DRIVING
RESPONSIBLE
EXPLORATION

GUIDELINES FOR EXPLORATION
IN THE MINERALS INDUSTRY

HEALTH & SAFETY

e-TOOLKIT

VERSION 2.0

AN INITIATIVE OF
PROSPECTORS & DEVELOPERS
ASSOCIATION OF CANADA

TABLE OF CONTENTS

1.0 General Safety Principles 1

1.1 | Health and Safety Programs 2

1.2 | Due Diligence with Respect to Safety 4

1.2.1 | Employees' Rights with Respect to Due Diligence 5
1.2.1.1 | Right to Know 5
1.2.1.2 | Right to Refuse Unsafe Work 6
1.2.1.3 | Right to Participate 6
1.2.1.4 | Right to a Violence-Free Workplace 6
1.2.2 | Responsibilities with Respect to Due Diligence 7
1.2.2.1 | Board of Directors 8
1.2.2.2 | Managers 8
1.2.2.3 | Supervisors 9
1.2.2.4 | Individual Employees and Workers 10
1.2.2.5 | Health and Safety Committee Members or Safety Representatives 10
1.2.3 | Training 11
1.2.4 | Inspections and Audits 12
1.2.5 | Documentation 14

1.3 | Internal Responsibility System 14

2.0 General Safety 16

2.1 | Preparations to Reduce Risks 18

2.1.1 | Working Alone Versus the "Buddy System" 20
2.1.1.1 | Risks and Hazards 20
2.1.1.2 | Jurisdictional Requirements 20
2.1.2 | Safety Meetings 22
2.1.2.1 | Pre-Program Induction Safety Meetings 23
2.1.2.2 | Routine Scheduled Safety Meetings 26
2.1.2.3 | Daily or Shift Work Safety Meetings 27
2.1.2.4 | Drill Site Safety Meetings 28
2.1.3 | Alcohol and Drug Policies 30
2.1.4 | Job Safety Analyses 30
2.1.5 | Risk Assessments 33
2.1.5.1 | The Risk Assessment Process 33
2.1.5.2 | Methods to Identify Risk Factors 38

2.2 | Accident and Incident Investigation and Reporting 44
2.2.1 | Securing the Site 46
2.2.2 | Observations 46
2.2.3 | Documentation 47
2.2.4 | Interviews 47
2.2.5 | Analysis 48
2.2.6 | Recommendations 48
3.0 Emergency Response 49
3.1 | Risks and Hazards 50
3.2 | Emergency Management Versus Crisis Management 50
3.3 | Guidelines for Developing Emergency Response Plans 51
3.4 | Components of Emergency Response Plans 53
3.4.1 | Site Operation Information 53
3.4.2 | Risk Assessment of Site Operations 54
3.4.3 | Emergency Equipment 54
3.4.4 | Trained Personnel 55
3.4.5 | Implementation of Emergency Response Plans 55
3.4.6 | Directions to the Site 56
3.4.7 | Communications and Contact Lists 56
3.4.8 | Training and Testing Emergency Response Plans 58
3.4.9 | Documentation 59
3.4.10 | Recovery 59
3.5 | Guidelines for Developing Emergency Response Procedures 59
3.5.1 | Medical Emergency 60
3.5.2 | Vehicle Accident or Incident 61
3.5.3 | Missing Persons 61
3.5.4 | Survival – Stranded Crew 61
3.5.5 | Aircraft Accident 62
3.5.6 | Boat Accident 63
3.5.7 | Fires 64
3.5.8 | Whiteouts and Extreme Cold 65
3.5.9 | Wild Animals 66
3.5.10 | Spills 67
3.5.11 | Bomb Threat and Security 68
3.5.12 | Example of a News Release 68

4.0 Personal Safety 70

4.1 | Risks and Hazards 71

4.2 | Hazard Control and Personal Protective Equipment (PPE) 71

4.2.1 | Physical Conditioning 73
4.2.2 | Head Protection 74
4.2.3 | Eye Protection 76
4.2.4 | Hearing Protection 79
4.2.5 | Hand Protection 81
4.2.6 | Foot Protection 84
4.2.7 | Lung Protection 86
4.2.8 | Protection from Ionizing Radiation 88

4.3 | Lifting and Back Protection 89

4.4 | Skin Protection 91

5.0 Field Equipment Safety 94

5.1 | General Guidelines for the Safe Use of Tools 94

5.2 | Rock Hammers and Chisels 97

5.3 | Axes, Swedish Brush Hooks, Knives and Machetes (Pangas) 98

5.4 | Augers 100

5.5 | Power Tools 102

5.6 | Chainsaws 104

5.6.1 | Risks and Hazards 104
5.6.2 | Preventions and Preparations 104
5.6.3 | Chainsaw Kickback 107
5.6.4 | Safety Considerations When Felling Trees 108

