment system, which should be rated for diesel and aviation fuels, as required. Check the specification sheet for the rating information.
- Post signs that clearly prohibit smoking and open flames in fuel storage and handling areas.
- Most fuel drums are clearly marked but occasionally markings are erased. If in doubt about the identity of a fuel – DO NOT USE IT. Report it to the supervisor or camp manager.
- Make sure empty and half full fuel drums cannot be blown over by aircraft prop wash or the rotor wash from helicopters.
- Mark fuel drums with company ownership as required.

- Secondary containment systems should be rated for aviation and diesel fuels. Check the specification sheet for rating information.
- Storage requirements for compressed gas cylinders: Compressed gas storage areas should be a minimum of 30 metres from any occupied building or tent. Separate the storage areas in compliance to WHMIS and MSDS specifications.
  - Flammable gases must be stored separate from oxidizers (e.g. hydrogen peroxide, nitric acid, sulphuric acid)
  - Corrosive substances must be stored separate from flammables
  - Full cylinders must be stored separate from empty cylinders
  - All cylinders must be stored separate from corrosive vapors
- Situate fuel storage areas away from the camp; ideally, locate the cache a minimum of 100 m (300 ft) from structures. Do not locate fuel drums too near the helipad in the event of a helicopter accident. Store fuel in a cleared, bermed area surrounded by a firebreak.
- Keep an accurate inventory as required by AHJs. Document the fuel caches. Include:
  - Date the cache was set up
  - Number of drums and the type of fuel
  - Dates of additions and deletions to the cache
  - Maintain a running total of full and empty drums at the cache.

Fuel Handling Tips

Handle fuel carefully to prevent accidents including fires, spills and fuel contamination. Employees who handle fuel should receive appropriate training in WHMIS and transportation of dangerous goods (TDG). Keep appropriate spill kits at fuelling sites or stations and take precautions to prevent injury and environmental damage.

- Wear PPE: Wear safety glasses or goggles and gloves. When drums are under pressure from sun exposure, the bungs may come off unexpectedly and the contents may splash out.
- Fuel drum placement:
  - Aviation fuel requires careful handling to prevent contamination.

    - Aviation fuel drums must be stored horizontally but may be placed upright when they may be used. Once a drum is opened and partially used, it is very important to replace and securely tighten the bungs. Store a drum in use in an inclined position (preferably 60-70°from the vertical)). Elevate the edge next to the large bung with a rock or a piece of wood so that the (small?) bung is at the high side (12 o'clock position) to prevent water entering the drum.
    - Do not expect pilots to use fuel more than two years old or if the bung seals are damaged. Pilots may refuse to use fuel that is stored upright for more than one day.
- Transferring fuel by hand from drums to smaller containers:
    - For fire safety, use only CSA-approved fuel containers and restrict the size to no larger than 20 L.
    - For diesel fuel, use yellow CSA-approved containers.
    - Use hand or power pumps with a flash or spark arrester to prevent a static spark when transferring fuel into jerry cans.
    - When transferring fuel to smaller containers, label each container clearly according to WHMIS requirements.
    - If it is necessary to use the same pump for various fuels, be sure to flush the pump out first and empty the waste into a container – never onto the ground. Label the waste fuel container.
    - Never use your mouth to siphon fuel.
- Follow the correct fuelling procedures and use the correct fuel for equipment, vehicles, ATVs, snowmobiles and boats. Check the operator's manual or ask someone who knows how to do the job correctly. Fuel may need filtering to prevent scale or dirt from entering fuel tanks.
- Manage waste petroleum products according to requirements of the AHJs. Isolate waste products in sealed appropriate containers until they can be properly disposed of either on or off the site.
- It is advisable not to refill fuel drums. If refilling a drum with gasoline, diesel or stove oil is unavoidable, follow these guidelines:
    - Use the same type of drum and ground the drum before filling. If you are not sure what type of fuel was previously in the drum – do not use the drum.
    - Closely inspect the drum for cleanliness inside and out and check for damage – do not use damaged drums.
    - Label the contents on the outside of the drum with indelible markings.
    - Make sure both bungs are tightly secured before transporting the refilled drum.
    - Do not refill drums with aviation fuel without the written permission of the charter aircraft company.
    - It is difficult to prevent spills so keep a spill kit close by during filling procedures.
- Transporting fuel drums and compressed gas cylinders

- Follow all TDG regulations for transportation. The following Transport Canada website provides information about dangerous goods training and links to a variety of topics regarding dangerous goods: http://www.tc.gc.ca/tdg/training/menu.htm
- Transport fuel drums upright in the back of pickup trucks – never in the cab. Carefully secure all drums so they cannot shift while underway.
- Transport and manoeuvre individual cylinders with the aid of a hand truck. Never roll them on their side over the ground or floor to move them.
- Follow safe slinging procedures when transporting fuel, refer to section 16.12 Slinging.

Propane Gas Handling Tips

Propane (a type of liquefied petroleum gas – LPG) is compressed into liquid and stored in special cylinders. General information about propane can be found in section 10.2 Propane and Other

Liquefied Petroleum Gases in the Excellence in Environmental Stewardship Toolkit on the e3 Plus website: http://www.pdac.ca/e3plus

- Handle propane storage tanks and cylinders carefully. Use, transport and store propane cylinders in an upright position. Make sure the safety cap covering the valve is in place on propane cylinders during transportation.
- Secure propane cylinders upright against the outside wall of the building, tent or drill shack when in use. They should be placed on a solid base or non-combustible rack and secured so they cannot tip over. Do not place them directly on wet soil as this may cause corrosion. Shield propane tanks from radiant or other direct heat sources and shield hoses from excessive heat and foot traffic. If a cylinder freezes to a surface, use warm water below 52°C (125°F) for thawing.
- Use only the correct installation methods, the correct tools and the proper fittings (regulators, hoses) when connecting propane cylinders to fuel lines.
- Store full and empty gas cylinders separately outdoors according to WHMIS regulations. Never store propane tanks inside living, working quarters, in basements or with oxidizers; oxidizers react with propane and contribute to fire and explosion.
- As propane gas is heavier than air, escaping gas will accumulate in low areas. Proper ventilation around all propane burning equipment is essential to prevent explosion.
- Propane pressure varies with the temperature of the liquid propane, not with the amount of propane in the cylinder. Never heat up a propane tank by using a torch etc., to try to increase the flow of gas from the cylinder.
- Always use soapy water to check for leaks at the joints and fittings. Never use a flame to check for leaks.
- Make sure the safety shut-off valve works properly.
- Propane tanks have a limited life span. Do not use corroded or rusty tanks or those that have past the expiry date.
- Propane tiger torches are useful to heat drilling equipment in very cold weather. Use them carefully as it is easy to start a fire with them.

- Additional information about storage and handling flammable fuels and compressed gases is available on the following websites:
  - http://www.iapa.ca/pdf/liquids.pdf
  - http://www.ccohs.ca/oshanswers/prevention/flammable_general.html
  - http://www.ccohs.ca/oshanswers/prevention/comp_gas.html

PDAC 18.4.4 Lanterns, Heating Stoves and Appliances

Most camps contain a variety of lanterns and heaters. Each type has different controls and characteristics. If you have not used a particular type before, read the manufacturer's operator manual or instructions and ask someone who knows how to use it.

Fire is a serious risk that may be caused by:

- Using the wrong type of fuel
- Smoking during fuelling
- Careless behaviour care when lighting lanterns or heating stoves

Propane or battery-powered lanterns are safest. Lanterns that burn flammable liquid can be knocked over and spill fuel, which may cause a rapidly spreading fire. Hang lanterns from the ceiling as they are more easily overturned when placed on a table. It is not advisable to use lanterns that burn naphtha or camp stove fuel, as the fuels are highly volatile and flammable.

When using this fuel is unavoidable, take the following precautions: Use the correct fuel.

- Light the lantern outside the tent.
- Pump the fuel tank to the recommended pressure.
- Light the match before turning on the fuel. Hold the flame under the burner.
- Let the mantle and burner tube heat up gradually. Open the fuel valve gradually until the mantle lights before opening valve wide. Do not pump the lantern too hard at first. Pump a lantern carefully once the flame is going smoothly.
- Never smoke while lighting lanterns and stoves.
- Place lanterns far enough away from the walls and ceiling of tents so the radiant heat does not set the tent on fire.
- Be careful when taking down a hanging lantern. Use a glove or stick, as the handle may be very hot.
- If a lantern runs dry, let it cool and make sure it is out before opening and adding fuel.
- Fuel vaporizes when poured into a hot lamp and may explode. Wipe off spilled fuel before lighting it again.
- When lighting a new mantle let it burn in the open for 15 minutes. This will allow toxic vapors dissipate.
- Always keep lanterns away from fuel drums, cans or tanks that contain or have contained flammable liquids.

Precautions for Heating Stoves In Tents

- Place oil and wood stove on a suitably sized sheet of metal. Place stoves at least 1 metre from any flammable material such as tent walls, and beds. Place a heat resistant barrier on the walls nearest the stove. Aluminum foil may be used, which will also reflect heat around the tent.

- Place insulation between the chimney and the support pole whenever an outside chimney needs a support pole. Brace and wire all pipes until they are solid enough to withstand a windstorm. Make sure the chimney does not touch the tent and the chimney vent that passes through the tent is made of adequate insulating material. Always use a heat-resistant spark arrester on oil and wood stoves at the chimney top.
- For all heaters/stoves, always check that the tent is well-ventilated but not drafty. Carbon monoxide and toxic fumes are significant hazards. See the following section 18.4.4.1 Carbon Monoxide Poisoning.
- New stoves and pipes smoke as the protective coating burns off. Make sure there is good ventilation as this smoke may contain toxic gases.
- When lighting a cold oil stove, let a small amount of oil run into the firepot. Light it by tossing a small piece of lighted paper into the firepot.
- If an oil stove is HOT, turn off the oil and do not light it again until the firepot cools. Oil evaporates when it seeps into a hot firepot, which may cause an explosion.
- Clean oil stove filters regularly.
- Clean soot buildup from chimneys
- Frequently inspect all fuel lines (hoses). Rubber hoses are superior to copper piping.
- Remember to turn stoves down or off when the tent or camp is not occupied.
- Install heating fuel on a proper stand outside the structure. Use absorbent mats to soak up any minor leaks from fittings of oil drums used for heating.
- Do not move kerosene heaters when lit.
- Do not put wet clothing, gear or packs within 1 metre of a heating stove or hang them from electrical cords or ropes above a stove. If clothing falls onto the stove it will catch fire.

Propane Heaters and Appliances

Propane fuel may produce deadly carbon monoxide through incomplete combustion. No propane heaters or appliances should be used in tents or any sleeping quarters without excellent ventilation. Whenever possible, place propane appliances such as refrigerators outside a building. Place a carbon monoxide detector in any area where propane appliances are used. See the following section 18.4.4.1 Carbon Monoxide Poisoning.

Make sure all fittings on the supply line are secure.

- Make sure there is adequate ventilation.
- If you smell propane (rotten eggs or cooking cabbage smell), do not try to light the heater or appliance. Check all connections using soap and water – never check with a match or flame.
- Read the instructions for operating and lighting the propane heaters, stoves, refrigerators, or other appliances.
- Most propane stoves and appliances have a pilot light that must be lit first. Keep combustibles away from any propane stove or appliance.
- If gas runs out:

- Turn off all control valves at the stove or appliance.
- Turn off the shutoff valve on the gas cylinder.
- Change the gas cylinder.
- Open the valve on the new gas cylinder and check for leaks.
- Open the valve at heater and light the pilot light.

- Propane refrigerators: Always transport refrigerators in the upright position. Install refrigerators in an area with sufficient ventilation. Keep them level and prevent them from rocking.
- Never operate propane without a proper regulator at the outlet of a propane cylinder.

Carbon Monoxide Poisoning

Carbon monoxide is the leading cause of death by poisoning in North America. Carbon monoxide is a colourless, tasteless odourless and non-irritating gas so you are unaware of it when you breathe it. Carbon monoxide combines readily with hemoglobin in the blood and reduces the oxygen-carrying capacity of the blood. Carbon monoxide can build up rapidly and poisoning can occur in very short time – even within minutes.

Risks

Primary risks to exploration employees are from small portable generators, heating stoves and gas powered tools when used where ventilation is inadequate. Small stoves or heat sources used inside a tent are particularly dangerous (e.g., during bad weather in fly camps). Risks are caused by:

- Confined spaces or semi-confined spaces: Toxic CO levels build up very quickly, sometimes in a few minutes and exceed the safe limits
- Ignorance: Lack of awareness of the risks and situations where CO poisoning can occur Indoor use of propane or gasoline fuelled equipment
- Pre-existing medical conditions: Chronic lung or cardiovascular disease increases the susceptibility, smokers
- Reproductive toxin: Pregnant women are very vulnerable, as the CO in their blood poisons the fetus more rapidly than it poisons the mother.

Sources of CO

- Incomplete combustion: Improperly adjusted oil or gas burners in space heaters, heating stoves, cooking stoves, and all fires
- Gasoline powered tools – chainsaws, chop saws, pressure washers, portable generators Vehicles
- During normal combustion very little CO is produced. However, incomplete combustion of any fuel greatly increases the production of CO.

Symptoms of Carbon Monoxide Poisoning

The symptoms depend on the concentration, the degree of physical exertion, and length of exposure. Because the brain is sensitive to oxygen deprivation, behaviour changes and confusion are common, but more easily recognized symptoms include the following:

- Low concentrations produce a slight headache, shortness of breath, nausea and dizziness
- Higher concentrations produce a severe headache, mental confusion, dizziness, impaired vision and/or hearing, and collapse or fainting with physical exertion
- Extreme concentrations produce unconsciousness, coma and death

Prevention and Preparation

Prevent exposure whenever possible.

- Include an assessment of all items that have the potential of generating carbon monoxide poisoning. Mitigate the risks.
- Develop and implement SOPs for working with equipment that produces CO. Develop ERPs that address potential CO poisoning.
- Educate workers about the risks, warning signs and required first aid treatment for CO poisoning.
- Engineering controls:
  - Install ventilation that is appropriate for the work space. Work in trenches and underground require proper air and exhaust ventilation for diesel motors – never use gasoline powered motors even near a trench where the exhaust may descend and accumulate.
  - Replace gasoline powered equipment with electric or diesel powered equipment when appropriate
  - Maintain fuel powered equipment in good condition and inspect it regularly
  - For heating and cooking stoves, make sure the flame of liquefied petroleum gas burns with a clear, blue flame. A flickering or yellow flame indicates that the air intake is restricted and needs adjustment, as more CO is produced when combustion is incomplete as indicated by a yellow flame.
- NEVER use a heat source inside a tent without excellent cross ventilation. Open vents at the top are not sufficient. Small heat sources in small tents or cabins are a deadly combination.
- Start vehicles and heavy equipment outdoors or in well-ventilated areas, especially in cold temperatures as engines produce more CO when it is cold.
- Do not barbecue with charcoal in any enclosed space. Coals emit carbon monoxide even when they are not glowing.
- Detection instruments: Use as detection instruments appropriate for the work site.
  - Gas detection tubes – indicate the level of CO by colour changes
  - Electronic detectors: various sizes – portable and stationary.
  - Do not use a home detector for buildings at a work site.
- Refer to section 22.7.3 Carbon Monoxide for information about carbon monoxide and for information about the occurrence in old underground workings.

PDAC 18.4.5 Generators

Field camps use a variety of generators in exploration activities. Small camps usually use small gasoline or diesel powered generators with a generating capacity of 300-5000 W. Permanent camps commonly use larger diesel powered generators with capacities of 2-50 kW or more.

Generators are also commonly used in ground geophysical surveys.

- Guidelines for the safe operation of generators
- Comply with the relevant building, fire and electrical codes regarding the use of generators and electrical distribution systems.
- Only trained personnel should operate and maintain generators. However, keep the operating instructions for each generator available in case a problem develops and the person who normally runs the generator is not present.
- Exhaust emissions contain poisonous carbon monoxide (CO). Never run a generator in a building, tent or in an enclosed area unless the exhaust pipe discharges outside the area so fumes cannot re-enter the enclosure.
- Operate the generator on a level surface. Otherwise, fuel and oil spillage may result. Use drip trays, absorbent pads and have a spill kit available.
- Know how to stop the generator quickly. Label the emergency shut-off; understand the operation of all the controls.
- A generator is a potential source of electrical shock. Do not allow the generator to get wet. Cover it to protect it from rain or snow. Do not use a generator if your hands are wet.

Small Generators

- When using generators in the field, make certain they do not rest on any organic material or vegetation that might ignite.
- Place small generators at least 1 metre (3 ft) away from any tent, building or other equipment when the generator is operating.
- Refer to 5.9 Small Generators for additional information regarding portable generators that may be used as the power source for field equipment or surveys.

Large Generators

- Larger generators and electrical distribution systems should be installed and/or inspected by a qualified electrician.
- Install large generators away from tents and structures and in insulated housing to reduce noise. Whenever possible, locate them downwind to reduce noise and emission pollution.

Installation and Maintenance

- To prevent damage to the generator, make certain it is grounded. Connect a length of heavy wire from the ground terminal to a ground spike. Grounding protects the generator from damage due to lightning. Be aware, however, that grounding the generator may increase the danger of shock to a person standing near it if the soil or flooring beneath the generator is wet.

- Install a ground fault circuit interrupter (GFCI) at the generator and plug all cords into it.
- Carry out regular maintenance and repairs. This includes regular oil changes and coolant level checks. Shut off the engine before carrying out maintenance. Keep a written log of maintenance and servicing.
- Place and operate small generators in a metal or plastic pan or drip tray to catch spills that frequently occur during fuelling.

Fuelling Procedures for Generators

- Fuel generators during daylight hours. Never allow a generator to run dry of fuel (unless you intend to do so). Each evening there should be enough fuel in the tank to last until morning.
- If fuelling must be done in darkness (e.g., Arctic winter), make sure there is adequate lighting to do the job safely.
- Gasoline is commonly used in small generators and it is extremely flammable and explosive. Fuel only in a well ventilated area with the generator engine stopped.
- Do not smoke or allow flames or sparks in the area where the generator is being fuelled.
- Take care not to overfill the fuel tank and cause spillage. Replace the filler cap tightly after fuelling. Clean up any spillage.
- If diesel generators are fed directly from 205 L (45-gallon) drums or a larger tank, place the drum or tank in a spill containment structure and keep an appropriate spill kit on hand.
- NOTE: If in doubt about the identity of a fuel – DO NOT USE IT. Report it to your supervisor.

PDAC 18.4.6 Electrical Safety

Qualified electricians should design and install electrical systems and wiring and carry out all repairs to electrical equipment. Employees who use electrical tools and equipment should be trained and should refer to the manufacturer's operator manual for safe operating procedures, especially the first time an item is used or if they have not used the equipment recently. Seek instruction when you are unsure about the correct use of electrical tools, equipment or appliances.

General Guidelines for Electrical Safety

Avoid electrical hazards by following safe work practices. An electric shock can be fatal when current passes through the body. Electrical burns can be extremely serious and may even require amputation of digits or limbs.

- Any moisture may provide a path for electricity and result in shock. Keep all appliances, power tools, plugs and cords away from water and damp surfaces.
- Make sure all electrical equipment is properly grounded.
- In the event of an electrical fire, always use a C-rated fire extinguisher – never use water, which will increase the risk of electrocution.

- Use extreme caution when handling aluminum ladders or other conductive materials and prevent them from touching exposed overhead electrical wires, light bulbs or other conductors.
- Do not work alone with or near high voltage electricity. Use the “buddy system” so emergency measures can be initiated if one person is injured.
- Treat every wire as if it were energized or “live” until you confirm that it is not.
- Clearly label the circuit breaker(s) and the main power emergency switch. Everyone should know the location and how to operate them to cut off power.

Electrical Equipment

- Use the correct power tool or appliance for the job. Securely store all equipment in its designated storage place when not in use. Keep items in good repair and free of dirt and grease; never use defective or worn tools or appliances.
- Grip the plug and not the cord when unplugging a tool or appliance. Always handle plugs with dry hands.
- Unplug tools, appliances and machinery before inspecting, cleaning, clearing a stoppage, or carrying out maintenance.
- Refer to sections 5.5 Power Tools and 5.10.3 General Safety Regarding Rock Cutting Saws for additional information.