5.7 | Brush Cutters 110

5.8 | Water Pumps 111

5.9 | Small Generators 112

5.10 | Rock and Core Handling and Cutting Equipment 114

5.10.1 | Risks and Hazards 114
5.10.2 | General Rock and Core Handling Guidelines 114
5.10.3 | General Safety Regarding Rock Cutting Saws 116

5.10.4 | Core Cutting Saws 118
5.10.5 | Core Splitters........ 119
5.10.6 | Portable Rock Saws........ 120
5.10.7 | Stationary Slab Saws 121

5.11 | Portable Handheld XRF Analyzers 121

6.0 Safe Traversing Practices 122

6.1 | Risks and Hazards........ 122

6.2 | Responsibilities (Due Diligence) and Traversing 123

6.3 | General Traversing Guidelines 124

6.3.1 | Development of Safe Operating Procedures 125
6.3.2 | Emergency Response Plans 127
6.3.3 | Training for Safe Traversing 127
6.3.4 | Day Pack Equipment 128
6.3.5 | Clothing........ 131
6.3.6 | Traversing Alone Versus the "Buddy System"........ 135
6.3.7 | Traverse Planning Tips 136
6.3.8 | Tips for Knowing Your Location 137
6.3.9 | Communication and Signaling Tips 138
6.3.10 | Emergency and Survival Tips 139

6.4 | Traversing in Specific Terrain 141

6.4.1 | Mountainous Terrain........ 141
6.4.2 | Snowfields and Glacier Terrain 144
6.4.3 | High Arctic Latitudes........ 146
6.4.4 | Cliffs and Steep Terrain 148
6.4.5 | Traversing Safety and Streams, Rivers and Lakes........ 149
6.4.6 | Wet Terrain........ 153
6.4.7 | Deserts........ 154
6.4.8 | Heavy Vegetation or Jungle 155
6.4.9 | Tropics........ 157
6.4.10 | Working Along Roads, Highways and Railway Cuts 158

7.0 Knowing Your Location 160

7.1 | Risks and Hazards 161

7.2 | Topographic Maps and Map Grids........ 162

7.3 | Air Photographs and Satellite Images........ 165

7.4 | Compasses 166

7.5 | Global Positioning Systems (GPS) 167

7.6 | Emergency Locator Devices (ELTs, PLBs) 169

7.7 | Batteries 171

8.0 Survival 173

8.1 | Risks and Hazards 174

8.2 | Responsibilities (Due Diligence) and Survival 175

8.3 | Prevention and Preparation for Survival Situations 177

8.3.1 | Attitude 177
8.3.2 | Knowledge.. 178
8.3.3 | Equipment 182
8.3.4 | Confronting a Survival Situation 182

8.4 | Survival Equipment Lists...184

8.5 | General Advice for Survival Situations...187

8.5.1 | Survival Advice for Cold Climate Conditions 188
8.5.2 | Survival Advice for Desert Conditions..189
8.5.3 | Survival Advice for Forested Areas 190

8.6 | Priorities for Survival Situations 191

8.6.1 | First Aid 192
8.6.2 | Location 192
8.6.3 | Shelter 192
8.6.4 | Fire 198
8.6.5 | Water and Food 201
8.6.6 | Signalling...205

8.7 | Search and Rescue (SAR)... 212

8.7.1 | Guidelines for the Lost or Injured Person 212
8.7.2 | Guidelines for the Project or Camp Manager 215

9.0 Weather and Environmental Risks 217

9.1 | Weather Hazards 217

9.1.1 | General Preparations 218

9.2 | Lightning 219
- 9.2.1 | Risks and Hazards 219
- 9.2.2 | Prevention and Preparation 219

9.3 | Whiteouts 222
- 9.3.1 | Risks and Hazards 222
- 9.3.2 | Prevention and Preparation 223

9.4 | Avalanches 225
- 9.4.1 | Risks and Hazards 226
- 9.4.2 | Prevention and Preparation 226

9.5 | Floods 230
- 9.5.1 | Risks and Hazards 230
- 9.5.2 | Prevention and Preparation 231

9.6 | Mudflows and Landslides 233
- 9.6.1 | Risks and Hazards 234
- 9.6.2 | Prevention and Preparation 234

9.7 | High Winds 235
- 9.7.1 | Tornadoes 238
- 9.7.2 | Hurricanes, Cyclones and Typhoons 241