Circuits

- Make sure all electrical systems are correctly grounded. All circuits should be equipped with ground fault circuit interrupters (GFCIs) also known as earth leakage safety switches or residual current devices. GFCIs protect people from electrical shock, as they will interrupt the circuit before a fuse in a circuit breaker panel is triggered.
- Keep the access clear around circuit panels and junction boxes. All workers should know the location of circuit breakers and fuses, especially for their immediate work area.
- Minimize hazards caused by electrical cabling by burying, elevating or barricading exposed cables. Mark the location of any buried cables. Protect cords and cables from damage when they cross roads or passage ways. Secure or suspend electrical cords with non-conducting materials. Make sure that cables do not get wet.
- Use only approved armoured (teck) cable for burial.

Electrical Cables, Power and Extension Cords

- Make sure power cords use the appropriate voltage for the electrical grid system. Use cords with ratings appropriate for the job.
- It is preferable to use only circuits with GFCIs. However, if there is no GFCI, use electrical cords that contain inline GFCIs. To use electrical cords that lack GFCIs may require a documented inspection program; therefore it is usually cheaper and safer to purchase and use cords with inline GFCIs.
- Visually inspect power cords before use. Make sure they are free of breaks in the insulation and have no taped splices. Inspect them for fraying and damage before each use. If damaged, cords should be repaired by an electrician or discarded.

- Use the correct type and length of cord for the job. A power cord should be as short as possible for the job. A cord should never be near your feet where it may become a tripping hazard, or draped over a workspace or cooking surface where it may get caught.
- Do not allow vehicles etc., to drive over power cords. Place the cord between planks for protection.

Maintenance

- All electrical and repair work should only be carried out by qualified electricians. Tag out defective tools and bring them to the attention of the supervisor for repair. Maintenance employees should be trained in and follow lockout procedures, as required.
- Wear proper PPE when carrying out maintenance work (e.g., safety glasses and electrical rated footwear).

Lockout and Tag Out procedures

Lockout is a program required by occupational health and safety legislation and regulations that requires machinery to be secured against inadvertent movement and the release of energy sources during maintenance work. Companies should develop a lockout and tag out program to implement during installation, maintenance and repairs of machinery and equipment. Employees who work with machinery or carry out maintenance on electrical circuits should receive formal training to learn lockout and tag out procedures.

During installation or maintenance on equipment, machinery or power systems, it is important to clearly notify co-workers that a device is not working (tag out) and (2) make sure that all possible forms of energy have been shut off and/or released so power will not be restored until work is completed and the “lockout” is removed by the designated person(s)

Tag Out Procedures

Set up a tagging system for hand tools and any piece of equipment that requires servicing, maintenance and/or repairs (including generators, vehicles, ATVs, snowmobiles). A specific “OUT OF SERVICE” tag that is signed and dated should be attached to the item that briefly explains the problem. Report the problem to a supervisor. The tag should: (1) be clearly written, (2) weatherproof, (3) securely attached, and (4) only be removed by a designated employee when required work is completed by a qualified person. No one should operate any equipment that carries an “OUT OF SERVICE” tag.

Lockout Procedures

A company should develop written lockout procedures to provide for the safety of maintenance workers and verify that no energy (power) will suddenly and unexpectedly be released or restored. Procedures should be in compliance with lockout regulations of the AHJs.

- The term “energy-isolating devices” refers to switches, circuit breakers and valves that must be locked out. A stop button on a control circuit is not a sufficient control for locking out. The main power source must be locked out that supplies a stop button on a machine.
- Personal lockout locks: Issue each worker who maintains or services equipment that requires locking out a personal lock with only one key, which is kept by that person.

Only that person may place the lock on a switch, valve, or circuit panel to lock out energy and only that person may remove the lock when work is completed. Each person who works on a machine or circuit places his or her personal lock on the switch and removes it. This prevents someone from inadvertently restoring the energy source.

- Develop and implement procedures to address when lockout work carries over to other shifts.
- Lockout is not required when a tool or piece of equipment that receives power through a disconnected supply (power cord) is kept under the immediate control of the worker at all times until the work is completed.

Employees are required to implement the company's written lockout procedures and follow them step by step. The steps include:

- Identify the machinery, equipment or power system. Notify other affected employees that the lockout system will be implemented. Make sure no other employee will be harmed by shutting off the equipment or machinery.
- Shut off the equipment or machine and make sure that all moving parts are completely stopped.
- Identify and turn off (de-activate) all energy sources. Turn off the switches or valves or other energy isolation devices so the equipment is completely isolated from all energy sources. Dissipate stored energy through bleeding, blocking or grounding etc. See the following section regarding various forms of hazardous energy.
- Apply a personal lock to the switch or control of each energy-isolating device (energy source). Each person who will work on the equipment must apply their personal lock.
- TEST the lockout to make sure it is effective and make sure each and every source of energy has been locked out. Before testing, it is essential to make sure all employees are clear and no hazards will be created if the lockout fails.

Forms of hazardous energy include the following:

- Electrical energy: Low voltage and high voltage equipment can kill workers. Never work on electrical equipment, lighting systems, or electrical panels unless they are locked out.
- Kinetic energy: Moving machinery parts may continue to move after electric power has been turned off. Guarding, blocking or restraints may be required during maintenance. Parts may be controlled by hydraulic or pneumatic pressure, which must be released and/or blocked.
- Potential energy: Some materials or parts of machines or equipment may be suspended or elevated when the energy source is stopped. Block any elevated machine parts that might fall due to gravity and pin or block parts suspended by hydraulic or pneumatic pressure. Loaded springs are a source of potential energy.
- Chemical energy: Flammable and combustible materials release energy in the form of a chemical reaction when they burn.
- Thermal energy: Thermal energy is energy that can be transferred to a cooler body. Hot steam pipes and pressurized gases are sources of thermal energy.

- Radiation energy: Lasers, light and ionizing radiation X-rays are forms of radiation that may require control.

Batteries

A variety of batteries are used in camps. Six- or twelve-volt lead acid batteries power various means of transportation and communications equipment in camps. Batteries are essential to power handheld Global Positioning Systems (GPS) units used for navigation and emergency location equipment, Emergency Locator Transmitters (ELTs), and Personal Locator Beacons (PLBs). Most units use AA or AAA batteries; rechargeable NiMH or Lithium ion batteries are recommended by some manufacturers for some equipment.

General battery tips

- Cheap batteries are false economy in the field.
- Follow the manufacturers' instructions to install and recharge batteries correctly.
- Do not mix batteries. Use the same brand and chemical type. All batteries should be the same age – replace all of them at the same time.
- Do not leave equipment switched on when the batteries are depleted. Remove depleted or damaged batteries. Do not leave them in equipment as they may corrode or leak and cause damage.
- Pay attention to the expiry date on batteries in PLBs and ELTs. Batteries should be replaced before the expiry date. Good batteries in ELTs should provide continuous transmission for 48 hours.
- If you carry battery powered equipment in very cold weather, keep the items close to your body inside several layers of clothing to preserve the charge. Take them out to use briefly and replace them in your clothing as soon as possible.

Battery recharging tips

- Follow the recommendations in the manufacturers' operator manuals for communications and navigational equipment regarding rechargeable batteries and rechargers. Match the charger with the battery. Some batteries should be almost, but not totally depleted before recharging.
- Charge batteries at room temperature whenever possible – not at temperatures below 0°C or above 40°C.

Battery storage tips

- Store batteries in cool, dry, well ventilated areas. Keep them away from any heat source, including direct sunlight.
- Never store batteries with flammable or explosive materials or with food.
- Store batteries of like chemistry together – not mixed with other types of batteries.

Safe battery disposal

- Follow the jurisdictional regulations for safe battery disposal.
- Comply with AHJs regarding recycling lead acid batteries (vehicles, ATVs, snowmobiles and boats).

- Nickel cadmium and lead acetate batteries can contaminate the environment and cause health problems. Make every effort to recycle or dispose of all batteries according to regulations.
- Do not throw batteries into a fire as they may explode, injure people and contaminate the environment.
- Additional information is available at the following websites:

Electrical safety:

- http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/electricity.pdf
- http://www.csao.org/UploadFiles/Safety_Manual/Hazards/Electricity.pdf
- http://www.ccohs.ca/oshanswers/safety_haz/electrical.html

Lockout:

- http://www.csao.org/UploadFiles/Safety_Manual/Hazards/Lock_and_Tag.pdf
- http://www.csao.org/UploadFiles/Safety_Talks/Lockout_Tagging.pdf
- http://www.iapa.ca/pdf/lockout.pdf
- http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/lockout.pdf

Batteries:

- http://www.ccohs.ca/oshanswers/safety_haz/garages/batteries.html
- http://www.ccohs.ca/oshanswers/safety_haz/battery-charging.html
- http://www1.servicecanada.gc.ca/eng/labour/fire_protection/policies_standards/guidelines/safe_storage.shtml

PDAC 18.5 First Aid

As a part of due diligence and compliance with AHJs, exploration companies are required to provide an adequate level of first aid resources in camps, including first aid staff, equipment and supplies. Injuries and illnesses usually happen suddenly and often they are unexpected. Because medical aid may be many hours away, the presence of well trained personnel and adequate first aid resources are essential. First aid providers should have the appropriate required level of training.

PDAC 18.5.1 Emergency First Aid Planning and Preparation

Regulations in the province, territory or state set out minimum requirements for the number of first aid providers, the size of treatment facility, and the quantity of first aid equipment and supplies.

- The requirements are determined by the size of camp and the degree of remoteness – the travel time required to obtain medical treatment. Compliance with AHJs is essential.
- Regulatory requirements for first aid provision may be found in jurisdictional Mines Acts and Regulations, jurisdictional Workers Compensation Board regulations, and possibly the regulations of the Ministries of Health and/or Labour etc.

- A designated first aid area is required. Sick quarters may be required for large camps.
- Large or advanced exploration sites should consider hiring a nurse or a paramedic.
- Camps should be equipped with an appropriate first aid and wilderness first aid texts. It may be advisable to stock references that address special circumstances such as hypothermia, cold water immersion hypothermia, and high altitude.
- Responsibilities of first aid attendants with advanced first aid qualifications:
  - Obtain a medical information sheet from each employee that provides the attendant with current and past medical information. It is understood that many jurisdictions have privacy regulations relating to medical matters. It may be advisable for a company to consult a lawyer on how this issue should be handled.
  - Complete a first aid record form for all injuries brought to the attention of the attendant. Any condition serious enough to impair a worker's ability to do his or her job should be referred to a first aid attendant for evaluation and the potential need for treatment in a medical facility. Employees should have minor cuts and injuries checked as they may develop into serious problems if ignored. Companies must retain first aid records on file for three year or as required by AHJs.
  - Complete a medical assessment form when transferring an employee for medical aid.
  - Maintain a complete first aid kit and document each use, which is a legal requirement in most jurisdictions. Carry out a monthly inventory of supplies and replenish the supplies after use so there is no shortage. Keep the first aid area clean and organized,

First aid preparations for camps should include the following potential events.

- Common illnesses and disorders should be addressed as appropriate with isolation, disinfecting the area, and monitoring the health of the patient.
- Common disorders include: colds, flu and other viruses, athlete's foot, fungus (ringworm), and scabies.
- Initial treatment for life-threatening illnesses such as malaria, as appropriate
- Treatment for burns, scalds and sunburn
- Abrasion, sprains and broken bones caused by slips, trips and falls or transportation accidents
- Serious cuts and lacerations from chainsaws, axes or other cutting tools
- Specific injuries or illnesses due terrain or climate, as appropriate:
  - Hypothermia, frostbite, cold water immersion hypothermia
  - Hyperthermia or heat exhaustion, heat stroke
  - Dehydration
  - Tick bites, spider and scorpion bites
  - Acute mountain sickness, which may require oxygen therapy
  - Animal attack and accidental exposure to bear spray

Post a notice with first aid contact information at central locations and at each communication station:

- Name(s) of first aid attendant and work location on site
- Telephone number, radio frequency or sat phone number to reach the first aid attendant from any location at any time
- Operating instructions for both radio and sat phone
- Contact number(s) for the nearest medical treatment centre and transportation providers (helicopter, fixed wing etc.).
- The times required to reach the medical centre by each and every available means of transportation

PDAC 18.5.2 First Aid Kits and Supplies

First aid kits are required to meet the specifications of the AHJs. First aid supplies and medications should reflect the anticipated injuries or illnesses, including those due environmental conditions and diseases common in the area as determined from risk assessments.

- First aid kits should contain sufficient supplies for the size and location of the camp.
- Include blankets, spine board, a basket stretcher(s) that fits in a truck or helicopter, as well as the appropriate quantity of oxygen, which is dependent on the time required to reach a medical treatment centre.
- Maintain kits so they are well stocked, clean and sterile and the contents are not expired.
- At remote sites, it may be necessary to stock medications that can be administered by people with advanced first aid training under the specific direction of a doctor by radio or satellite telephone. For example, the Royal Flying Doctor Service is available in Australia and different services are available for other parts of the world.
- A suitable first aid kit should be present in every truck, ATV, snowmobile, boat, drill rig, as well as in heavy equipment.
- Traversing employees should carry an adequate first aid kit at all times.
- Consider potential first aid requirements for specific locations or activities and stock appropriate first aid equipment.
  - High altitude camps require oxygen and equipment to treat various forms of acute mountain sickness.
  - Heat exhaustion and/or heat stroke in very hot climates
  - When working on ice, be prepared to treat hypothermia, frostbite and cold water immersion hypothermia. Hypothermia kits should be available (i.e., in snowmobiles, vehicles, at drill sites).
  - Be prepared for serious cuts and injuries where there is work with chainsaws, heavy equipment and vehicles including ATVs and snowmobiles.

PDAC 18.5.3 First Aid Training

It should be the goal of every exploration company that all employees, including temporary field employees and office staff, are certified in standard first aid and cardio pulmonary resuscitation (CPR). Up-to-date first aid and CPR certification should be mandatory for all permanent and long term exploration employees. People with first aid training are more likely to assist in a valuable way during an emergency.

- Only the 16-hour first aid training that includes the transportation endorsement is acceptable by all jurisdictional Workers' Compensation Boards across Canada.
- In addition to standard first aid, wilderness first aid training is strongly advised for employees who work in remote locations, although there is no standardized certification for the courses.
- Advanced first aid training is highly advisable for people who spend long periods of time in the field and may be required for people in charge of camps. Advanced first aid certification requires a minimum 70 hour first aid course that includes transportation and oxygen therapy (i.e., Industrial First Aid, Level 3 First Aid, or Advanced First Aid)
- CPR refresher training should be taken annually. Standard first aid requires recertification every three years. Advanced first aid training requires recertification every two years.
- Consider bringing a first aid trainer into large camps to train as many employees as possible.
- It is advisable to consider reimbursing summer students and short term employees for the cost of their first aid training.

PDAC 18.6 Health

In remote areas, it can be challenging to manage exploration camps and provide a healthy life style for employees. This requires keeping camps as clean as possible through careful attention to sanitation despite isolation and climatic conditions. Difficult working conditions may lead to physical stress and fatigue and contribute to employees' susceptibility to illnesses and/or accidents.

Risks and Hazards

- Water-borne diseases caused by contamination at the water source, inadequate water purity testing, improperly maintained water system; the presence of parasites, bacteria, viruses, animal or human waste products, or toxic chemicals in the water system
- Water-borne diseases caused by sewage contamination of ground or surface waters
- Food-borne diseases caused by cross-contamination, spoiled food, food poisoning from food handlers' lack of hygiene, the presence of parasites or bacteria on raw food
- Communicable diseases spread by kitchen workers and camp employees caused by unhygienic practices, lack of immunizations, confined living conditions
- Animal attack or vermin invasion caused by improper food storage, preparation or disposal practices. Attractants result in human habituation and/or food conditioning of animals.
- Poor nutrition caused by inadequate diet, inadequate or inappropriate food supplies Inability to meet project goals caused by lost time from employee illnesses
- Employee burnout caused by fatigue and/or mental stress, which contributes to accidents

PDAC 18.6.1 Employee Hygiene

Exploration employees typically spend weeks or months working long hours while living in exploration camps. Clean water and safe nutritious food are essential for both productivity and morale. Good personal hygiene standards are important so dirt and potential infections from work sites do not contaminate the kitchen and eating areas.

- Handwashing facilities should be located to encourage employees to wash their hands before eating, after using the toilet, and after handling any materials that might cause contamination (e.g., residues from samples containing radioactive minerals or asbestiform minerals). Frequent handwashing reduces the likelihood of contracting contagious diseases.
- Bathing/shower facilities should be used on a regular basis (daily is best).
- Clothes washing facilities should be used frequently to keep work clothes free of grease, grime and dirt. Some sampling areas may require clothes washing facilities so potentially contaminated work clothing remains in that area. Under some circumstances, for example drill camps, it may be necessary to have dedicated washing machines for excessively dirty, greasy clothes.

PDAC 18.6.2 Guidelines for Kitchen Safety, Food Handling and Food Storage

Provide balanced, healthy and nutritional meals for field employees. Food-borne illness can, however, sweep through a camp and disable many people at one time. Therefore, hygienic food preparation and handling procedures and safe food storage are critical to maintaining employee health. The risk of food contamination increases in hot, moist weather conditions, especially in the tropics where bacteria can multiply very rapidly.

- Set up the cooking area separate from the sleeping area. The space between these locations should be open with clear visibility if bears are a risk.
- Restrict food to the kitchen and dining areas; no food should be permitted in sleeping or work areas to control vermin (or bears).
- Set up handwashing facilities so workers can wash before meals. Workers should not wear dirty work clothes and boots in the kitchen and eating areas.
- Projects should have a policy stating that employees must not feed wildlife. Feeding wildlife encourages animals to become human habituated and food conditioned. Some carry life-threatening diseases such as rabies and plague.
- Camps should have an emergency lighting system in the kitchen area in the event of a power failure.

Kitchen staff

Preventing food-borne illnesses starts with selecting competent food handlers. They should be familiar with safe food preparation, storage and cleanup practices.

- Select camp kitchen staff carefully. Whenever possible, hire kitchen staff with food handling certification. In Canada, food handler training is available in every province and territory and a requirement in some provinces.
- Make sure the food handlers have up-to-date immunizations. Prior to employment, food handlers should undergo medical screening for communicable diseases (e.g., TB

and hepatitis), and in some locations they should tested for typhoid, cholera, and/or worms (ova and parasites).

- Handwashing: Make sure that all kitchen staff use proper handwashing techniques with soap and water. Insist that staff practice meticulous personal hygiene before and during food preparation, after touching unsanitized surfaces (including face, nose, hair etc.), handling garbage and after using the toilet. If necessary, train food handlers in required handwashing procedures.
- Consider placing hand sanitizer dispensers at key locations.
- No smoking is permitted while preparing food. Cover skin infections or cuts with waterproof dressings. Kitchen staff should inform their supervisor if they are feeling ill.
- Long hair should be restrained or worn up and out of the way. Do not wear loose clothing, especially loose sleeves that may catch fire or catch on sharp edges.
- Follow safe lifting and manual handling techniques to prevent back injuries and repetitive strain injuries during kitchen work.

Kitchen Operations Safety

- Kitchen fire safety
  - ALWAYS keep an appropriate-sized fire extinguisher(s) in the kitchen mounted in an easily accessible place near an exit. Depending on the kitchen size and set up, consider stocking a Class K fire extinguisher(s) designed for fighting fires in deep fat fryers.
  - If a fire starts on the stove – turn off the heat and cover the pan. Use salt or baking soda on the flames, not water, as it will cause grease to flare and splatter and spread the fire. Use a B or BC type fire extinguisher if one is required.
  - If clothing catches fire, drop to the ground and roll. STOP – DROP – and ROLL.
  - Follow firefighting routines. See section 18.4.2 Fire Safety
- Burn prevention – common injuries for kitchen workers.
  - Always use dry kitchen towels, hot pads or oven mitts when handling hot utensils and pots and pans. Damp items will produce a steam burn on the hands or arms.
  - Do not move pots that contain hot oil. Let them cool in place before moving them.
  - Work cautiously with steaming pots. Lift the lid carefully away from your face. Pour hot liquids carefully.
- Handle kitchen knives properly.
  - Keep knives sharp and use the correct knife for the job.
  - Cut away from yourself and cut food on a cutting board – not in your hand.
  - Store kitchen knives safely – never store them loose in a drawer where grabbing one may result in a severe cut. Do not leave sharp knives in a sink or put them in a dishwasher.
- Follow safe practices when using electric kitchen appliances.
  - Read the manufacturer's operator manual and be familiar with the safe operating procedures. Refer to section 18.4.6. Electrical Safety.
  - Outlets with GFCIs (Ground Fault Circuit Interrupter) are recommended. Do not overload outlets; use power bars.

- Only use electrical cords that are in good condition and that are as short as possible for the job. Have frayed electrical cords repaired or replaced; only certified electricians should make repairs.
- Never unplug electrical cords with wet hands. Always unplug an appliance before cleaning it or clearing a blockage.

Tips for sanitizing kitchen and food preparation surfaces

- Sanitizing solution: Make a dilute bleach solution by putting about 15 ml (1 Tablespoon) of 5% bleach in 4 litres (1 gallon) of water. This produces a bleach solution that works well for sanitizing surfaces and eating utensils. Use this solution in a spray bottle on surfaces after they are washed with hot soapy water. If a washing cloth is kept in the solution for cleaning tables, change the solution at least once a day (more frequently for large facilities). Make a fresh solution often.
- Food preparation areas must be kept meticulously clean. It is essential to wash all food preparation surfaces with hot soapy water before food preparation begins and again before a different food is prepared on the surface to prevent cross-contamination. Rinse with a sanitizing solution.
- Use cleaning products appropriate for the equipment used (i.e., stove, refrigerator). Post appropriate MSDSs nearby.
- Wash hands before and after handling any raw meats or foods that might carry bacteria on the surface such as melons or dirt-laden vegetables.
- Clean plates, utensils and cooking containers after each meal. It is best to use three sinks: one each for washing, rinsing and sanitizing. Water temperature for hand washing dishes should be at least 43°C (110°F) and items should be allowed to air dry. Water temperature should be at least 60°C (140°F) in dishwashers.
- Wipe down the eating surfaces with sanitizing solution after each meal. Wash cloth towels and dishcloths daily in a washing machine (hot cycle).
- Sponges should not be used for cleaning in the kitchen area as they retain bacteria. Clean floors and food storage areas daily.
- Gloves: Wear rubber kitchen gloves when washing dishes to protect hands from hot water and excessive exposure to soap and water. If disposable kitchen food preparation gloves are worn, the wearer must change them as often as he or she would normally wash their hands – whenever there is a chance of cross-contamination and when the hands have touched something unsanitary.

Food Preparation Safety

Tips for food preparation to prevent cross-contamination

Cross contamination is one of the most common causes of food-borne illness and occurs when bacteria from raw food (especially meat and poultry) is spread to other foods.

- Use potable (drinking) water only to wash salad greens, fruits, vegetables and any food that will be consumed raw. It is advisable to wash pre-washed produce. Wash skins of melons before slicing and fruits that will be peeled by knife or by hand to prevent bacteria being carried onto the fruit.

- If possible, use a designated cutting board for meat, poultry and seafood, and a separate board for vegetables and fruits. This way, raw fruits and vegetables will not be accidentally contaminated by raw meats etc. Wash cutting boards with hot soapy water and sanitizing solution after use.
- Keep raw meat, poultry and seafood separate from all other foods. Store them on the bottom shelf of a refrigerator. Then, leaking packages will not drip onto other foods.
- Wash foods in a bowl, not in a water-filled sink. After washing meat, chicken, or fish, always wash the sink as well as the container, as splashed water may contain contaminating bacteria.
- When cooking meats, poultry or seafood on a grill, place the cooked food in a clean container. Discard marinades after raw items are removed.

Critical Food Temperatures – heating, cooling and refrigeration tips

- It is essential to keep prepared food at a safe temperature to prevent the growth of bacteria. This requires that cold foods be kept cold (less than 4°C or 40°F) and hot foods be kept hot (warmer than 60°C or 140°F). Bacteria grow rapidly in the temperature range between 4° to 60°C (40° to 140°F). Food should be heated rapidly and cooled rapidly through this temperature range.
- Food that requires refrigeration should be discarded if it sits for two hours or more between the temperature range of 4° to 60°C (40° to 140°F).
- A large pot of hot food takes a long time to cool through the critical temperature range. To chill cooked food quickly, place it in a shallow pan to expose a large surface area to cooler temperatures and/or place it into a number of smaller containers.
- Store all leftover food in sealed, metal or plastic containers and refrigerate as necessary.
- Label and date the containers.
- Defrost all foods in the refrigerator. Always defrost meat in a refrigerator – not out in the open on a work surface or outside on the barbecue.

Food Storage Tips

- Food handlers should unpack and inspect all food shipments for quality immediately after it arrives. Inspect for quality, freshness, and potential contamination including by vermin. After inspection, store it promptly for maximum safety. Proper storage includes both preservation of food quality by refrigeration and prevention of invasion by nuisance animals and insects. Never store food in sleeping tents.
- Store perishable goods in appropriate places – cupboards, refrigerators or freezers.
- Store heavy and bulky items on lower shelves but not necessarily the lowest shelf. Store foods in containers that are insect proof, rodent proof and bear proof, as required. Label the contents.
- Once frozen goods have thawed, they must not be refrozen. Cook thawed food as soon as possible or discard any food that has been thawed for too long.
- Rotate stored food so that food is used up in the order received. Pay attention to expiry dates and required storage instructions such as “refrigerate after opening”.

- Store food in covered containers or plastic bags in refrigerators to prevent juices from other items dripping onto them. Seal raw meat, poultry and fish and place them on the lowest shelf of a refrigerator so they cannot drip onto other foods.
- Discard food when (1) packaging seals are broken, (2) any tins are rusted, “bloated” or “popped”, (3) it has passed the expiry date and (4) improperly stored food (e.g., without required refrigeration).
- Always keep grease stored in an airtight container; use as soon as possible.
- If a camp will be left unattended during the day, it is very important to prevent bears and other animals from accessing food. Place all food in metal storage drums whenever possible. In addition, strong smelling foods should be carefully sealed in layers of resealable plastic bags. Consider using an item such as a “Critter Gitter”, which is an infrared motion detection device that emits a very loud noise and flashing lights to scare off animals that enter the designated detection area. Place it so the food is in the detection area (refer to section 10.3.6 in Chapter 10).

Kitchens: Animal and Insect Controls

Vermin include rats, mice, cockroaches, bedbugs, flies and other noxious animals or insects. Construct camp buildings to exclude vermin as best possible. Companies should take adequate steps to keep the premises free of vermin and insects by using appropriate fly screens, traps and baits. If mice are a problem where Hantavirus is known to be present, follow the safe cleaning procedures in section 18.6.5.3 Hantaviral Diseases.

Bears: All kitchens or cooking areas must be kept clean, whether they are established or fly camps. Bears have a very keen sense of smell and will seek out and find carelessly stored food and incompletely burned garbage (i.e., attractants).

- Control the smells of food, garbage and waste products to minimize attracting bears. See section 18.6.4 Waste Management Guidelines.
- Prepare only enough food that can be consumed at one meal. Store food in bear proof containers.
- Use non greasy foods whenever possible. Use or incinerate all leftover grease as soon as possible.
- Remove leftover lunch food from daypacks and dispose of it properly each day.
- For fly camps:
  - Suspend food stores (caches) between trees when possible. Food should hang at least 4 m off the ground and at least 100 m from the sleeping tent.
  - Store food in proper bear proof containers. If this is not possible, several layers of very heavy plastic bags may work if they are carefully sealed to be airtight.
- Refer to section 10.3 Bears in Chapter 10 for additional information.
- Additional food safety information is available in section 12.8.3 Safe Food and Water and on the following websites:
  - http://www.fsis.usda.gov/Factsheets/Food_Safety_in_the_Kitchen/index.asp
  - http://www.inspection.gc.ca/english/fssa/concen/cause/salmonellae.shtml
  - http://www.inspection.gc.ca/english/fssa/concen/tipcon/kitchene.shtml
  - http://www.ccohs.ca/oshanswers/diseases/washing_hands.html

PDAC 18.6.3 Drinking Water Safety

The primary risks associated with drinking water are disease-bearing organisms, turbidity and the presence of toxic chemicals or sewage that may contaminate drinking water. These are worldwide issues, and water in any locality and in any climate or terrain may be affected by one or more of these factors. For information about location, supply and storage of potable (drinking) water, refer to Section 9.0 Water Use and Conservation in the e3 Plus Excellence in Environmental Stewardship Toolkit. Website: http://www.pdac.ca/e3plus

General Requirements for Drinking Water

Depending on the degree of risks and water treatment requirements, it may be advisable to seek expert advice to develop a treatment system for drinking water. It is essential to eliminate any disease-causing organisms, solids and any toxic chemicals from drinking water.

- Determine the quantity of drinking water required for the camp. Consider the factors: (1) whether the camp is temporary or permanent, (2) number of employees, (3) the season,
- (4) the exploration activities (e.g., drilling, mineral/rock cutting, sorting) and (5) existing and future requirements (showers, dishwashers, clothes washers) of the camp or project.
- Obtain the required permits, which will depend on the jurisdiction.
- Follow prescribed treatment procedures to make sure the water supply is safe to drink.
- Where camps are not subject to water quality regulations, water should meet WHO drinking water guidelines or better. Refer to the following website: http://www.who.int/water_sanitation_health/dwq/gdwq3rev/en/index.html
- Install an approved water treatment and purification system. Various types of water treatment/purification systems are commercially available. Some systems employ filtration, chlorination, reverse osmosis, or ultra violet technology or a combination of these. UV systems are commonly used in camps. Consult an expert on the most appropriate type of system for a specific site, as necessary.
- Take monthly (or more frequent) water samples for analysis to confirm that water meets drinking water standards.
  - Operate and maintain the water treatment system according to the manufacturer’s instructions.
  - Change any filters and check the UV lights, as appropriate, to make sure they are functioning and that the light is not blocked by stains or dirt etc. Replace the UV bulbs if the light is blocked.
- As a general rule, drinking water should be treated with 0.4-0.5 mg sodium hypochlorite/litre water although the precise amount of sodium hypochlorite required to disinfect drinking water is dependent on the water chemistry (pH), temperature, contact time, and amount of sediment in the water being treated. Chlorine disinfection of drinking water has limitations against the protozoan pathogens – in particular Cryptosporidium. Refer to the following website: http://www.cdc.gov/crypto/factsheets/filters.html

- Bleach: Bleach is used for sanitizing purposes in kitchens. In an emergency it can also be used to purify drinking water or for part of that process. Refer to Chapter 12, section 12.8.3.3 Water Treatment in Remote Areas or Developing Countries.

Tips regarding water sources at established camps

- Procedures to sanitize a water storage tank: When reopening a site, the water tank must be sanitized before the water is potable.
  - Clean the water storage tank and then fill the tank with water. Treat the volume of water in the tank with the appropriate quantity of sodium hypochlorite (bleach). Run the taps until the water smells of bleach. Let the water stand in the lines and the tank for at least 24 hours to kill any residual bacteria. While this water may be used for showering, it should not be used for cooking or drinking for at least 24 hours. The water should immediately be sent for testing to confirm it is safe to drink. Use precautions when drinking, cooking or brushing teeth with this water until the test results confirm the water is safe to drink.
- Components of water treatment systems: At the start of a field season, place new water filters and new ultra violet (UV) lights in the treatment system, if applicable. If the site operates year round, inspect and maintain components on a regular schedule.
- Water shipped by tanker trucks: If large volumes of potable water are transported to the site in water tankers, chlorine should be added to provide a free residual chlorine concentration of at least 0.5 mg/litre at the point of delivery to users. Tankers should be used solely for drinking water or, if this is not possible, must be thoroughly cleaned prior to use to be sure that there is no residual contamination.
- System shut down: When the water system is shut down, the water tank must be completely drained. It will be necessary to use a sump pump to empty out all the water. It is very important to remove all sand and sediment so there is no place for bacteria to grow when the tank is not in use. It is advisable to make sure there are filters and UV lights available for start up at the next field season.
- Schistosomiasis: If schistosomiasis is endemic in the area, take extra care with treatment of drinking and bathing water. Refer to 12.8.3.4 Safe Water for Swimming and Bathing and 12.8.5.13 Schistosomiasis.
- Additional information is available on the following websites:
  - http://wwwnc.cdc.gov/travel/yellowbook/2010/chapter-2/water-disinfection.aspx#Drinking
  - http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/outdoor-plein_air-eng.php
  - http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum_guide-res_recom/index-eng.php
  - http://www.epa.gov/OGWDW/faq/emerg.html
  - http://www.epa.gov/OGWDW/standards.html

PDAC 18.6.4 Waste Management

Proper waste management is fundamental to camp safety. Project management should determine how waste products are ultimately handled – whether they are recycled or subject to various treatment and disposal options. Depending on the regulations, it may be advisable to seek expert advice to develop a waste management program. It is essential to eliminate potential camp sewage discharge or spills that may contaminate surface and ground water, eliminate potential disease-causing organisms and smells from accumulations of waste deposits that attract wildlife, including vermin.

Waste management is addressed in the e3 Plus Excellence in Environmental Stewardship Toolkit. Refer to Chapter 12.0 Waste Management for details regarding waste identification, classification, management, camp sewage and wastewater and hazardous wastes. Website: http://www.pdac.ca/e3plus

General tips regarding waste management

- Secure required permits and follow all applicable regulations of the AHJs regarding waste classification, management and disposal, including for any hazardous waste products that may be produced at the site.
- Recycle as much waste as possible and consider donating safe materials that might otherwise be disposed of as waste for public use, especially when a camp is in a developing country.
- Waste storage areas:
  - All waste storage areas should have restricted access to limit entry by employees, the public and animals.
  - Comply with regulations for management of dangerous waste products. Store them in appropriate labelled containers in a secure area until they are removed from the site for recycling or disposal. Comply with regulations such as TGD (transportation of dangerous goods) or hazardous materials.
  - Provide fly-tight garbage containers in convenient locations. Maintain containers so they do not become foul smelling, unsightly or breeding place for flies.
- In bear country, waste odours may attract bears creating a hazard for people, for company property and for the bears.
  - Wash all bottles to eliminate odours and recycle if possible.
  - Recycling cans: Recycling cans is the best solution but storing soda pop cans for recycling is not advisable in bear country as their smell is a strong attractant. It is better to squash them … burn them …and then recycle or dispose of them according to local regulations.
  - Tetra pak drink boxes create a lot of garbage that attracts bears. Find an alternative.

Incineration Versus Burning

It is important to dispose of food waste daily. Incineration is usually best completed at least once a day, as required. If burning and/or incineration are options, understand the difference between the two processes.

- Incinerators: When burning waste is permissible, most regions require the use of an incinerator rather than a burn barrel. Use a properly designed auxiliary fuel-fired commercial refuse incinerator that complies with local regulations.
- Burn barrels: A burn barrel is usually an oil drum punched full of holes to allow some extra airflow to create a hot fire. A burn barrel may be acceptable for a very small, temporary or fly camp, but this method requires a lot of attention and fuel to thoroughly

burn garbage. Burn barrels require the use a slow burning fuel, such as diesel, combined with lots of air to create a hot incinerating fire. Quick burning fuels do not burn garbage thoroughly; they scorch the garbage and spread the smells. The top of any burn barrel must be covered with a wire mesh lid to prevent sparks from starting a forest fire and stop animals and the wind from removing garbage. Check local regulations to make sure that using a burn barrel will be in compliance for any camp.

- Waste disposal facilities must conform to the site permits. Remove waste to an approved landfill location or incinerate it completely. Where permitted, locate the incineration area 100-200 metres from camp. In open areas it is advisable for the burning site to be visible from camp in order to monitor it. Clear away vegetation within 3 metres of the incinerator and have a fire extinguisher in place. All incinerators should have a wire mesh lid to stop garbage from being removed by animals and winds.
  - Incinerate waste daily, preferably after each meal, but do not burn it in the evening when lingering smells might attract bears while people sleep.
  - Where permitted, incinerate all waste completely to ash and cool it. If waste is not completely burned to ash, store the residue in airtight containers in an appropriate area protected from animals. Remove it to a proper disposal site.
  - Landfills: Burying refuse is not usually permitted except for combustion residue (ash) from incinerators. It may be possible to obtain a landfill permit for remote camps where transportation to a municipal landfill is impractical. Usually, waste residues should be stored in animal-proof containers and hauled together with non-food waste to a municipal landfill.
- The potential for attracting bears is a serious risk due to smells when a fire smoulders or contains insufficiently burned garbage.
- All burning or incineration must be continuously monitored. Keep a 20-lb fire extinguisher immediately available.

Wastewater and Sewage

Treat wastewater and sewage according to regulations of the AHJs and the camp permits. Large camps will require a properly designed and approved sewage disposal system such as a septic tank and a subsurface leach field. Expert advice may be required, especially where septic tanks and leach fields will not work. Commercially available wastewater treatment packages are viable alternatives.

- Grey water: The wastewater left over from dishwashing, showers and washing machines should be carefully treated to remove odours. Where regulations permit, use dolomite or lime in sumps in preference to a water/bleach solution. Do not allow grease or fine food particles to accumulate in sumps; use grease traps to recover the waste and then incinerate it. Cover sumps with plywood to minimize access and odours. It is recommended to fence in large sumps (required in some jurisdictions).
  - Large permanent camps should treat grey water with approved sewage treatment systems.
  - In small camps with no grey water disposal system, strain food bits out of dishwater. Place them with garbage and pour dishwater into a proper location and treat it with dolomite or lime to remove odours.

- Camp sewage: Treat and maintain camp sewage as appropriate for the site and size of camp. Incinerators or composting toilets are possible alternatives that could be considered for small to medium sized camps. A proper sewage and/or latrine system is necessary to control potential water contamination, odours and diseases. Construct and maintain latrines (when permitted) where chemical or water flush or other types of toilets are not used.
  - Construct and maintain all camp sewage toilets correctly.
    - Prevent flies, insects, and rats from gaining access to waste materials.
    - Prevent surface or ground water from entering the pit or vault.
    - Prevent waste material in the privy from contaminating any water supply.
    - Self closing seat covers are advisable and should be in operation at all times.
  - If latrines are permitted, latrines must conform to public health standards or to any conditions stipulated in work permits. Locate a latrine at least 100 m (300 ft) from any stream or shoreline. It should be downwind from camp and at least 30 to 40 metres away from the kitchen area. Locate handwashing facilities between the latrine and camp to promote hygiene. A good place is at the beginning of the access path to the latrine.
  - A plan for a latrine: Dig a hole about 1.5 m square and about 1.5 m deep. Cover the hole with wooden planks leaving a hole for personal use. Place the latrine shelter on top of the hole. Cover the opening when not in use to reduce flies and the possibility of small animals falling in. Keep a container of lime with a designated ladle to disinfect the latrine. Place lime and dirt in the pit daily. Peat moss may work if there is not too much urine. When the latrine is no longer required, fill the hole with the excavated soil. Keep the path to the latrine clear so it can be used safely at night.
  - Use dolomite lime and earth regularly in latrines. Burn all tampons and sanitary napkins in a very hot fire.

PDAC 18.8 Housekeeping

Good housekeeping is an important element of camp safety, as a dirty, messy site impacts employee work attitude as well as safety. Good housekeeping prevents injuries and illnesses, especially those due to:

- Trips, slips and falls
- Fires
- Inadequate storage, handling and labelling of hazardous materials
- Poor sanitation e.g., athlete's foot, scabies, food poisoning, vermin infestation

Aspects of good housekeeping:

- Address housekeeping requirements and expectations at the safety induction meeting at the start of the field season. Review them at safety meetings as required.
- Comply with requirements of the AHJs for storage and handling systems for hazardous material, fuels, compressed gas cylinders, explosives and firearms etc.