9.8 | Environmental Risks 243

9.9 | Cold Injuries 243
- 9.9.1 | Risks and Hazards 243
- 9.9.2 | Project Planning to Prevent Cold Injuries 244
- 9.9.3 | Hypothermia 245
  - 9.9.3.1 | Prevention and Preparation 245
  - 9.9.3.2 | Symptoms and Recognition 246
  - 9.9.3.3 | Treatment for Mild Hypothermia 248
- 9.9.4 | Cold Water Immersion Hypothermia 249
- 9.9.5 | Frostbite 250
- 9.9.6 | Immersion Foot 252

9.10 | Heat Illnesses and Solar Injuries 255
- 9.10.1 | Risks and Hazards 255
- 9.10.2 | Project Planning to Prevent Heat Illnesses 255
- 9.10.3 | Hyperthermia 256
  - 9.10.3.1 | Prevention and Preparation 256
  - 9.10.3.2 | Less Serious Forms of Hyperthermia 258
  - 9.10.3.3 | Heat Exhaustion and Heat Stroke 258
  - 9.10.3.4 | Interim Treatment – Prior to Evacuation to a Medical Centre 260

9.10.4 | Sunburn ... 261
9.10.5 | Snow Blindness ... 263

9.11 | Altitude Illness ... 264

9.11.1 | Risks and Hazards ... 265
9.11.2 | Acute Mountain Sickness (AMS) ... 266
9.11.2.1 | Symptoms of AMS ... 266
9.11.2.2 | Recognition and Classification of Acute Mountain Sickness (AMS) ... 268
9.11.2.3 | Treatment for AMS ... 269
9.11.3 | Severe AMS – High Altitude Cerebral Edema (HACE) ... 269
9.11.4 | Severe AMS – High Altitude Pulmonary Edema (HAPE) ... 269
9.11.5 | Other Altitude-Related Illnesses ... 270
9.11.6 | Planning for High Altitude Projects ... 271

10.0 Wildlife ... 274

10.1 | Risks and Hazards ... 274

10.2 | Responsibilities (Due Diligence) Regarding Wildlife ... 275

10.3 | Bears ... 276

10.3.1 | Precautions and Preventions ... 277
10.3.2 | Types of Bears ... 279
10.3.3 | Bear Habitats and Signs ... 280
10.3.4 | Tips for Project or Camp Site Locations ... 282
10.3.5 | Food Handling and Waste Management ... 283
10.3.5.1 | Guidelines for Food Handling and Storage ... 283
10.3.5.2 | Guidelines for Waste Management ... 284
10.3.6 | Bear Warning Systems for Camps ... 286
10.3.7 | Bear Response Plans ... 287
10.3.8 | Bear Behaviour ... 288
10.3.8.1 | Bear Behaviour – Recognizing Signs of Stress ... 289
10.3.8.2 | Defensive and Non-Defensive Bear Behaviour ... 290
10.3.9 | Bear Deterrents ... 290
10.3.9.1 | Noise Makers ... 291
10.3.9.2 | Bear Pepper Spray ... 292
10.3.9.3 | Firearms ... 294
10.3.9.4 | When it is Necessary to Shoot a Bear ... 296
10.3.9.5 | Deterrents Use – Effective Range ... 296
10.3.10 | Guidelines for Bear Encounters ... 297
10.3.10.1 | Tips for Avoiding Bear Encounters on Traverses ... 297
10.3.10.2 | Bear Encounters – How You Should React ... 299
10.3.10.3 | Encounters – When Bears React Defensively ... 299
10.3.10.4 | Encounters – When Bears React Non-Defensively ... 300

10.4 | Other Large Mammals 301
10.4.1 | North and South America 301
10.4.2 | Africa and Asia 305
10.5 | Dogs, Cats and Monkeys 306
10.6 | Reptiles 306
10.6.1 | Snakes 307
10.6.1.1 | Prevention and Preparation to Avoid Snakebite 308
10.6.1.2 | Treatment of Snakebite 310
10.6.1.3 | Australian Pressure-Immobilization Technique for Snakebite 313
10.6.2 | Crocodiles and Alligators 314
10.7 | Insects, Arthropods and Leeches 316
10.7.1 | Mosquitoes and Flies 316
10.7.2 | Bees, Wasps and Ants 318
10.7.2.1 | Allergic Reactions and Anaphylactic Shock 319
10.7.3 | Ticks 320
10.7.4 | Fleas 322
10.7.5 | Bed Bugs 323
10.7.6 | Triatoma Bugs 323
10.7.7 | Scorpions 324
10.7.8 | Spiders 325
10.7.9 | Leeches 328
11.0 Surveying Safety: Geophysical, Geochemical and Line Cutting 329
11.1 | General Risks and Hazards Associated with All Surveys 330
11.1.1 | Essential Safety Guidelines for All Surveys 330
11.1.2 | General Safety Tips 331
11.2 | Geophysical Survey Safety 333
11.2.1 | Specific Risks and Hazards Associated with Geophysical Surveys 333
11.2.2 | Field Safety Tips for Geophysical Surveys 334
11.3 | Geochemical Survey Safety 339
11.3.1 | General Prevention and Preparation 339
11.3.2 | Stream Sediment Surveys 341
11.4 | Line Cutting Safety 345
12.0 Travel, Safety and Security 349
12.1 | Risks and Hazards 349