- Carry out inspections to make sure the site is orderly. Document inspections.
- Dispose of rubbish and other wastes daily according to requirements of AHJs.
- Keep storage areas free of debris, vegetation and rubbish to prevent fires and tripping hazards.
- Keep walkways and paths well lit, especially at night and apply sand or other material to create non-slip surfaces when mud, snow or ice are hazards.
- Keep flammable materials – including wet clothing – away from heat sources such as heating stoves, radiators and heating ducts, lights and electrical wiring.
- Keep the area around electrical panel and junction boxes clear.
- Place “No Smoking” and relevant hazard signs where flammable materials are stored. Use tarpaulins to protect materials that may be damaged by weather or sunlight.
- Keep gear organized and in appropriate storage areas.
  - Tools and power tools, cords
  - Communications equipment, batteries, radio antennas
  - Allocate an area in tents or cabins to dry wet clothing where they will not become a fire or a tripping hazard. Never permit wet items to hang from electrical power cords or near heat sources where they may fall and start a fire. Keep wet items on the floor at least 1 metre back from heat sources.
- For additional information, refer to sections 6.2 Housekeeping and 6.3 Housekeeping and Hazardous Materials in the e3Plus Excellence in Environmental Stewardship Toolkit.
  - Website: http://www.pdac.ca/e3plus

PDAC 19.0 Communications

Introduction

Regular communications play an extremely important role in safe and effective exploration work. Good communication promotes safe work, builds morale, and encourages the efficient use of time, equipment and personnel. Established and tested communications routines are essential during emergency situations. The term “communication” covers all contacts between offices, projects, base camps, fly camps, fixed wing aircraft, helicopters, crews on traverses, parties travelling in vehicles (including all-terrain vehicles and snowmobiles) and boats. Company communications routines should also include check-in systems for personnel who are working out of a hotel etc., and for those travelling outside their home country.

Because no single communications system or check-in schedule will suffice, it is usually the responsibility of each project manager to develop and maintain standard operating procedures (SOPs) for routine and emergency communications. Each project or camp manager should assess the requirements of their work site(s) and take into account such factors as isolation, terrain, time of year, weather, means of transportation and other pertinent risks.

Acronyms

BGAN – Broadband Global Area Network

Cospas-Sarsat – "Cospas" is the Russian transliteration meaning "space system for the detection of vessels in distress" – Search And Rescue Satellite Aided Tracking

ELT – Emergency Locator Transmitter

EPIRB – Emergency Position Indicating Radio Beacon

ERP – Emergency Response Plan

GPS – Global Positioning System

HF – High Frequency

LEO – Low Earth Orbit

OHS – Occupational Health and Safety

PLB – Personal Locator Beacon

RCMP – Royal Canadian Mounted Police

SAR – Search And Rescue

SOP – Safe Operating Procedure

SSB – Single Side Band

UHF – Ultra High Frequency

UTM – Universal Transverse Mercator

VOIP – Voice Over Internet Protocol

VHF – Very High Frequency

PDAC 19.1 Risks and Hazards

Lack of preparation and knowledge regarding communication equipment and procedures can have serious consequences. Risks and Hazards include:

- Inability to communicate during normal daily operations due to:
  - Loss of battery power
  - Poorly trained employees
  - Inappropriate communication equipment for the region (e.g., Arctic) or the terrain (e.g., mountainous)
  - Service plan lapses
  - Incompatible radio frequencies, wrong radio antenna
  - Lack of repeaters
  - Dropped mobile/cell phone calls
  - Equipment breakage due to poor quality equipment
- Lack of or inadequate communications during emergency situations due to:
  - Poorly trained employees
  - Missing instructions to operate the satellite telephone
  - Equipment malfunctions

- Delay in implementing emergency response plans due to:
  - Lack of emergency response planning regarding communications within the company or between the company and contractors
  - Wrong or inadequate equipment (communications, first aid, transportation)
  - Lack of training
  - ELT failure in the event of an air crash
- Stranding and/or missed transportation pick up due to:
  - Loss of battery power
  - Poor quality equipment
  - Wrong communication equipment
- Miscommunications leading to:
  - Slinging incidents
  - Stranding
- Lack of response to emergency EPIRB or ELT alarm due to:
  - Out-of-date EPIRB or ELT equipment
  - Lack of training to manually turn on emergency equipment

PDAC 19.3 Equipment Selection

Proper planning and selection of communication equipment is essential. Some countries restrict the importation of communication equipment and parts so take this into account during the selection process.

PDAC 19.3.1 Equipment Considerations

Select communication equipment that meets the requirements of the project size, location and situation.

- Local knowledge may be the best source of information to determine the most appropriate equipment to use, especially when starting a project in a new area. Other sources of information include equipment and communications service suppliers, government agencies, charter aircraft and expediting service companies, and the RCMP or local search and rescue organizations.
- Carry out a cost benefit analysis of various types of equipment that takes employee safety into account; do a cost benefit analysis of purchasing versus renting equipment. Carefully analyse the cost of the service plans; some plans are complicated and an administrative error can leave employees without communication.

Consider the following factors that affect communications. They include but are not limited to:

- Isolation
- Terrain
- Latitude
- Transmission distance requirements
- General and specific atmospheric conditions in the project area Means of transportation (aircraft, vehicles, boats)

- Local risks (e.g., weather, working on ice, presence of dust/sand)
- Requirements for a communications system in a fixed location (camp, drill site, mine site) and/or a mobile system (on a person, vehicle, boat etc.)

Assess what the communication equipment will be used for. Determine which types of equipment are required for communications between various parties:

- Project and head office, world contacts Project and expediter
- Project and aviation services
- Project on site and off site work locations (e.g., drill sites) Project and transportation (vehicles, aircraft, boats)
- Ground personnel and helicopter for pick up and during slinging operations Members of the same or different work parties (traversing, on or off site)
- Traversing personnel and air support or ground vehicles
- Project on site and off site employees and emergency support (e.g., medevac, first aid, security, fire)

Consider the following factors:

- Backup communications system requirements in case the main system fails. Consider which is better, a duplicate system or different systems that compliment each other.
- Equipment performance in very cold weather, very rainy weather, dusty conditions Equipment performance in very rugged terrain
- Privacy of conversations – essential or not Importing and licensing restrictions
- Potential maintenance issues – durability, life expectancy of equipment, availability of replacement parts

Consider if the project requires:

- Bandwidth for internet access Fax capabilities
- Satellite dish (depends on phone/data system) Wireless router
- Employee internet access and personal communications
- Two stations – one for company use and one for general use
- VOIP (Voice Over Internet Protocol), Skype (a software that allows users to make telephone calls over the internet at low cost)

PDAC 19.3.2 Satellite Telephones

Satellite telephone equipment is reliable. It is usually the preferred equipment to use at remote sites. They range in size from stationary units to handheld units. Satellite telephones transmit to orbiting satellites rather than to terrestrial mobile phone systems (some use both). The coverage depends on the satellite orbit configuration – geosynchronous or Low Earth Orbit (LEO).

Geosynchronous satellites are stationary relative to the earth surface; consequently high topography, buildings or trees may interfere with direct transmission. One may have to move to a higher or unobstructed location to secure reception. LEO satellites provide continuous access as they orbit the earth. If you cannot make contact, wait a while and another satellite will come into range. However, LEO satellite coverage in the high Arctic or Antarctica is lacking because LEO satellites do not orbit in these regions.

Technology changes rapidly and costs are generally decreasing, but stationary and portable satellite telephones can be expensive to operate. As suggested in sections 19.2 and 19.3.1, a company should carry out a risk assessment and a cost benefit analysis to determine the most suitable communication equipment for a project, and this is particularly true regarding satellite telephones. It can be dangerous if communications do not work as this will jeopardize employee safety. It is not advisable to cut costs and be dependent on a communication system with inadequate coverage (the saying “penny wise and pound foolish” may apply). It may be advisable to check with knowledgeable local sources to help determine the requirements.

- Satellite telephones can be portable but some systems require a 12-volt battery or a generator for power.
- Satphones usually provide private conversations but they can be intercepted.
- Satellite internet in conjunction with VOIP can be an economical option for voice communication. However, it is only as reliable as the internet connection in use and there are often significant delays. This technology is evolving rapidly.

Safety Regarding Satellite Telephones:

- Everyone needs training if satellite phones are used at a project. Depending on the type and model, there may be difficulties if the users are not well trained in the required operation procedures (e.g., switching on the phone, dialling). In addition, the project manager should be very familiar with the service plan or service may suddenly be interrupted. Satellite phones should be compatible with other satphones used at the project and by the company at other projects.
- User instructions should (1) be posted at the central location with a stationary satphone and (2) accompany every portable satellite phone at all times.
- Emergency situations are not the time to learn to use a satellite phone. Every person who may possibly be in the position to use a satphone in an emergency should be trained to use them.
- Keep satellite phones in a waterproof and shockproof case.
- Charge satellite phones each night or at the manufacturer’s specified interval while in regular use and test them routinely when they are not in use.
- For best transmission, set up the portable equipment in a location with wide access to the sky, as you will not know the precise location of the satellite that picks up and transmits a call. A hilltop location will provide better transmission than a clearing in a forest of tall trees, a ravine or a valley.
- At high latitudes satellite dishes should face toward the equator to increase reception; usually the orientation is specified by the service provider.
- When using a satellite communications system, locate the satellite dish so people do not come within 3.5 metres during transmission. The presence of a person or object in front of a dish may block the transmission.

Safety Regarding Satellite Dishes:

- While a properly installed satellite dish is grounded, everyone should stay away from the dish during a thunderstorm. The base is metal and may attract lightning, depending on the location.
- No one should stand in front of the antenna; satellite dishes emit radio waves.

- Protect satellite communication dishes (phones, internet) from impact by ATVs and snowmobiles etc. Collisions may damage the dish and/or affect the orientation, which can interrupt communications.

Types of Satellite Telephones

- Iridium satellite telephones “Iridiums” use LEO technology, are portable, and provide dependable voice and data communications service worldwide. In 2009, Iridiums are the best handheld option for the Arctic. There is 99% availability so the phone system can be relied upon for emergency use. http://www.iridium.com/
- MSAT (geosynchronous) has reliable satellite telephones and internet coverage for most of North America, Central America and some of South America. There is 99% availability so the phone system can be relied upon for emergency use. http://www.skyterra.com/index.cfm
- Globalstar (LEO) satellite phones and handheld are also portable but have less coverage than Iridium (in 2009) and at the time of publication they lack sufficient satellite coverage in the high Arctic. The voice service is intermittent with periods of one hour or greater when there is no service. It should not be depended upon for emergency use. http://www.globalstar.ca/en/
- BGAN (Broadband Global Area Network) offers internet access and voice communications from a portable mobile device through Inmarsat (geosynchronous). At the time of publication the cost is very high but it offers great flexibility. http://www.inmarsat.com/Services/Land/BGAN/default.aspx
- Rentals can be arranged through numerous communications companies.

PDAC 19.3.3 Two-Way Radios

- The use of radio equipment in mineral exploration has changed with the introduction and development of satellite telephone technology. Presently two-way radios are mostly used for communications between (1) aircraft and ground personnel, (2) employees at project work sites and the communications base, and (3) employees on traverse. As traverse routes usually take field crews out of radio range (if there are no repeaters), it may be necessary to rely on handheld satellite phones to contact the project communications base. Check with knowledgeable sources to help determine the requirements for a project.

Tips Regarding Two-Way Radios

- Make certain there are sufficient numbers of two-way radios (including batteries and rechargers) and other portable equipment for all operations. Allow for loss and breakage. In very remote areas, be sure to take enough equipment to include supplies for emergency caches.
- Professional quality radios are required for work in very cold temperatures.
- Some two-way radios include a GPS unit. It is strongly recommended that any person working alone be equipped with a combination GPS/radio unit. A person can be located immediately when they engage the radio “send” button.
- Digital technology is replacing analog technology, but consider if analog radio equipment will suffice or if the project requires digital equipment.

- Verify that you have the proper radio setup to communicate with aircraft, if applicable. Repeater stations can be installed to increase the range.
- In some locations two-way radios (walkie-talkies) that can accommodate several types of antennas are more versatile.
- Frequencies:
  - The length of dipole antennas should match the frequencies the radio uses.
  - Check that the project uses radios with the same frequencies as the contractor's radios. Program the frequencies into each radio – base station and handhelds.
  - Predetermine which frequency to use for ground personnel to communicate with an aircraft pilot (e.g., traverse support, slinging). This may vary with individual aircraft.
  - Radio frequencies used should allow communications with outside camps and other contacts. In some areas there may be a common frequency used by industry over which help can be readily obtained.
- Antennas should be set up at the appropriate height and face the proper direction. Try to place the antenna as high as possible and set it up at 90 degrees to the target location. The higher the antenna, the better the transmission and reception.
- Carry and know how to set up an emergency antenna and how to repair a broken one.
- All dipole antennas should be flagged so they are visible. Antennas can get caught in helicopter rotors and may even decapitate an ATV or snowmobile rider who is unaware of its location.

Types of Radio Transmissions

- Two-way radio systems normally use Very High Frequency (VHF) or Ultra High Frequency (UHF). Both transmit by "line-of-sight". Under ideal conditions VHF transmits farther than UHF. The transmission of both VHF and UHF are affected by rugged or mountainous terrain and vegetation cover.
- UHF is less susceptible to interference than VHF systems.
- Repeaters are required to increase transmission distance in mountainous and rugged terrain.
- Sometimes VHF/UHF antennas can be placed in an elevated position (hilltop or above foliage) to increase transmission distance.
- Factors to consider regarding High Frequency (HF) include:
  - HF systems will transmit over much longer distances than VHF/UHF systems but communications may be adversely affected by interference, especially from electronic devices. Transmission and reception quality may vary greatly depending on factors such as diurnal or seasonal atmospheric conditions, solar activity and the aurora borealis.
  - An HF system requires a large antenna, which should be placed where it will not interfere with aircraft flight paths. Flag antennas and make sure they are visible from the air and by ground vehicles.
  - HF radios are being superseded by satellite phones.

PDAC 19.3.4 Mobile or Cellular Telephones

- Mobile or cellular telephones only function near civilization or where there are repeaters. Mobile/cell phones may not be compatible with systems operating in different parts of a country. Therefore, they are of limited use in many field areas. When considering mobile phones, test them to be sure there is adequate coverage of the field area. Reception is usually better on a hilltop.
- Small mobile/cell phones have limited power and range. More powerful 3-watt models should be installed in vehicles to increase the communication range where coverage is adequate.
- Calls may be cut off or "dropped" for no apparent reason even in urban areas. In addition, mobile/cell phone communications are not private.
- Some mobile/cell phones have two-way radio options, which may be useful on some job sites. Some mobile/cell phones are equipped with a GPS feature, which is an additional safety factor.
- When travelling outside North America it may be advisable to rent a mobile/cell phone (or satphone) for use in a specific country. Information is available at the following website: http://www.roadpost.ca/sitemap.aspx

Follow these guidelines for the safe use of mobile phones in hazardous site locations.

- Radio frequency (RF) energy is potentially hazardous near combustible or explosive materials, especially at sites where blasting occurs. Mobile/cell phones must be completely switched off, as incoming calls and automatic processes in this type of phone may still activate the phone's transmitter even if you are not making a call.
- Do not operate a mobile phone in an aircraft under any normal circumstances, as the phone may interfere with aircraft navigation/communications and/or electronic control systems. The phone must be completely switched off.

PDAC 19.3.5 Emergency Locator Devices (ELTs, PLBs, EPIRBs)

Various emergency distress radio beacons are available designed for use with the Cospas-Sarsat international search and rescue satellite system. If an emergency locator device is activated, it transmits on 406 MHz, the frequency of the receiving Cospas-Sarsat satellite system, and initiates search and rescue procedures. Information regarding how the system works is available on the following website: http://www.sarsat.noaa.gov

Three types of emergency beacons are currently in use with the Cospas-Sarsat system.

- Personal Locator Beacons (PLBs) for individual use
- Emergency Position Indicating Radio Beacons (EPIRBs) for maritime use Emergency Locator Transmitters (ELTs) for aircraft

Personal Locator Beacons (PLBs)

A Personal Locator Beacon, a device containing a small radio frequency transmitter and a GPS unit, is designed to be carried by an individual in remote areas away from normal emergency response services. PLBs are intended for emergency use, not as navigational tools. They may be purchased or rented.

- In very remote areas it may be advisable to equip employees with PLBs that tie in with the Cospas-Sarsat system. When a project uses them, a protocol system must be set up to avoid launching a full scale search when a charter aircraft can reach the person in distress. Make sure employees know how to cancel a false alarm or the company may be required to pay a large false alarm charge.
- A PLB must only be activated in a distress emergency situation where there is serious danger to human life and only in areas where cell phone coverage or other communications methods such as two-way radios or satphones are not available. Employees should have other means of notifying their project or camp of an emergency situation.
- 406 MHz PLB units provide global coverage but they need to be coded for the specific country where they will be used. If you plan to use the PLB in another country, take it to an authorized dealer to be re-coded for that country. PLBs must be registered with the appropriate authorities in the country of intended use. In Canada, a PLB can be registered directly with Cospas-Sarsat or online at:
  - http://beacons.nss.gc.ca/
  - https://www.406registration.com/
- Note: Older analogue PLB units that operate exclusively on the 121.5 MHz frequency should not be used. As of February 1, 2009, the Cospas-Sarsat system only processes signals from the newer 406 MHz emergency beacons.
- Anyone using a PLB should be familiar with the operator’s manual. Use the correct batteries and make sure they are fully charged before departing on a long trip. Replace batteries according to the manufacturer’s directions.
- The “SPOT”: The “Spot Satellite Messenger” is a type of PLB that can send messages using the Globalsat network. A “check in” message can be sent to a designated receiver (office, family) and an emergency message – a “911” signal – can be sent to a GEOS International Emergency Response Centre. The Centre then notifies the contacts of the emergency situation. It is rugged and has a long lasting battery, but there are drawbacks. There is no way for the user to tell if the signal has been sent or received successfully.
- While it works well in most of North America, it does not function well in the Arctic and southern Africa. It is not intended as – nor is it usable as – a navigational tool. The device is inexpensive; the cost in 2009 is around $150 plus $99 per year subscription (US dollars). Information about the “Spot” is available on the following website:
  - http://international.findmespot.com

Emergency Position Indicating Radio Beacon (EPIRBs)

EPIRBs are designed for use on boats.

- Each EPIRB has an identification number kept on file by the National Search and Rescue Secretariat (NSS) in Canada and the National Oceanic and Atmospheric Association (NOAA) in the USA. The registration should be kept up-to-date (see the previous section on PLBs to register them in Canada).
- In some areas, employees using boats should carry a regular 406 EPIRB unit that floats and will activate at a specified depth when it contacts water.

- The following Transport Canada website has additional information regarding EPIRBs for marine use: http://www.tc.gc.ca/marinesafety/tp/tp10038/70-lse-EPIRB.htm

Emergency Locator Transmitters (ELTs)

Emergency Locator Transmitters are specifically for use in aircraft and are designed to activate automatically upon impact; they can also be activated manually.

- The newer digital ELTs operate at 406 MHz and effective February 1, 2009 only signals at this frequency will be processed by the Cospas-Sarsat system. Frequencies of 121.5 and 243 MHz will no longer alert Search and Rescue (SAR). Exploration companies should inquire whether all aircraft they intend to charter are equipped with up-to-date ELTs.
- Pilots of charter aircraft should indicate the location of the ELT in the aircraft to passengers and describe how to remove and manually activate the unit in the event of emergency.

Batteries

Various types of batteries are used at project sites. Follow the manufacturer's instructions regarding the correct use of rechargeable batteries and rechargers. Replace batteries as directed.

- Workers should start each day with fully charged batteries and carry sufficient fully charged spare batteries for their communication (and navigation) equipment.
- For additional information regarding batteries, refer to sections 7.7 Batteries and 18.4.6.3 Batteries.

PDAC 19.5 Communications Routines, Schedules and Protocols

PDAC 19.5.1 Routines and Schedules

- Before the field season commences, check all company owned communication equipment and test each item prior to use. If possible, test the equipment with all potential contacts to assess transmission quality. This may include emergency contacts such as the charter aircraft companies and contractors.
- Test rental equipment to make sure it functions according to the rental agreement.
- Obtain frequencies from contractors (e.g., air support and drilling companies) and program the radios with these frequencies. All employees should know which frequencies provide weather and emergency information.
- When mobilizing a new project or camp, set up the communications station immediately and try to make sure it works properly before the air support departs. When demobilizing a camp the radio should be the last item dismantled, especially if everyone is being flown out.
- The camp should be on radio standby whenever aircraft are flying in, especially if weather is changing, or there are low clouds or fog in the area.
- Minimize non-essential radio messages by scheduling additional or personal orders to expediters when everyone is in camp. Then, one message can be sent.

- The communications system should include a communications log that records each transmission.
- When a lightning storm approaches a field project or camp, immediately disconnect the antenna and ground it away from the radio, as appropriate. This may prevent possible equipment damage and/or a fire.

Daily Checks

Employees working off site should follow communications routines and checks before departing each day:

- Each day verify that your communication equipment functions properly before leaving the project, camp or office.
- Make sure all the contact numbers you may possibly need are programmed into satellite phones or cell phones and that you are carrying the operation instructions for the equipment.
- If using two-way radios, confirm which channel everyone is using.
- The planned drop off point may have to be changed due to conditions. Make sure that any changes are communicated to the project/camp and not just to the particular pilot or driver who drops you off.
- Carry extra appropriate signalling devices (smoke flares, mirror, whistle, and fluorescent orange helicopter cloth) in addition to electronic devices and extra batteries.

Regular Scheduled Checks

Regular scheduled check-in reporting procedures contribute to a well run field operation and increase morale and security.

- Employee tracking system: Maintain a “white board” or other clear method for a “check out – check-in” system in a central location available to everyone. Post a map that shows all work locations (off site work locations, drill sites) and detailed daily traverse routes with clearly marked drop off and pick up points. Designate someone to keep track of employees throughout the day.
  - Employees should check in with the pilot, driver, base camp or office as soon as they are dropped off to verify their radios function properly. If a radio fails to function, the aircraft or vehicle should not leave them and employee should not proceed.
  - Before disembarking, make sure to confirm the time and pick up site with the pilot or driver in case the radio fails to function later.
  - When more than one field crew is working in the same area, they should be able to communicate with each other.
- Employee check-in schedules: Set up appropriate check-in schedules for contact between field parties, drill sites, work sites and the base camp or project base. Someone should monitor the base camp radio while personnel are in the field. It should be a requirement for each person in charge (including the traverse crew chief and the drill supervisor) to account for all their employees working on site, in the field or at a drill site at check-in times.

- Set up a prescribed length of time after which a search will begin for an overdue field employee, field party, vehicle, boat or aircraft.
- The frequency of check-in times may vary according to working conditions and OHS regulations (e.g., when employees works alone or in hot or cold conditions). The check-in time intervals are subject to change; when working conditions deteriorate, employees should check in more frequently.
- Employees should always notify the project or base camp when they change plans while on traverse. Notify camp of any potential problem (e.g., impending bad weather, unexpected obstacles, change of pick up location, vehicle breakdown, a bear sighting).
- Stay in communication with your field partner and/or other crews. Then you may learn if there has been a change in plans for your pick up vehicle, boat, or aircraft.
- The check-in schedule and search criteria applies to all employees. Everyone should use the system, including visitors.
- Keep check-in conversations to a minimum to conserve battery power, but do not hesitate to break a routine check-in schedule to relay important information.

Additional Check-In Routines

- At minimum, a base camp should keep an hourly radio contact schedule with helicopters working in the field. The PDAC Health and Safety Guidelines recommend a contact interval of 30 minutes.
- All projects and base camps should contact the company office at established intervals.
- Employees working out of a hotel or motel should arrange a check-in schedule to contact the office. Then the company will know if you fail to return and can initiate a search.
- Individuals travelling abroad from the office should also have established check-in schedules with communications protocols. This can be by email.
- In some areas it may be advisable to check in with local landowners, local police or even local villagers to inform them of your daily routes and estimated time of return. If you fail to return, they will be able to initiate a search.

PDAC 19.5.2 Radio Use Protocols

Users commonly share radio frequencies so it is important to keep traffic to a minimum and respect other users' time.

- Use the correct language so everyone understands your responses:
  - "**Affirmative**" to confirm a message ("yes")
  - "**Negative**" to deny a message ("no")
  - "**Roger**" to acknowledge a message ("OK")
  - Say "**over**" at the end of each piece of traffic you transmit so the receiver knows you have finished and he or she may proceed.
- See section 19.7 Communications Tips Regarding Transportation (Boats) for information regarding the use of "PAN-PAN-PAN" and "MAYDAY-MAYDAY-MAYDAY" for urgent or emergency communications.

- Speak clearly and slowly if transmission or reception is poor. Sometimes it is necessary to spell words out to make sure your message is received correctly and understood.

Learn and use the International Phonetic Alphabet.

PDAC 19.6 Emergency Communications

Most emergency response plans (ERPs) rely on good communications. A project should have several systems for communications, if possible. Unfortunately, communication problems often occur during emergencies and sometimes people often forget how to do the simplest things at that time.

- Post all emergency communications procedures, equipment operating instructions, emergency telephone numbers and radio frequencies at each communication station and the muster station. Store a copy in the glove box of each vehicle (and ATVs, snowmobiles, boats) and in support aircraft.
- Traversing employees should carry all emergency contact numbers, ERP information and operating instructions they may potentially require plus extra signalling devices to communicate with a pilot should there is an equipment failure (see section 19.5.1).
- Develop some worst-case emergency scenarios for the project/camp and work areas and determine emergency communications requirements.
- Determine how long it will take to contact emergency services and evacuate an injured employee from each work site, including the most remote place where traversing employees might experience an emergency.
- Test emergency communications plans to see if they work.
- Refer to Chapter 3. Emergency Response for additional information.

PDAC 19.6.1 Project Emergency Call List

Post a project emergency call list at each communication station. The most important numbers should be at the top of the list. It should list, as appropriate:

- Telephone numbers or radio frequencies for medical help
  - On site first aid attendant
  - Hospital, health centre, nursing station, poison control (include map with directions)
  - Aviation services
- Telephone numbers or radio frequencies for other emergencies
  - Local SAR organization(s)
  - Local police, RCMP, security services
  - Expediter
  - Fire fighting services (government: province, territory, state)
  - Forest Fire report number
  - Other nearby projects, especially if they have air support and your project does not, or they have better medical aid
  - Spill report number

- Location: list both latitude and longitude and UTM units

Additional considerations:

- Post a separate list with company personnel and contact telephone numbers.
- Regarding medical facilities: Know (list, if necessary) which facilities treat specific injuries so a patient is not evacuated to the wrong facility. This may be especially important for injuries such as snakebite. Include maps to each hospital/clinic etc.
- The expediter may be able to arrange emergency assistance more quickly than someone in camp.
- Know the location and number of the nearest helicopter or fixed wing aircraft. Know how to contact them quickly. This may be at a different company's project.
- Any necessary government numbers (Workers Compensation Board, Mines Inspector, Environmental Spill Report etc.)
- Procedures for search and rescue if a PLB signal is set off and instructions to cancel the alert, if necessary.

When calling in an emergency from the field, state:

- Your name – that your call is an emergency.
- Your location – both latitude and longitude and UTM units.
- Nature of the emergency.
- Type of assistance required.
- NOTE: Be ready to relay messages for other parties in need of assistance.

PDAC 19.6 2 Company Hotlines

Depending on the size of the company and the type or location of project work, it may be advisable to establish a hotline to assist employees in the event of emergencies that threaten their safety, health or liberty. The service should be designed to address major emergencies experienced by employees who are travelling or working outside of their normal operations base

or out of reach of management at a local exploration office. Field personnel should always carry appropriate telephone numbers or telephone cards to access the hotline. It should be possible to call "collect" from any country. The hotline telephone number must be tested periodically to verify that it works.

A hotline must be manned 24-hours a day by a service that will immediately place the employee in contact with a designated company officer. The hotline should have numbers to use when calling from:

- Canada and USA
- Elsewhere in the world

PDAC 20.0 Drilling Sites

Introduction

Exploration employees who work at drill sites face exposure to hazards associated with drill equipment and sampling processes as well as the inherent hazards of location, terrain and climate. In addition, it is common practice for the senior geologist at a project to be in effect the project manager, and thus wholly or partially responsible for health and safety of both exploration company employees and contractor employees. Exploration companies should select a capable drilling contractor with the correct drill equipment for the job – preferably a drill rig with automated or mechanized rod handling features to reduce the risks of injuries. Drills are required by law to have other safety features such as guards on all moving parts, emergency shut offs and lockout capability (not just unhooking the battery).

This section highlights common risks and hazards associated with drill sites and focuses on safe work procedures and strategies to prevent accidents. The aim is to highlight safety information for exploration geologists and geotechnical personnel etc., rather than for drillers and drilling contractors who should have their own safety programs and safe operating procedures (SOPs). All parties working at drill sites should be required to comply with all relevant regulations of the authorities having jurisdiction (AHJs).

Accident prevention at drill sites depends on planning and preparation in three areas:

- Make certain that drilling contractors apply the highest possible safety standards.
- Make certain that exploration company drill site personnel (e.g., geologists, samplers) and visitors are informed and understand the potential hazards and risks of their roles and follow safe procedures.
- Make certain that project managers have sufficiently detailed technical knowledge of drilling processes to effectively manage drilling projects and monitor contractor's safety compliance.

PDAC 20.1 Risks, Hazards and Common Injuries Related to Drilling

Safe drilling requires preparation and adherence to safe work practices by all parties. Injuries may result from hazards specific to drilling itself and related to machinery, tools and equipment; to the substances used in drilling and mineral identification; or alternatively to field conditions, such as to terrain and ground conditions, animals, or climate and weather. Lack of experience of the site geologist and/or drill crew members may contribute to increased potential injuries when risks and hazards are not recognized. A wide range of risks may be encountered during a drill program:

Risks related to moving and rotating machinery and equipment:

- Crush injuries caused by catching fingers or feet in “pinch points” between moving machine parts, catastrophic failure of drill tower supports
- Impact injuries caused by hitting fingers or hands when using tools, flying material such as broken cables (winches)
- Entanglement injuries caused by unguarded machinery, loose clothing, jewelry, unconfined long hair

Risks related to high pressure air and hydraulic systems:

- Explosion and fire caused by misting of hydraulic fluids from pin hole leaks contacting an open flame (e.g., a drill shack heater or onto hot engine parts), malfunctions of booster compressors, tiger torches

- Impact injuries caused by hose failures, hose coupling failures, material ejected from cyclones, when sample discharge hoses fail and spray rock chips
- Eye damage due to grit and dust getting into eyes when sampling or cleaning machinery with compressed air
- Tissue damage or embolism caused by high pressure hydraulic fluids piercing the skin from a pin hole leak in a hydraulic hose or when cleaning clothing with high pressure air
- Hearing loss caused by high noise level of operating machinery while wearing inadequate hearing protection
- Injuries caused by the discharge from pressure relief valves when there are inadequate extensions

Slips, trips and falls may be caused by:

- Uneven ground, stumps, rocks, wet, icy ground or surfaces on the drill platform or drill shack steps, unsecured or improper rise and run on steps
- Stepping in spilled drilling muds or additives, sumps, holes Inadequate footwear
- Lack of, wrong type, or inadequate use of fall protection equipment Working near cliffs or on benches
- Improper illumination and/or inadequate lighting around the drill shack at night, poor housekeeping

Other risks:

- Accidents during drill set up, drill moves or tear down (e.g., drill platform collapse, drill tower erection, especially during helicopter set ups)
- Hypothermia caused by wearing inadequate clothing for the weather, wind chill, lack of warm-up breaks
- Hyperthermia and/or sunburn caused by working in sun or heat, wearing inadequate clothing, lack of cooling breaks, inadequate fluid intake (dehydration)
- Drowning or cold water immersion hypothermia caused by falling through ice or breakthrough with equipment
- Electrocution, fire explosion caused by contact with underground gas lines, cables, utilities, or overhead power lines
- Burns caused by contact with hot engine parts, being sprayed by hydraulic fluids, fires Injury or death caused by being hit by falling dead trees (chicots), hung-up trees and snags left after pad preparation
- ATV and snowmobile crashes caused by excessive speed, improper riding procedures Bear invasion caused by the presence of garbage and rod grease
- Exposure to toxic substances caused by:
  - Lack of, inadequate or malfunctioning PPE
  - Inhalation of toxic additives or fumes, failure to remove hazardous material or exhaust from work area
  - Licking core or samples
- Equipment damage caused by many of the above hazards

- Normal field work risks when travelling to and from the drill, or to and from sites such as the water pump etc., which may be remote from the drill

Common Drilling Injuries

Generally, most injuries in the drilling sector are caused by (1) slips and falls, (2) improper lifting and (3) vehicle accidents. Most lost time incidents are the result of back and hand injuries to drilling employees. Other injuries of great concern include fingers caught between rods, being struck or hit by falling objects and entanglement – when clothing etc., draws the victim into the machinery or rotating drill rods. While they are less common, these injuries can be very serious or fatal. Winter work adds the potential serious risk of breaking through ice and drowning.

- Slips, trips and falls: Drilling by its very nature creates a difficult working environment – the presence of large amounts of water, drill muds and grease, with wooden planks and drill rods, in an uncontrolled environment compared to a factory floor, means that it is very easy for exposure to these hazards to result in trips and falls. Drilling in winter or during periods of heavy rain can exacerbate this situation. The drilling platform, ladders and access areas can become slippery due to grease, drilling muds or fluids, or ice buildup etc.
- Lifting injuries: Core boxes and samples can be very heavy, especially when the rock is a massive sulphide. Back and hand injuries are common.
- Transportation related injuries: Drill sites are usually remote and may require access using poor roads, ice roads or by aircraft. The modes of transportation including four-wheel drive vehicles, all-terrain vehicles (ATVs), snowmobiles, boats and especially helicopters all expose workers to increased risks. Crashes and/or collisions can result in severe injury or death.
- Impact injuries: Workers may strike or be struck by an object as a result of a fall, or be struck by thrashing high pressure hoses, ejected machinery parts, or the uncontrolled movement of drill rods, winches, cables and tools.
- Entanglement injuries: Loose clothing (e.g., shirttails, jacket drawstrings, boot laces), unconfined long hair and jewelry can easily catch on rotating machine parts. These include rotating drill rods, smooth shafts, spindles, winches and recesses or projections on shafts such as couplings, protruding set screws, keys and keyways. If you are pulled or drawn into the machinery you may be severely injured or killed.
- Crush injuries: It is easy to crush a finger, hand, arm or foot where two machine parts close together (“pinch points” or “nip points”) or where one machine part moves against another (drill rods, core barrels). Samplers at cyclones must beware of this potential injury as it is easy to catch fingers between a cyclone and sampling apparatus. Severed, crushed or damaged fingers are a common injury.
- Entrapment injuries: Part of your body or clothing may catch between "drawing-in" hazards (e.g., drive belts and pulleys, pull-down chains and sprockets, wire ropes and sheaves).
- Burns: Burns may result from contact with hot engine parts such as manifolds, exhaust pipes and mufflers, or if a hose fails and sprays hot hydraulic or compressor oil into the work area. Burns may also result from contact with tiger torches, oil stoves used for heating the drill shack or with heaters for brine solutions.

- Dust and Noise: Effects of dust and noise are cumulative. Excessive inhalation of dust (especially asbestos, silica and coal dust) can produce fatal lung diseases. Excessive noise produces deafness. Both are preventable so use the correct personal protective equipment (PPE).

PDAC 20.3 Drill Site Location, Planning and Preparation

The drilling sites should be assessed by the exploration company project manager with the drilling contractor well in advance of the initial drill rig set up or moves. Potential problems should be discussed and addressed. Risks should be identified through the risk assessment process and mitigated when possible according to a risk mitigation plan.

PDAC 20.3.1 General Preparations

- Permits: Obtain all required permits from the authorities having jurisdiction (AHJs).
- Permits may be required for access, environmental, cutting trees, water use and course alteration, septic systems, waste disposal, and reclamation etc.
- Power lines, underground cables and utilities: When it is necessary to drill near these hazards, follow regulations of the AHJs, notify the appropriate authorities and use extreme caution. See section 20.3.2 below.
- Plan site specific SOPs and ERPs, as required. This is especially important when it is necessary to drill near power lines or on ice. ERPs should include provision for a safe shelter, as required.

Location

Carefully plan the drill site layout to minimize natural and manmade hazards that contribute to accidents. Refer to section 18.4.1 Site Selection and Location.

- Access: Evaluate the drill site for adequate entry and exit. Take into consideration the drill rig and carrier and required service vehicles and equipment. Plan for adequate parking space for supply vehicles.
- Where there is no road access, carefully plan for an airstrip or helicopter landing site, or for water access or ice road, as required. Plan safe fuel storage areas for all required means of transportation and for drill equipment.
- Address potential drill site hazards such as manual handling, the need for special platforms on steep terrain, guard barriers to prevent falls (e.g., steep slopes, old open mine works), confined work space, adequate access and parking space, aircraft landing areas, fuel storage etc.
- Remove physical hazards such as dangerous trees and branches, stumps and loose rock that could fall or slide unpredictably.
- Assess the stability risk on steep slopes with thick soil cover in regions of high rainfall especially mountainous tropical areas, for example, Papua New Guinea. Water soaking into the ground can invisibly undermine the drill pad – with potential catastrophic failure. Design a drainage system to channel water flow coming down the hill site away from the drill pad.

- Determine if suitable water is available and in sufficient quantity. Secure any required permits. Determine if a holding tank is required. Maintain any required setback of the drill site from watercourses.
- Plan adequate work space at the drill site – both horizontal and vertical – as a restricted work space increases the risk of accidents. Sufficient operating space is very important if the drill will operate at night.
- Make sure the site is stable enough and will take the weight of the drill and equipment. Place the drill and any supporting jacks on firm and solid ground. If it is necessary to construct drill pads on steep slopes using “cut and fill” methods, do not locate equipment on the area of fill until it is properly compacted and sufficient drainage is in place. If drilling on ice, rigorously test the ice thickness and build up the access routes and drill pad as required.
- Plan the site layout with clear escape routes from all areas in case of emergency (e.g., fire, flood). Include at least two routes in ERPs.
- Make sure sufficient firefighting equipment and first aid kits are present at the drill site. All employees must know their location and be trained to use the firefighting equipment.
- Aircraft: If aircraft access is required, carefully plan the location of the airstrip or helicopter landing pad. Include plans for fuel storage that comply with permits and regulations.
- Water: Arrange for water delivery if insufficient water is available. Arrange for safe disposal of excess water. Follow all regulations (e.g., permits, setbacks).
- Where sumps are required, make sure they are of sufficient volume to contain all circulation fluids and are placed an adequate distance from water courses. Calculate the volume requirements from the depth and diameter of the proposed hole.
- Plan for the safe disposal of drill cuttings, drilling muds or sludges, as required. Locate the sample and core viewing areas (core shack) well clear of the drill rig, operating machinery, cyclones and high pressure hoses and pumps.
- It should be mandatory to keep appropriate spill kits at the drill site and fuel caches.
- While it is important to minimize environmental disturbance during drilling operations, this must be balanced with the health and safety considerations so employees are not placed in added danger. Refer to section 5.7 Special Terrains in the e3 Plus Environmental Stewardship Toolkit at: www.pdac.ca/e3plus.

Special Site Considerations

- Old mine sites and chemical hazards: Watch out for possible unidentified or unmapped raises and stopes, old machinery or rails, rotting wood from supports etc. Watch out for dumps that may contain toxic materials etc. Refer to Section 22. Abandoned Surface and Old Underground Mine Workings.
- High pressure gas and water: When the potential exists to encounter high pressure gas and water, particularly when drilling, the contractor must be informed and instructed to use blowout protection on drill equipment. Consider extending the exclusion zone around the rig to prevent potential exposure to other workers.
- Sedimentary terrain: When drilling in some sedimentary terrain, there may be the potential to encounter poisonous or flammable gases such as H_2S or methane.

Develop site specific SOPs that address the potential risk of encountering gases. Appropriate equipment such as gas detectors and masks must be available at the drill site.

- Additional hazards may include extreme climate and/or terrain (Arctic, desert or mountainous regions), wildlife (e.g., venomous snakes, insects, bears, wolves) and cultural, language or security issues. Refer to Sections 9. Weather and Environmental Risks, 10. Wildlife, and 12. Travel Safety and Security.

PDAC 20.4 General Safety Guidelines for Drill Sites

Good planning, organization and standards of conduct help drill projects run smoothly.

PDAC 20.4.1 Emergency Response Plans (ERPs)

- Carry out a risk assessment before the start of drill operations and develop site specific ERPs that address the risks by elimination and mitigation. Send copies of the ERP to the regional exploration company office and the contractor.
- All on site employees must be familiar with the plan and trained to carry out their assigned responsibilities for emergencies.
- If evacuation is part of an ERP carry out a practice exercise (drill) to see if the contacts and plans work.
- Emergency equipment: Both the drill and the base of operations should have required emergency equipment that includes:
  - Suitable and well maintained first aid kits and appropriate stretchers to transport patients (appropriate size and number)
  - Fire extinguishers, firefighting equipment and any required spill containment kits (properly located)
  - Signalling devices, emergency shelter and survival equipment suitable for the climate
  - Bear deterrents, a suitable gun and ammunition (for trained employees) as required
  - Survival shacks should be supplied with seasonally appropriate items including: sleeping bags, stove, lantern, propane canisters, matches and lighter, candles, food and water (in totally animal proof containers), flashlights, extra batteries, extra clothing, mosquito netting, sun screen, bug spray, bear spray etc., as appropriate. Include oxygen at high altitude (more than about 3000 m).

PDAC 20.4.2 Communications

Drill sites must have sufficient reliable communication equipment appropriate for the location that enables communication with the base of operations under all emergency conditions. Have suitable backup equipment and spare batteries. Maintain communication equipment in good repair and test it regularly.

- Establish and maintain a regular communication schedule between the drill and base camp or office.
- Post communication procedures in a prominent place (i.e., operation instructions for the equipment, the radio frequencies or telephone numbers, the list of emergency contacts). Operating instructions and emergency procedures should be posted at each

communication station and attached to portable equipment, especially satellite telephones.

- Train all employees to use the communication equipment.
- Establish clear SOPs regarding procedures to follow in case communication cannot be established between the base camp and field workers.
- Refer to Section 3. Emergency Response and 19. Communications for information regarding communication equipment, general communication procedures, emergency procedures and contact lists.

PDAC 20.4.3 Pre-Program Safety Meetings

- Hold a detailed safety meeting for all employees at the start of a drilling program. It is most effective to hold it at the drill or at least include a visit to the drill rig. This makes certain that all drill site personnel understand the potential risks and hazards, the safety policies, safe operating procedures (SOPs) that apply when working around the rig. Encourage responsibility for employee personal safety and for the safety of others.
- At the safety induction, ask the contractor's drilling supervisor or senior driller to physically point out the known hazards and each exclusion zone around specific drill equipment such as the high pressure hoses, compressor and cyclone. The hazards are not always obvious to exploration employees, especially those who lack experience around a drill or are only familiar with a different drilling process.
- It is highly recommended for the company geologist/sampler to hold a short safety meeting with both drilling crews when shifts change so that the "off" crew can talk about shift issues with the "on" crew.
- Refer to section 2.1.2 Safety Meetings for additional information including suggested agenda topics.

PDAC 20.4.4 Inspections

- The supervisor should carry out a drill site safety inspection at the start of a drilling program and prior to starting each hole during long programs. Safety inspections should include the drill rig, accessory equipment, hoses and connections, vehicles, procedures, methods of operations etc. Verify that the emergency shutoff switch is in good working order at the start of the program. Both company and contractor personnel should participate in all inspections. It is advisable to use checklists and maintain these records at base camp.
- The driller should conduct a quick inspection of the work area and rig before work each shift to note and correct any hazards.
- The exploration company representative should continuously look out for hazards and unsafe work practices and inform the drill supervisor so they can be corrected or mitigated. It is advisable to hold frequent surprise inspections (as often as once a week).

PDAC 20.4.5 Reporting

Make certain accident reporting and investigations are done in accordance with applicable regulations (i.e., what constitutes a reportable event varies by jurisdiction).

- Immediately report injuries, accidents, incidents, near misses, unsafe conditions and any serious safety concerns to the supervisor.
- Report all accidents or incidents to the exploration company site representative within 24 hours. Contractors must provide a written copy of an accident/incident report to the exploration company as soon as possible (a verbal report is required within 24 hours).
- Make sure reportable events are reported to the correct AHJ within the required timeframe. Firmly established whether the exploration company or the contractor is responsible for reporting to AHJs on required forms.
- Investigate all accidents and incidents promptly. Immediately implement new SOPs that arise from an investigation of any injury or safety incident to prevent recurrence. The drilling operation must not recommence until the site and/or equipment is made safe.
- Document training, inspections etc., as required by the AHJs. Refer to section 1.2.5 Documentation for relevant information.

PDAC 20.4.6 Employee Conduct

Responsible behaviour is essential at all times at the drill site.

- Do not distract your co-worker while he or she is concentrating on a job.
- Never throw objects in the drilling or work area. Hand them to your co-worker or set them in their correct place.
- Operating machinery or vehicles under the influence of alcohol or deleterious drugs is extremely dangerous and is an offence that should be addressed in a company alcohol and drug policy. It is important for everyone’s health and safety that consequences are enforced.
- Horseplay must not be tolerated around operating drilling machinery. Fighting must not be tolerated at any time. These offences should be addressed in a company conduct policy. It is important for everyone’s health and safety that consequences are enforced.
- Walk – do not run – in drilling and work areas. Haste frequently contributes to accidents. Employees may only use firefighting equipment for the correct and intended use (e.g., water hoses, compressed air hoses, electrical tools, hand tools). Such equipment must never be used for pranks or practical jokes. Do not clean clothing with compressed air as air, dirt and grit may be driven into your skin, or eyes.
- All employees and contractors are required to adhere to regulations of the AHJs and company guidelines or policies related to the use of (1) firearms and (2) the recreational use of company vehicles, ATVs, snowmobiles, boats etc., including license requirements.

PDAC 20.4.7 Site Visitors

No visitors should enter or remain at the drill site without a work-related reason.

- Visitors to drill sites should receive a safety induction so they are aware of and understand the hazards and keep clear of all operating machinery. A trained and experienced employee (such as a supervisor) should always accompany all visitors if they must approach operating machinery.

- Visitors must wear required PPE.
- Visitors should view samples and core only in an area well clear of operating drills, cyclones, compressors and high pressure water or air hoses.
- Visitors should park vehicles in a designated area well clear of the drill site.

PDAC 20.5 Guidelines for Safe Work Practices

Companies should develop safe operating procedures (SOPs) that include the use of personal protective equipment (PPE), fall protection when working at heights, good housekeeping practices and manual handling and lifting practices. While there are additional topics that SOPs should cover, it is important to address these issues as many injuries are associated with these activities.

PDAC 20.5.1 Personal Protective Equipment (PPE)

All employees must use the correct PPE as specified by regulations, company and contractor SOPs, chemical warning labels, materials safety data sheets (MSDSs), or specific hazardous site conditions.

- All personnel within 30 m (100 ft) of an operating drill or operating ancillary equipment (skidder, bulldozer, pump etc.) must wear and use all required PPE. Display appropriate signs that indicate PPE is mandatory. For some work, special PPE may be required (e.g., fall arrest equipment or special protective clothing).
- PPE: Inspect PPE frequently and maintain it in clean, good working condition. Select PPE carefully – if it fits poorly or is uncomfortable, it may not function correctly and it may be ignored. Replace damaged or worn PPE.
  - Head protection: Hard hats must be government approved. Use add-on sun brims in very sunny locations. Use hard hat liners for cold weather but make sure the hard hat is properly adjusted and fits correctly.
  - Foot protection: Safety boots should be sturdy and have steel-capped toes. Soles should be in good condition.
  - Eye protection: Approved safety glasses with side shields must be worn at all times by all personnel at a drill site. Combination sun/safety glasses may help promote the use of eye protection. Notify the supervisor if you wear contact lenses. Generally, contact lenses should not be worn at the site; workers who require corrective lenses should wear prescription safety glasses, or safety glasses designed to be worn over regular prescription glasses.
  - Hearing protection: When the drill is operating, always wear correctly fitted earplugs and/or earmuffs correctly rated for the noise level. Double hearing protection should be used when noise levels are above 105 dB(A). The risk depends on the intensity of noise and length of exposure. While most cases of industrial deafness are due to years of exposure to moderate noise levels, hearing may be permanently damaged by exposure to very high noise levels for relatively short periods. Do not neglect to wear auditory PPE.
  - Personal entertainment devices should not be worn for many reasons, including the fact that ear plugs or headphones do not provide hearing protection. Refer to section 4.2.4 Hearing Protection.

- Respiratory protection: Wear suitable respiratory protection in the vicinity of any drill using compressed air as the circulation medium, when processing dry samples and when working in dusty conditions. Project managers should be aware of jurisdictional requirements for respiratory PPE. Seek professional advice if necessary. While dust masks may provide acceptable protection, certain working conditions may require a respirator that must be fit tested. For example, disposable filter-type dust masks do not provide adequate protection in the presence of high concentrations of hazardous atmospheric contaminants such as silica, asbestos or coal dust. Regular dust masks are meant to protect against sawdust and are entirely inadequate. Do not neglect to wear respiratory PPE.
- Hand protection: Properly fitting gloves reduce hand injuries, which are one of the most common lost time injuries at drill sites. Wear appropriate gloves to handle core trays and chemicals etc. Drillers should wear close-fitting gloves when handling drill rods, winch cables and ropes etc. A variety of gloves that provide various types of hand protection (cut resistant, chemical resistant, insulated) should be available on every work site. Wear warm gloves/mitts when working outside the drill shack in winter conditions.
- Fall protection: A full-body harness and shock-absorbing lanyard is mandatory when working on the drill mast. Make sure the lanyard is set so a fall is stopped short of the ground. See section 20.5.2 below.
- Clothing: Some jobs may require special clothing worn only at the drill site (e.g., for radioactive, asbestiform or other hazardous minerals). All employees should wear suitable work clothing for warm or cold climates. Wear overalls, jackets and hardhats with high visibility reflective strips. Reflective vests should not be worn in the drill shack and immediate vicinity of the drill due to the risk of entanglement. NEVER WEAR loose, unbuttoned, torn or ragged clothing, loose gloves with wide cuffs, jackets or “hoodies” with drawstrings, lacings or straps, loose boot-laces, unrestrained long hair, necklaces, rings or other jewelry. Injuries from being drawn into moving machinery are often serious or fatal.

● Refer to Section 4. Personal Safety for additional information regarding PPE.

PDAC 20.5.3 Housekeeping

Drillers should keep the drill site neat, organized and free of debris as an important ongoing part of a drilling program. An orderly site improves working conditions and reduces the risk of trips, slips, falls, sprains, cuts and more serious injuries.

● Organize the drill site to allow sufficient space for easy access to drilling supplies. Use designated areas for unloading equipment and supplies. Store them in designated convenient places where they will not become a hazard and cause injuries.
● Make sure all flooring is solid and secured.
● All hoses should be up off the floor and secured. Use proper signage in the appropriate places.
● Storage: Use suitable racks for storing drill rods, casing, augers and tools that prevent them from sliding, rolling or falling off. Store drilling additives, fuels and oils according to regulations and in ways that prevent harm to employees and the environment.

- Keep access ways and passages within the site tidy and free of personal items and equipment. Keep them free of grease, oil, ice, mud and other slipping and tripping hazards. Keep work areas and passageways well lit, especially at night.
- Keep areas near emergency equipment clear at all times (e.g., fire extinguishers, hoses and emergency PPE).
- Keep the drill mast free of loose objects at all times.
- Clean and return tools and equipment to their proper storage space. Tools left lying around create a tripping hazard and get damaged or lost.
- Roll up hoses, cables, slings and extension cords and other items that may cause tripping hazards after use. Store them correctly. Replace worn or damaged hoses and cords.
- Remove garbage from the drill site regularly (each shift). Regularly dispose of it in designated containers according to local AHJs. Do not burn garbage unless permitted. Place oily rags in sealable metal cans – not with other garbage.
- Keep the drill platform flooring stable and free of debris, oil and mud etc. There should be no nails sticking out or holes that could cause injury. In winter, do not allow ice to build up on drill platforms, steps or drill equipment.
- All steps must be safe – securely built, kept free of objects, cleaned of grease, ice and other slippery deposits. Where feasible, all steps should have secure handrails.
- Keep ladders free of mud, ice etc. Use ladders only for their designated purpose. Secure them carefully at the top and keep the area around the base and top of the ladder clear of unnecessary items. When moving ladders, especially aluminum ladders, beware of overhead electrical wires and never allow them to touch exposed electrical conductors.
- Barricade or rope off any unsafe working areas. This includes sumps, areas with drilling muds and hose discharge areas.
- If drilling mud is used, minimize the spillage of mud as it can cause very slippery conditions. Even a minor mud spill immediately becomes a slipping hazard.
- Good housekeeping is mandatory wherever core saws are used, as water-laden dust that covers the floor, clothing and machinery will dry out allowing the dust to become airborne and respirable.
- Cover materials to protect them from weather, as required.
- Immediately clean up any leaks and spills according to regulations and company environmental guidelines. Understand and follow the regulations regarding reportable spills. Keep appropriate spill containment kits at appropriate places. Immediately cover over a spill area with a non-slip material to prevent slips and falls.

PDAC 20.5.4 Manual Handling

Note: For exploration personnel, most manual handling injuries occur when handling bagged samples or heavy core trays. Most drill related injuries to drill crews occur while handling drill rods or using tools.

Plan the drill site layout carefully to eliminate manual handling as much as possible. Identify and eliminate the high risk tasks and encourage the use of mechanical lifting and handling devices.

- Follow correct lifting procedures.
  - Do not lift heavy loads unaided. Use hand trucks and trolleys etc., or get help – including for fully loaded core boxes.
  - Do some warm up exercises when a job requires lots of lifting and use extra caution if lifting is necessary when it is cold or you are tired; fatigue increases the likelihood of back strain or injury.
  - Take your time and take frequent rest breaks when performing continuous, strenuous tasks or lifting (e.g., moving core boxes, tripping rods and casing).
  - For safe lifting procedures, refer to section 4.3 Lifting and Back Protection.
- Storage areas should facilitate both manual handling and the movement of personnel around the site. Materials should be easy to access and stow away.
- Store materials according to requirements of AHJs, which may include specified distances between certain materials, fire walls and special ventilation.
- Organize tool storage and label storage bins.
- Store heavier items on lower shelves but not necessarily on the lowest shelf.
- The contractor should provide safe racks to stack and secure all rods, casing and drilling stores so they cannot roll or be knocked down. Place racks on stable ground.
- Be alert for slipping or tripping hazards when lifting or moving heavy items. Identify and eliminate the hazards.
- Use gloves when handling core trays. Drillers and helpers should use gloves for handling wire rope and drill rods etc.

PDAC 20.6 General Hazards Associated with Drills and Specific Equipment

Drill site employees must be fully informed regarding relevant drilling methods and sampling procedures. While most tasks related to drilling are the responsibility of drillers, the company employees (geotechnical, samplers and project geologists) who work around the drill need to be familiar with the drillers' work so they can spot hazards, risks, report problems to the contractor's supervisor, as well as take responsibility for their own safety.

The following publications are additional sources for information regarding drilling safety: Canadian Diamond Drilling Association: Safe Work Methods Surface Handbook

- Environmental Remediation Drilling Safety Guideline:
- http://www.riskworld.com/nreports/2005/ERDSafetyGuidelines.htm
- Exploration Drilling Hazards Checklist:
- http://www.dpi.nsw.gov.au/ data/assets/pdf_file/0007/178720/IGA-003-Exploration-Drilling-Hazard-Checklist.pdf

PDAC 20.6.1 General Safety around Drill Sites

- Exclusion zones: It is advisable to establish an exclusion zone around hazardous areas of the drill rig and associated machinery. Exclusion zones (for people other than the drill crew) might include the drill shack during drill operations and should include the drill mast area, rotating drill rods, unguarded moving parts, compressors, high pressure air and hydraulic hoses, sample discharge hoses, high pressure water pumps, mud pumps, and wherever drill rods are being handled or hoisted. Exclusion zones should also be established where ground is slippery from the use of drilling products and the air is dusty or contains harmful products. Inform all employees and visitors of the exclusion zones through a site safety induction. Each zone should be pointed out at the drill and again whenever circumstances indicate a review is necessary. NO ONE – drilling crew, company employees and visitors – should enter an exclusion zone without a work-related reason. Everyone is required to wear appropriate PPE.

- Do not distract or speak with the drill operator during rod changes and while the drill rods are rotating. Request the driller to stop the drill when it is necessary to hold discussions or inspections. Make sure you are seen and approach from a direction that eliminates the need for anyone to cross in front of rotating drill rods, which is especially important when drilling inclined holes.
- Be vigilant and stand back at least the height of the drill mast, especially during hoisting, handling or changing drill rods. Rods sometimes fall from the mast.
- Always avoid walking near the rotating drill rods – a slip or fall could be fatal.
- Drills are very noisy so it is advisable for everyone who works around the drill rig to use standardized and universally accepted hand signals (that have been discussed and verified between all parties) for communication regarding operations if radio communication is not available.

PDAC 20.6.2 General Safety Tips Regarding Drilling Methods

Drillers are responsible for working safely, but the company geologist or person in charge should be familiar with the drillers' work in order to assess whether safe work procedures are being used. The geologist should be prepared to make unannounced visits to the drill to audit whether safety guards are in place during operation and whether contractors are wearing appropriate PPE. Tolerating infractions of safety rules may leave the geologist or project manager partially liable if there is a safety incident.

- Only authorized contractor employees are permitted to operate, drive, climb, work on, repair or service a contractor's drill rig, vehicles or equipment. Operators must be qualified and fully trained.
- Drill stability: Do not operate the drill before it is levelled and securely anchored. Operate the drill from the operator's station and do not leave the controls while the drill is running. Stop the engine for discussions.
- Lock out the drill before carrying out maintenance – don't just shut it down. Never carry out maintenance while the drill is running. Replace all guards for moving parts etc., after maintenance is completed. Complete the maintenance log.
- Working at heights: A full-body harness must be worn and anchored when working on the mast. The wearer should inspect his/her harness each time it is used. See the previous section 20.5.2.
- Tower erection:
  - A fall arrest system is required by those working on the tower.
  - Proper working platforms must be used during tower erection.

- Lay out all materials in an orderly manner to provide for an efficient and safe operation.
- All tools used in the tower construction must be secured.
- All material being raised on the mast must be tied securely so there is no danger of ropes becoming undone or objects falling.
- Drill towers are raised by hydraulic rams. They require support by braces, stays or mast locking pins, as this provides a backup in the event of a hydraulic failure.
- Secure the mast by guy lines if applicable.
- Provide lighting at the mast as required.

- Tools:
  - Use the correct tool for its intended purpose. If it isn't working properly, it probably isn't the correct tool.
  - Securely store all hand and power tools in their designated storage place. Cover knife blades and other sharp objects and store them separately.
  - Do not climb the mast, ladders or to heights while holding tools. Use a tool hoist or a bag. Never leave tools unsecured in the helper's bag.
  - Never leave tools where they might be knocked down or fall onto a person (e.g., overhead work spaces, on ladders). Do not throw or drop tools and do not leave tools on the ground.
  - Never store a pry bar sticking into the ground as serious injury may result if someone falls onto it.
  - Replace worn tools; watch for worn jaws on pipe wrenches.
  - Drill rod safety: The immediate area around rotating drill rods is exceedingly dangerous regardless of the drilling method. Injuries are usually serious and often fatal when workers (or clothing) become drawn into or entangled in rotating drill rods. Although some guards exist, effective guarding of rotating drill rods is difficult to achieve.
- Drill rods should not be lifted and placed against the mast unless they are securely held. There should be a safe means for safe vertical storage or lay them flat in a safe place.
- When a driller or helper is handling drill rods, they should:
  - Wear gloves.
  - Never let rods slide through their bare hands. Rods may have small metal burrs that will cut hands badly.
  - Never grab a drill rod while it is rotating – even when wearing gloves or when greasing the rods.
  - Keep their hands clear from the pin and box ends to avoid fingers being pinched or severed. Never place fingers or hands over the end of an open rod when they could become pinched between the rod and something else.
  - Never reach behind or around rotating drill rods for any reason.
  - Never touch a frozen rod with bare hands.

- When a driller or helper is handling core barrels or geotechnical soil sample tubes, they should:
  - Wear gloves.
  - Never place their hands over the bottom of the core barrel and inner tube when inserting or removing it from drill rods, augers or casing.
  - Keep hands away from the sharp ends of the split spoon or Shelby tube
  - – only hold the mid portion of the tube.
  - Use a mechanical means – water or mud and not compressed air – if it is necessary to pump core or soil samples from core barrels or sampling tubes.
  - Beware of the weight of drill core in the core tube especially when handling rock with high density such as massive sulphides. This also applies to core boxes with high density rock.
- When a lightning storm threatens, shut the drill down and move all personnel to a safe location because the drill mast may act as a lightning rod. Lower the drill mast if time permits. Refer to section 9.2 Lightning.
- Do not operate truck mounted drills during high winds or any drill when there is insufficient light.

PDAC 20.6.3 Specific Hazards Regarding Drilling Methods

Depending on the job, different drilling methods and equipment may be required – each with its own hazards that samplers should be aware of. In mineral exploration, the commonly used drilling methods are: diamond drilling, reverse circulation (RC), air core, rotary air blast (RAB) and auger drilling.

Specific Drilling Methods

Diamond Drills

- Diamond drills are used for core recovery. Core boxes are heavy and require careful lifting and handling to avoid back and hand injuries (e.g., massive sulphides). Core boxes should be designed to hold safe weights of core, taking into account the core diameter.
- Drills with automated drill rod handling equipment offer increased safety over rigs where employees must handle the drill rods.
- Always avoid placing any part of your body near the wireline drum while it is rotating. Never touch the cables on the rig that haul core barrels or logging tools as they may move at any time without notice. Drums and winches should always be guarded.
- Many modern diamond drills use hydraulic systems. Hoses and hose couplings should be properly secured with whip checks or safety chains because hose and coupling failure is a serious hazard. Restraining cables or safety chains should be used for hose/water swivel connections at the top of the drill stem to restrain the hose in case of failure.

Reverse Circulation (RC) and Air Core Drills

Reverse circulation is a drilling method that provides rock chips for samples. Compressed air, sometimes with water, mud or a foaming agent is blown down the outer section of a double wall drill pipe and rock chips are forced up the inner tube. The capacity of the air compressor determines the speed and depth of the drilling as well as the rate at which cuttings are obtained. The larger the compressor, the greater the risk of injury from blown hoses. When failures occur, the higher pressures may cause severe consequences – serious injuries or fatalities. Hazards related to RC drilling include the following:

- Dust – a serious hazard due to the volume of compressed air employed and expelled. The cyclone should be set up downwind from the primary working areas around the drill and unless necessary; no worker should linger near the cyclone while the drill is operating. Everyone who works around the drill rig should be supplied with the proper respiratory protection and use PPE when working around the cyclone or drill collar.
- High noise levels: Wear hearing protection.
- Blown hoses may result in severe injury when high pressure air lines burst due to blockages or come uncoupled. See section 20.6.3.6 below.
- Explosions associated with booster compressors
- When approaching an RC drill, do so away from the collar blow-out pipe to avoid being hit by flying rocks or foam, if used. Normally, a long PVC pipe or hose diverts the discharge away from traffic areas, people and machinery. The area should be an exclusion zone that no one enters except to take samples.
- Cyclone hazards: Rock chips are ejected at such speed that a cyclone is required to separate the rock cuttings and dust from the return air. Samplers must be aware of the hazards:
  - Dust, vibrations and high noise levels are common hazards.
  - Make sure cyclones are firmly secured with safety restraints. If a cyclone breaks loose, the high air pressure can propel it away from the drill potentially causing serious injury to a sampler or anyone in its path. In addition, the return hose connection to the cyclone must be restrained with whip checks to prevent the hose whipping out of control and impacting anyone nearby.
  - Keep hands clear of the rim and the inside of a cyclone. NEVER reach up into the cyclone to retrieve a sample bag or clear a blockage as the knife valve may close and sever your fingers.
  - Either dry or wet samples may be taken from cyclones. Develop and follow appropriate SOPs for the sampling procedures.
  - When cleaning or maintenance work is done on a cyclone, the knife valve MUST be locked out and the air pressure turned off.
  - Wear respiratory PPE, eye protection, hearing protection and steel toed boots that provide good traction. The sampler should obtain samples quickly and leave the area.

Exposed Machine Parts

- Guards should be placed over:
  - All accessible moving parts e.g., rotating drill rods, pulleys, gears, shafts and belts, winches, unguarded pull-down sprockets or sheaves
  - Hot machinery parts, when possible
- Make sure machine guarding does not present a hazard (i.e., loose enough to catch clothing, sharp edges).

- Pinch points or nip points: Most “caught between” or “drawing-in” injuries involve drill rod handling, rotating drill rods, rod wrenches, rod clamp jaws, pull-down cables, pulleys, drive belts and sheaves, or pull-down chains and sprockets.
- Auger blades cannot always be guarded. They are very sharp and can catch and draw in loose clothing.

Mechanical Failures

It may be difficult to detect early signs of mechanical failure. Mechanical failures are less likely to occur when drill crews are properly trained and they adhere to the manufacturer’s recommended maintenance and inspections schedules. Keep accurate maintenance log books and store them in a secure place, as they are useful in an accident investigation.

- The failure of machinery, components and tools etc., may result in serious impact injuries and/or death. Examples include structural cracks in the mast that cause it to collapse, metal fatigue in tools such as stilsen wrenches (powered rod wrenches) and the ejection of failed parts such as fan blades.
- Specify a requirement in the contract that only engineered and inspected towers may be used; confirm this through an inspection before drill operations commence.
- Welds: Make sure all welds made in a shop or at the drill site conform to the manufacturer’s specifications and standards.
- Drillers should make sure that any welds made in a camp are done by a qualified person.
  - Do not use “camp welded joints” for operations where safety is critical, such as for slinging or lifting.
  - Do not sling or lift heavy objects by parts (e.g., welds) that are not designed to take the weight.

Hydraulic Systems

Nearly all drills incorporate some form of hydraulic system. To reduce risks, contractors should make sure that (1) hydraulic pressures do not exceed the manufacturer’s recommendations, (2) hoses are inspected frequently and properly secured, (3) damaged hoses or couplings are replaced immediately, (4) replacements are correctly pressure-rated and compatible with hose fittings being used and (5) applicable safety guards are properly installed and used. Guards should be engineered – not “homemade” or constructed in camp. There are risks with homemade guards including failure due to poor welding, improper protection, and in fact they may increase safety hazards instead of reducing them.

- Loads: Never stand under any object being lifted or held up solely by hydraulic cylinders (rams). Set the load down prior to turning off the machine to relieve pressure from cylinders, components and hoses.
- Hydraulic failure can produce projectiles such as whipping hose ends, loose fittings, or streams of pressurized and/or hot oil. See the section on hose safety below.
- Pinhole leaks: Never try to find a leak in a hydraulic hose with your hands. Use a soap solution or piece of cardboard. The escape velocity of hydraulic oil from a pinhole leak can penetrate the skin and enter the blood stream, which may cause serious infection leading to gangrene, amputation or death.

- Burns: As hydraulic systems generate considerable heat, a burst hose can spray hot oil or water and cause severe burns.
- Fires and explosion: Leaks of hot hydraulic fluids (especially a mist) can cause a fire and/or explosion when sprayed onto hot machinery.

Compressed Air Systems

Compressed air is used as the circulation medium for reverse circulation (RC), rotary air blast (RAB), air core, and rotary percussion drilling. Failure of a high pressure hose or hose coupling may cause the hose to break away with explosive force and thrash about; a sample discharge hose that fails may eject rock chips. The impact from any of these may result in serious injury or death. Because of the complexity of compressed air systems, exploration companies usually rely heavily on the standard of the contractor's maintenance and inspection procedures to manage the risks and hazards of compressed air systems.

- Establish an exclusion zone around all compressors and high pressure air hoses. Train all employees to understand the destructive capability of breakaway high pressure air line hoses.
- Compressors discharge compressed air intermittently and whenever a compressor shuts down. Surface dust or gravel may be blown up from the ground. Stay away as you won't know when this may occur.
- All air compressors must be equipped with a fully operational pressure relief valve. All air hoses must be fitted with safety chains or whip checks at both ends.
- Never direct compressed air toward the body or use it to clean clothing. If air is forced through the skin, air bubbles may enter the blood and cause an embolism, which can be life-threatening.
- Do not use compressed air to pump core from a triple-tube core barrel.

High Pressure Hoses

There is potential for any pressurized hose to fail if the external surface is deformed, cut or damaged. Even a minor cut may lead to rust and corrosion of the internal wire braiding. Hoses subject to internal blockages may fail without warning.

- To prevent hose damage:
  - Hoses should have no twists, kinks or bends.
  - Each hose should be the correct length – long enough to flex, but not too long.
  - Do not place hoses under tension.
  - Do not permit hoses to rub or abrade against other objects. Use wraps (snakeskin) on hoses in high wear areas, including where subject to vibration wear.
  - Do not drive over pressurized hoses.
- To prevent hose failure:
  - Always check that hydraulic hoses and couplings are correctly installed. To be safe, hoses, clamps and couplings must match and lock completely into the stem groove as shown below. The coupling assembly should never contain mismatched parts. Company personnel should be able to identify incorrectly fitted hose couplings. They should observe hose couplings and hose conditions during their work operations as part of proactive safety behaviour.

- Contractors are required to carry out regular safety checks on all air hoses, sample hoses, hose couplings and hose restraining devices (whip checks).

- Do not hold a discharge hose or place your feet near them. A coiled hose may suddenly whip out of control and the impact can cause serious or fatal injuries.
- Whip checks: Always make sure whip checks, safety chains or restraints are securely attached to each end of high pressure hoses. Stocking type whip checks are recommended because they provide the best protection (see below). Two cable stocking type whip checks – one at each end – are recommended.

High Pressure Pumping Systems

- Although most supply pumps do not pump at high pressure, some supply pumps are required to pump at high pressure if the lifts are extreme. Pressures can reach 400-500 psi if the lifts approach 300 m and a high pressure waterline is employed. A surge tank on the pump is recommended.
- Pressure relief (PR) valves. High pressure pumps, especially the triplex circulation pump, may explode if they lack a functioning pressure relief (PR) valve. At the start of all drilling programs, have the driller demonstrate that all pump PR valves actually open at the preset relief pressure under operating conditions.
- Establish an exclusion zone around high pressure mud and water pumps.
- Locate water pumps at least 5 m from the banks of a lake, a permanent or intermittent water course. Install them to prevent spills of fuel or lubricants. It is advisable to set them up in a berm and over a metal pan to catch drips when fuelling.
- Make sure a spill kit and absorbent media are present at the supply pump to soak up any hydrocarbons from the drip pan.

Fire

Fire is always a hazard, as drill sites contain many combustible materials. When the location is dry or very cold, fire is an even more serious risk. Whenever possible, clear the drill site of material such as long dry grass.

- Comply with the jurisdictional requirements for firefighting equipment. Depending on the minimum required equipment, it may be advisable to supply additional or larger fire extinguishers.
- One of the greatest risks of potential fire and explosion occurs when a mist of hydraulic fluid from a pin hole leak comes in contact with the open flame of a drill shack heater. External heaters, remote ignition or double walled stoves may reduce this fire risk.
- Leaking or broken fuel lines and ruptured hydraulic or compressor oil hoses may cause fires. Make sure the drill engine exhaust exits the rig or drill shack so it is not near combustible material. Consider placing spark arrestors on engine exhausts in hot, dry weather.
- All drill sites and camps are required to have the appropriate equipment and procedures to address local fire risks (e.g., forest fire, brush fire, grass fire). Keep informed about local fire hazard ratings.
- Mount approved fire extinguishers in readily accessible places (near exit) to fight a fire and escape. It is advisable to have two clearly labelled ABC type 9 kg (20 lb) fire

extinguishers at the drill although AHJs may require only one smaller extinguisher. Fire extinguishers are required at oil storage locations, water pump shacks, on all support trucks and personnel vehicles. Check extinguishers regularly and recharge them immediately after use. Know the location, limitations and use of all firefighting equipment at the site (refer to section 18.4.2 Fire Safety).

- Follow safe smoking rules. Do not smoke or allow open spark producing equipment within 15 m of drill equipment, fuels, fuel storage areas etc.
- Isolate fuels, oils and gas cylinders in a cleared designated area. Do not store empty or full containers of flammable liquids within 15 m of drill rigs, pumps and other machinery. Secure all tanks and cylinders to prevent tipping over.
- Pay strict attention to the safe use and storage of flammable materials (refer to sections 20.7.4 Hazardous Materials and 18.4.5 Fuel Handling).
- Never fuel engines, machines, or heat sources while they are running. Allow mufflers, exhaust pipes and hot components time to cool off before fuelling.
- Keep engines free of excessive dirt, grease, oil, spilled fuel and accumulated leaves, twigs or other flammable material.
- Pay special attention to safe handling of wood or oil stoves, propane tiger torches and electrical wiring in drill shacks, as these items may easily start a fire.
- Do not hang wet clothing to dry where they may catch fire, including near lanterns, over oil stoves or heaters, or draped over electrical cords strung from the ceiling.
- Do not leave fires unattended, including camp fires.
- Keep a fire extinguisher nearby when maintenance is carried out. Do not weld or perform maintenance using a heat source near the fuel or oil system of machinery, including compressors.

Waterline Heaters

Waterline heaters have the potential to cause fires if they are not operated correctly. Follow instructions in the manufacturer’s operator manual. Some tips:

- The fire box must be set up away from the motor end of the pump. At least four lengths of stove pipe should be used for a smoke stack.
- If the pump stops, shut down the fire as quickly as possible to avoid overheating the copper coil.
- When shutting down the coil, make sure the fire is nearly out before shutting down the pump. If the coil is dirty, it may burn for a considerable time after the oil is shut off.
- Adjust the amount of oil going into the burner so there is no smoke coming out of the smoke stack. If it is smoking, you are causing the coil to become dirty, which will insulate the coil and keep it from absorbing the heat. Also, if too much fuel is fed, the unburned fuel may leak out of the heater and cause a fire hazard.

PDAC 20.7 Health Hazards

General health issues are addressed throughout this section. In addition:

- Keep the drinking water supply in a clearly marked, clean and closed container at the drill site and in sample handling facilities. Drink this water only. Provide clean cups for drinking purposes. Keep potable water clearly separate from water that is not potable.
- Provide soap and water and hand sanitizer to prevent the spread of disease and infections.

PDAC 20.7.1 Noise

Noise hazards are covered in previous sections. The most important points are:

- Wear appropriate hearing PPE when working at or near the drill. See section 20.5.1 above.
- The driller should temporarily shut down when it is necessary to hold discussions.
- Wearing personal entertainment devices including iPods and MP3 players with earphones should never be permitted while operating or working around the drill, when driving heavy equipment, or when working in sample processing areas. For detailed information on this subject, refer to section 4.2.4 Hearing Protection.

PDAC 20.7.2 Respiratory Hazards

Dust may be a serious problem when working around drills using compressed air circulation and when processing samples.

- Wear approved respiratory protection as required and change the filters frequently. Make sure respirators are fit tested regularly; keep appropriate records. See section 20.5.1 above and section 4.2.7 Lung Protection.
- Stand upwind whenever drilling additives (powders) are used.
- For additional information, see sections 20.7.4.1 Silica Dust and 20.7.4.2 Asbestos and Amphiboles (below). For information about dust control at drill sites refer to section 10.9 Dust on the e3 Plus Excellence in Environmental Stewardship Toolkit at: www.pdac.ca/e3plus

PDAC 20.7.4 Hazardous Materials

Some substances used at drill sites require caution, training and/or PPE when used. All employees should receive general WHMIS training and site specific WHMIS training that addresses the hazardous materials they work with or risk exposure to (refer to section 18.1.4).

Workers should be familiar with the appropriate Materials Safety Data Sheets (MSDSs) and follow the specific instructions for PPE, storage, handling, first aid, spill response and disposal specifications. Jurisdictional regulations require that workers have access to MSDSs. In addition to electronic copies, it is advisable to keep paper copies of MSDSs in a binder where products are stored and in a central location (e.g., drill shack or drill truck).

Workers should read the MSDS before handling a product for the first time, as they contain information about PPE, safe handling and storage, first aid and more. Should exposure occur and medical treatment be required, take a copy of the MSDS sheet to the hospital so the medical personnel know what product is involved. Correct treatment can begin sooner. Train employees to know that hazardous substances can enter the body through:

- Breathing (inhalation)
- Contact with skin or eyes

- Swallowing (ingestion)
- Direct contact through injection (e.g., compressed air or hydraulic pinhole leaks)

Silica Dust

Exploration employees are exposed to airborne silica dust during core splitting, rock cutting, drilling, rock crushing activities etc. Freshly fractured silica is more reactive than old silica dust and both long term and heavy short term exposure to airborne silica affects the lungs. Silica dust is carcinogenic and long term exposure may result in silicosis, a fatal lung disease. Use the following methods to reduce employee exposure to silica dust:

- Engineering controls: Use local exhaust ventilation or water spray systems to reduce dust levels. Restrict access to work areas so no one may enter without PPE.
- PPE: Provide and require the use of appropriate PPE such as respirators and protective clothing.
- Training: Inform workers about the dangers of silica exposure, how to use dust controls and PPE, proper wet cutting methods and proper wet clean-up methods.
- Supervisors should make sure employees follow SOPs, use PPE and follow training protocols, including the use of correct wet methods for cutting and cleanup.
- It is advisable to reduce exposure limits to silica dust from the threshold limit values (TLVs) in situations where exposure exceeds an 8-hour workday and a 40-hour workweek. This is common practice in many field camps.
- Because you breathe more rapidly at high altitude, exposure to silica and other airborne contaminants and gases may be greater than at lower elevations. Companies should work to reduce the risk of exposure.
- For large projects, it may be advisable to develop and implement a silica exposure plan.
- An effective plan includes: purpose and responsibilities, risk assessment, controls, education, training, written safe operating procedures, washing or decontamination facilities, health monitoring and documentation.

Information regarding respirable crystalline silica is available at the following websites:

- http://www2.worksafebc.com/i/posters/2009/WS%2009_04.html
- http://www.worksafebc.com/publications/health_and_safety/by_topic/occupational_hygiene/defaul t.asp#silica
- http://www.msha.gov/alliances/formed/IG103.pdf

Drilling Additives and Fluids

Chemical drilling fluid additives may be used by contractors to alter the physical properties of drilling mud. Most are highly alkaline and can cause skin burns and eye injuries. Follow the MSDS directions for handling and storing drilling additives. Drilling and exploration companies should endeavour to always use environmentally friendly drilling additives, for example, those that are biodegradable.

- Stand upwind when additives are used to avoid breathing the particles. Wear a dust mask or respirator; wear goggles to prevent dust entering your eyes.

- Store the following chemicals in the correct space and conditions – keep them dry. Make sure all bags and containers are correctly labelled.
  - Potassium chloride, potassium hydroxide and soda ash may be used to increase pH levels.
  - Sodium chloride (common salt) is commonly used as a weighting agent to increase fluid density, to aid in drilling water-sensitive clays and shales, and as antifreeze in very cold regions.
  - Calcium chloride, which is exothermic, is used to prepare low solids high-density drilling mud for use in permafrost.
  - Sodium bicarbonate is used to lower pH and treat cement contamination.
- Two-part chemical foam mixes are widely used in RC and RAB drilling to seal around the drill hole collar pipe. Follow the MSDS directions.
- Information regarding drilling fluids (drilling muds) is located in section 10.5 in the e3 Plus Excellence in Environmental Stewardship Toolkit at: www.pdac.ca/e3plus.

Caustic Soda (NaOH)

There are less hazardous chemicals available for raising the pH of drilling fluids and there is no reason to use caustic soda. It can seriously damage your skin on contact and your lungs if it is inhaled.

Other Hazardous Materials

Most of the following materials are commonly found in drill camps. Most materials are cross referenced to the e3 Plus Environmental Stewardship Toolkit. Examples of MSDSs are provided with some products.

- A combination of developer/fixer chemicals may be used to process films from down-hole survey cameras. The chemicals are slightly caustic so follow the MSDS directions for the specific ingredients.
- Acids and bases: Refer to section 10.7 Acids and Bases in the e3 Plus Environmental Stewardship Toolkit at: www.pdac.ca/e3plus
- Antifreeze: Refer to section 10.8 Antifreeze in the e3 Plus Environmental Stewardship Toolkit at: www.pdac.ca/e3plus
- Bear bangers: http://www.truflare.ca/MSDS12gaBBangers.html
- Battery acid: Battery acid is very corrosive. It can burn the skin and cause blindness if splashed in the eyes, or if a battery explodes when charged. Always wear eye protection. http://www.eastpenn-deka.com/assets/base/a.pdf
- Bleach: Bleach is used for sanitizing purposes in camp kitchens. In an emergency it can also be used to purify drinking water or for part of that process. Refer to section 12.8.3.3 Water Treatment in Remote Areas or Developing Countries.
- http://www.frontiersd.mb.ca/safety/MSDS/Imperial%20Soap/Javex-12.pdf
  http://fastweb.mrjanitorialsupplies.com/msds/0130030.pdf
- Fuels and petroleum products: Refer to section 10.1 Fuels and Petroleum Products in the e3 Plus Environmental Stewardship Toolkit at: www.pdac.ca/e3plus

- Hydrofluoric acid (HF): Avoid the use of hydrofluoric acid as it is an extremely toxic and corrosive acid. For additional information, refer to the subsection covering HF in section 20.9.6 Toxic Substances used for Mineral Identification.
- Propane, propylene, butane, butylene: Refer to section 10.2 Propane and Other Liquefied Petroleum Gases in the e3 Plus Environmental Stewardship Toolkit at: www.pdac.ca/e3plus
- Solvents and paints: Refer to section 10.4. Solvents and Paints in the e3 Plus Environmental Stewardship Toolkit at: www.pdac.ca/e3plus

PDAC 20.8 Guidelines for Safe Drill Moves

Carry out a risk assessment of the route and site before all drill moves. Mitigate the risks as much as possible through careful planning, good communication and following SOPs. Follow the instructions in the manufacturer's operator manual.

Risks and Hazards

- Equipment damage or loss caused by:
  - Contact with overhead hazards (power lines, tree branches, canopies of service stations)
  - Overturning or becoming stuck due to steep terrain, soft, rough or unstable ground
  - Breaking through ice
- Oversize equipment may cause collisions with vehicles, heavy equipment or obstacles when the drill is too long to safely navigate the route.
- Impact injuries caused by unsecured equipment
- Electrocution and/or burns caused by contact with overhead power lines
- Slinging accidents caused by poor planning, marginal weather conditions, poor ground conditions, lack of training, lack of or poor communication between ground staff and pilot, pilot fatigue, forceful clients or contractors who push pilots to complete the job
- Drowning or hypothermia caused by equipment breakthrough on ice (see section 20.3.3 Drilling on Ice)

Preparation and Prevention

Preparation and planning are important before all drill moves. Verify that the location is adequate (e.g., slope, clearance, free of obstructions and dangerous branches). Complete site preparations before the move commences. The exploration company representative should show the foreman/senior driller the next site prior to completion of the current hole so arrangements can proceed for the move. Inspect the drill transport conveyance (skidder, truck/flatbed etc.) to make sure it is in good working order. Be vigilant while the drill move is underway.

For all moves:

- Carry out an inspection to make sure the drill rig and transporting conveyance, including skids, are in good condition to accomplish the move. Verify the brakes are in good working order before all moves.

- Know the overhead clearance, width, length and weight of the drill rig and conveyance. Never move the drill with the mast in the raised or partially raised position.
- Secure and check all loads.
- Use a spotter to assist when lateral or overhead clearance is close and when it is necessary to back up, check for power lines or when it is advisable to stop traffic.
- Remove ignition keys when the equipment is unattended. Set all brakes and locks when the move is completed.
- No passengers may ride on the drill rig.
- If private roads are used, secure permission and be aware of specific driving habits and rules when sharing the road with other vehicles (e.g., logging trucks). Use radios with frequencies that allow you to hear communications of other traffic using the roads.

When moving a drill rig on public roads:

- Verify the brakes are in good working order before all moves. Refer to section 13.5.2 Regular Vehicle Inspections.
- Only licensed operators may drive the vehicle. Operate according to federal, provincial, territorial, and state and local regulations (AHJs).
- Check out the route and assess the hazards. Depending on the route, there may be bridges, power lines, steep and/or rough roads, sharp corners, soft shoulders, slippery conditions, protruding rocks or overhanging branches etc.
- Know the highway and bridge load restrictions as well as other restrictions on load, width and overhead clearances. Allow for the mast overhang when turning corners or approaching other vehicles or structures.
- Watch for low hanging electrical lines, high voltage power lines etc., particularly at entrances to drilling sites or commercial sites.

When moving a drill off road:

- Walk the route before moving the drill rig to assess the slope of the land and inspect the terrain for obstacles and other potential hazards.
- Use established tracks whenever possible. Do not cause unnecessary damage to trees, pasture or other vegetation.
- Always check the brakes before travelling, particularly on rough, uneven or hilly ground.
- When possible travel directly uphill or downhill. Use caution when traversing slopes as any added weight (e.g., tools) may raise the centre of gravity and cause it to tip more easily. Avoid traversing slopes that are slippery or rough.
- Consider a back-up piece of moving gear (cat, skidder) if the route is steep (one on each end of the rig).
- Do not leave a rig or carrier idling on slopes or loose ground. Block the wheels if it is stopped on an incline.

When moving a drill at night:

Moving a drill at night (in darkness), especially off road, has unique hazards. Some companies do not allow any night moves. No night move should be considered when it will soon be daylight. Even if just reorienting the drill for the next hole at the same drill pad, great care should be taken if doing so during darkness. Do not consider any moves during night time darkness, unless the following minimum conditions are met:

- The whole area of the move must be very well lit with powerful lights. The move route has to be well surveyed and inspected during daylight.
- Extraordinary efforts should be made to make sure the route is clear of all obstacles that could cause problems during the move.
- Everyone has to wear high visibility reflective clothing.
- Everyone – employees and all equipment should keep a safe distance from operating equipment until they receive a signal to approach or pass.

Helicopter assisted drill moves (slinging)

Slinging drills between drilling locations is common practice where access is limited, especially in northern Canada. Slinging requires specially trained pilots, trained ground personnel and clear communication between all personnel regarding the task at hand. For information regarding safe slinging procedures, refer to Section 16. Aircraft.

PDAC 20.9 Core Facilities and Sample Preparation

Core examination and sample preparations are often heavy dirty work that may be carried out in uncomfortable conditions – often for long periods of time. Common problems include injuries from handling bagged samples or heavy core trays, breathing dust and getting grit in the eyes.

PDAC 20.9.1 Risks and Hazards

- Back strains or injuries and neck strains caused by lifting heavy core boxes, logging core for long periods of time, working at an improper height or in an awkward body position.
- Cuts and impact injuries caused by lifting sharp core boxes, saw blades, samples that disintegrate when cut, dropped samples or core boxes.
- Hearing loss caused by high noise levels when insufficient PPE is worn around drills, core saws, crusher equipment etc.
- Eye injuries caused by flying particles.
- Electrocution or shock caused by short circuits when using electric core and slab saws with wet cutting methods, improper installation of electrical equipment.
- Fires caused by sparks from gasoline powered core or slab saws, smoking, improper fuelling practices, setting hot saws on combustible material.
- Fire, explosion, spills caused by improper fuelling practices such as not attending the fuelling nozzle (never block it open), using matches or a lighter rather than a flashlight to check contents or the level in a fuel tank or container.
- Burns caused by improper fuelling practices, hot motor parts, mixing acid for mineral tests.

- Sunburn, heat illness, or hypothermia caused by exposure to sun, heat, rain or cold in open sample collection or core logging areas, wearing inadequate clothing.
- Impact injuries caused by collapsing core storage racks, examining tables and benches.
- Radiation exposure caused by radon accumulations when radioactive samples are kept in closed storage sheds.
- Lung diseases caused by exposure to silica or amphibole dust around core saws and cyclones.
- Repetitive strain injuries caused by repeating the same task too frequently.

PDAC 20.9.2 General Safety Practices

- Develop and implement SOPs for each type of equipment used for sample collection, preparation and logging. Written SOPs should take into account the manufacturer's operator manual and any additional precautions required at the site. The site ERP should include procedures that address potential injuries that may happen in the core and sample preparation facilities.
- Training: Employees should receive training to safely handle equipment and core. Include SOPs for each type of equipment used.
- Personal protective equipment (PPE) should include the following:
  - Safety glasses with side shields or goggles
  - Respiratory protection is essential when working in sample and core cutting facilities and when sampling from cyclones.
  - Steel toed boots with good traction to prevent slips and falls and injuries from dropped rocks, core boxes etc.
  - Gloves help prevent cuts, provide thermal protection and prevent insect and scorpion stings etc.
  - Waterproof clothing to protect from water spray when using wet cutting methods.
  - Clothing – wear appropriate clothing for protection from the sun, heat, cold and wind.
- Hearing protection should be worn, as required, but especially when working with saws.
- People working in the core processing area should not wear personal entertainment devices including iPods and MP3 players as they may be distracted from the sound of malfunctioning machinery or warning signals etc. Ear plugs or headphones do not provide hearing protection. Refer to section 4.2.4 Hearing Protection.
- Monitoring and sampling: Some sample splitting and bagging etc., must be done in the vicinity of the drill. Company employees must use the same PPE as drillers to minimize hazards such as noise, dust, falling objects or pressure hose blowouts and follow the same clothing restrictions to minimize the potential risk of being caught in moving parts. Use the correct tools – use a long handled shovel to collect cuttings – never use your hands. Do not place your hands where they can be crushed, severed or harmed by machinery (e.g., cyclones).

PDAC 20.9.3 Core Facilities

- Set up core handling and logging facilities away from the drill to avoid the hazards associated with the rig and site. Build facilities with sufficient light to avoid eyestrain. Provide protection from sun, wind and rain with a roof or tarps. Make sure the roof can withstand snow loading, if necessary.
- Prevent water, snow, mud and ice from causing slipping hazards. Use nonslip rubber mats or deck tread on walkways and work areas where water and snow may be tracked- in.
- Construct core storage racks so they are strong enough and stable enough to bear the weight of fully loaded core boxes. Check the stability and strength of core racks periodically, especially if the core storage area is old, as racks deteriorate over time.
- Racks should not be built too high. Manual lifting problems increase when it is necessary to lift objects above shoulder height.
- Build tables and benches at a comfortable height for core loggers to prevent back and neck strain. They should be stable and built strongly enough not to collapse under the weight of fully loaded core boxes.
- Electrical safety: Electrical equipment should be installed by a qualified electrician. All electrical equipment including saws, power cords and cables should be grounded and incorporate ground fault circuit interrupters (GFCIs) for protection against electric shock and potential electrocution e.g., earth leakage. Do not take short cuts with electrical wiring just because a drill site is a temporary location (refer to Camp 18.4.6 Electrical Safety).
- Be alert for snakes, spiders, scorpions, bees or wasps, spiders and other critters that may take up residence in core boxes and between stacked boxes.

PDAC 20.9.4 Sample Preparation

Some sample preparation may take place at the project site. Design sample preparation areas to minimize handling and utilize mechanical lifting devices whenever possible.

- Everyone – not just the machine operators – who enters or works in a sample preparation area should wear all required PPE.
- Follow SOPs and wear PPE when sampling rock cuttings directly from cyclones.
- Refer to section 5.10 Rock and Core Handling and Cutting Equipment for information regarding specific core saws and other cutting equipment.
- Additional core saw safety tips include:
  - Core saw operators should be required to wear a full-face shield and hearing protection. As core saws use water to wet down the dust generated from the cutting procedures, a waterproof apron, gloves and steel toed rubber work boots may also be required. If core saws are operated in a confined area, enough silica dust may become airborne to create hazardous breathing conditions and require extraction ventilation equipment. It may be necessary to use a dust mask or a respirator (see 20.7.4 Hazardous Material above).
  - Before sawing rocks or splitting core, check the conditions of the saw/splitter, the ventilation and drainage of the overall workspace to prevent respiratory hazards,

slips and falls, and possible electrocution. Replace the blade if there are broken teeth on the saw blade.
  - To prevent carbon monoxide poisoning, gasoline fuelled cutting equipment should only be used outdoors and the exhaust should be vented away from the operator. Follow safe fuelling procedures.
  - When using a core saw, wear non-flammable clothing and change clothes if you spill fuel, oil or grease on them. Sparks generated while cutting may cause clothing to catch fire. Fabrics with a fuzzy finish (e.g., flannel shirts, fleece) may catch fire due to the oxygen surrounding the fibres. Wool fibres do not support combustion well and are safer than cotton. Avoid wearing synthetic fabrics (polyester or nylon) as they melt onto the skin when they ignite.
- Drying ovens may present a fire hazard so keep a fire extinguisher nearby.
- Crushers and pulverisers: These machines present several hazards for which even short term exposure can create serious health problems (e.g., deafness, lung disease).
  - Wear hearing protection at all times.
  - Dust is generated so wear respiratory protection at all times.
  - Never place fingers or hands inside a crusher or any place where they could potentially be caught or crushed.

PDAC 20.9.5 Core Logging

- Follow the regulations of authorities having jurisdiction (AHJs), especially regarding ventilation and PPE. For example, when working with asbestiform and amphibole minerals in Québec, regulations specify required PPE, including respirators, and that separate work clothing must be washed on site and kept only for sample preparation purposes. See section 20.7.4.2 Asbestos and Amphiboles.
- Follow safe lifting and manual handling procedures as logging is physically demanding work. It is advisable for core loggers to do stretching exercises and take regular breaks to avoid neck and back strains. Do some warm-up exercises before a job that requires lifting lots of core boxes.
  - Establish regular personnel rotations to reduce long term exposure to noise, dust and provide respite from arduous sampling activities.
  - Check your footing and route before lifting or moving core, especially near the drill where the ground may be slippery.
  - Use mechanical lifting devices whenever possible to reduce physical exertion. Use extra caution when it is necessary to lift objects above shoulder height.
  - Try to store core temporarily at waist height. For example, use a pickup truck to transport core to a temporary stand at waist height or to a core rack.
  - Try to build core viewing racks that are waist height (avoid putting core on the ground).
  - Refer to sections 4.3 Lifting and Back Protection and 20.5.4 Manual Handling.
- Do not lick core. Provide water at the drill and core logging sites to wet the core for examination. Licking core without knowing what drilling additives are present is risky, as several additives are poisonous.

- Chemicals: Use caution when handling chemicals to test mineralogy. See section 20.9.6 below.
- Radioactive core:
  - When moving core containing radioactive minerals, wet the core and wear dust masks.
  - Core storage: Place core on a concrete floor. The floor should be sealed and painted a different colour from the core so the dust is visible.
  - Only use wet methods to cut core.
  - For detailed information refer to Section 15. Guidelines for Radiation Protection during Exploration for Uranium in the e3 Plus Environmental Stewardship Toolkit at: www.pdac.ca/e3plus.

PDAC 20.9.6 Toxic Substances Used for Mineral Identification

The following substances may be used to indicate the presence of ore minerals or carbonate mineralization. Follow safe practices when using chemicals. Whenever a controlled substance is transferred from its labelled container, the new container must be clearly labelled unless it will be entirely used up during the work shift and it will never leave the control of the person using the substance. Internet links are provided to some material safety data sheets (MSDSs) for educational purposes. Refer to 18.2.3 Workplace Hazardous Materials Information System (WHMIS).

Blue Juice

"Blue Juice" is composed of 5 grams of potassium ferricyanide per litre of 10% HCl. It is used in gold exploration to differentiate between the various carbonate alterations associated with gold mineralization. It is usually sprayed on drill core.

- PPE: It is advisable to wear gloves and safety glasses or goggles when using blue juice.Label the container and follow the directions below if it is necessary to make up the 10%
- HCl solution from concentrated HCl.
- An MSDS for potassium ferricyanide is available at the following website: http://www.anachemia.com/msds/english/7630.pdf

Dilute Hydrochloric Acid (10% HCl)

Dilute HCl is often used in the field for testing minerals and core for the presence of carbonates. Use care as dilute HCl can cause burns to the skin and damage clothing.

- PPE: Wear safety glasses or splash goggles and gloves. Use HCl where there is good ventilation to avoid breathing fumes. Be familiar with first aid procedures which include removing clothing and thoroughly washing skin and flushing eyes if they come in contact with dilute HCl.
- If it is necessary to prepare a 10% solution of HCl, place the appropriate amount of water in a container and add the correct amount of concentrated acid to the water. Note: Do not do the reverse. If water is added to concentrated acid, the mixture may boil and splatter, which will cause burns on contact. Label all containers or bottles that contain HCl – do not presume that co-workers will be able to identify the contents because it is a small bottle that contains an eyedropper.

- Additional information regarding dilute HCl can be found at the following website: http://www.sciencestuff.com/msds/C1816.html

Hydrofluoric Acid (HF)

Hydrofluoric acid is an extremely toxic and corrosive acid. Burns from HF on the skin may not become evident for several hours; the fluoride penetrates the skin to deep tissue and reacts with calcium and magnesium in the body (in bones, heart, liver, kidneys etc.). Exposure to HF requires immediate medical attention.

Whenever possible, companies should use alternative downhole survey methods rather than hydrogen fluoride. It is advisable for contracts to stipulate that hole orientation surveys use an alternative method (e.g., single and multi-shot cameras, and magnetic and non-magnetic digital downhole survey techniques).

- K-feldspar staining requires the use of concentrated HF. The preferred and recommended place to carry out staining is in a controlled laboratory environment in an exhaust/fume hood with the extraction fan operating. If staining must be done outdoors, do it well away from people and equipment where fumes can dissipate quickly. Wear PPE and remain upwind of any fumes as they can severely burn the lungs.
- Training is essential.
  - If the chemical is on site, develop a site specific SOP for handling HF and an ER procedure that addresses hydrogen fluoride spills and inadvertent exposure.
  - Workers required to use HF must be trained in the correct procedures for use, transport, and storage. This includes WHMIS training to be familiar with the MSDS, and appropriate first aid. It is essential to use PPE and work where there is good ventilation.
  - Minimum PPE: protective goggles and face shield, gloves, boots, and a respirator, as appropriate
- HF can poison and kill with little or no warning.
- Symptoms: Inhalation can be fatal.
  - Low concentration – shortage of breath, coughing, sore throat
  - High concentration – severe headache, dizziness, impairment, mental confusion, collapse or fainting, burns to all tissue exposed. When it is absorbed into the bloodstream, HF reacts with calcium and magnesium in the body and is life-threatening.
  - Extreme concentration – unconsciousness, coma, death
  - Symptoms: Skin contact with liquid or gas causes severe burns and permanent tissue damage. Chemical burns to as little as 2% to body surface can be fatal.
  - Additional information about HF is available at the following websites: http://www.jtbaker.com/msds/englishhtml/H3994.htm http://www.osha.gov/SLTC/healthguidelines/hydrogenfluoride/index.html

Nickel Powder

"Nickel powder" is dimethylglioxime, a compound applied to drill core or rock samples to indicate the presence of nickel.

- PPE: It is advisable to wear gloves and safety glasses. Work in an area with good ventilation to avoid breathing the powder. As it can irritate the skin, avoid contact and flush skin and eyes with water if exposed. Wash contaminated clothing.
- An MSDS for dimethylglioxime is available at the following website: http://www.anachemia.com/msds/english/3608.pdf

Zinc Zap

"Zinc Zap" is a solution of chemicals (hydrochloric acid (HCl), potassium ferricyanide, and oxalic acid and N, N-diethylaniline). Although the individual chemicals are potentially dangerous in concentrated form, they are very dilute in a zinc zap solution and therefore it is not considered dangerous or hazardous goods. Nevertheless, take care when using zinc zap solutions. Wash your hands thoroughly after use to prevent oral contact. When zinc zap is applied to a specimen a bright reddish-brown colour indicates the presence of zinc.

The following instructions are adapted from the Field Geologists' Manual, 4th ed. by D. A. Berkman.

- To prepare a zinc zap solution: Wear safety goggles, a splash apron, gloves, and work in a well ventilated area (preferably a fume hood with the fan operating). Label the containers.
  - Solution #1: Dissolve in one litre of distilled water:
    - 9 mL of concentrated hydrochloric acid
    - 30 g of oxalic acid
    - 5 mL diethylaniline
  - Solution #2: Dissolve in one litre of distilled water:
    - 30 g potassium ferricyanide
- Mix equal parts of solution #1 and solution #2 to create "zinc zap". Each solution kept separately has a shelf life of about three months. When mixed together, the shelf life is about one week.

MSDS sheets for zinc zap component are available at:

- Potassium ferricyanide: http://www.jtbaker.com/msds/englishhtml/p5752.htm
- Oxalic acid: http://www.jtbaker.com/msds/englishhtml/o6044.htm
- N,N-diethylaniline: http://www.sciencelab.com/xMSDS-N_N_Dimethylaniline-9923806
- Hydrochloric acid: http://www.jtbaker.com/msds/englishhtml/H3880.htm