12.2 | Responsibilities (Due Diligence) and Travel Safety....350

12.3 | International Travel Preparations....352

12.3.1 | Preparation Checklist....352
12.3.2 | Aircraft Travel Considerations....354

12.4 | Personal and Travel Security....355

12.5 | Hotel Safety....358

12.6 | Hotel Fire Safety....359

12.7 | Kidnap and Ransom....362

12.7.1 | Express Kidnapping....363

12.8 | Travel Health....364

12.8.1 | Ear Barotrauma and Jet Lag....365
12.8.2 | Deep Vein Thromboses (Blood Clots)....366
12.8.3 | Safe Food and Water in Developing Countries....367
12.8.3.1 | Safe Food Guidelines....367
12.8.3.2 | Safe Water and Drinks....368
12.8.3.3 | Water Treatment in Remote Areas or Developing Countries....370
12.8.3.4 | Safe Water for Swimming and Bathing....372
12.8.3.5 | Fluid Replacement Therapy....372
12.8.4 | Protection from Insect Bites....374
12.8.5 | Diseases....376
12.8.5.1 | Chagas Disease (Trypanosomiasis – American)....377
12.8.5.2 | Cholera....378
12.8.5.3 | Dengue Fever....379
12.8.5.4 | Hepatitis, Viral....380
12.8.5.5 | Histoplasmosis....383
12.8.5.6 | Japanese Encephalitis (JE)....383
12.8.5.7 | Legionnaires' Disease....384
12.8.5.8 | Leptospirosis....386
12.8.5.9 | Malaria....387
12.8.5.10 | Meningococcal Meningitis....392
12.8.5.11 | Plague....393
12.8.5.12 | Rabies....393
12.8.5.13 | Schistosomiasis....395
12.8.5.14 | Travellers' Diarrhea....396
12.8.5.15 | Typhoid....397
12.8.5.16 | Yellow Fever....398

DRIVING RESPONSIBLE EXPLORATION

13.0 Vehicles ... 400

13.1 | Risks and Hazards ... 400

13.2 | Responsibilities (Due Diligence) Regarding Vehicles ... 401

13.3 | Safe Driving Guidelines for All Vehicles ... 402

13.4 | Equipment Lists for Vehicles ... 403

13.5 | Vehicle Maintenance and Inspections ... 406

13.5.1 | Vehicle Maintenance ... 406
13.5.2 | Regular Vehicle Inspections ... 407
13.5.3 | Contractor's Vehicles ... 408
13.5.4 | Rental or Leased Vehicles ... 409

13.6 | Training ... 409

13.6.1 | Loading Guidelines ... 410
13.6.2 | Vehicle Controls and Equipment ... 410
13.6.3 | How to Change a Tire ... 411
13.6.4 | How to Use a Hi-Lift Jack (Jack-All, Kangaroo Jack) ... 413
13.6.5 | Starting a Vehicle with Booster Cables (Jump Start) ... 414
13.6.6 | Winches ... 415
13.6.7 | Fuelling Procedures ... 416

13.7 | Handling and Driving Skills ... 417

13.7.1 | Braking ... 417
13.7.2 | Parking ... 418
13.7.3 | Reversing ... 419
13.7.4 | Crossing Streams ... 419
13.7.5 | Towing ... 420

13.8 | Defensive Driving Skills and Attitudes ... 425

13.8.1 | General Defensive Driving Techniques ... 425
13.8.2 | Techniques for Unpaved Roads ... 427
13.8.3 | Weather-Related Safe Driving Techniques ... 427

13.9 | Four-Wheel Drive Vehicle Operation Guidelines ... 431

13.9.1 | General Driving Techniques ... 431
13.9.2 | Off-Road Driving Guidelines ... 432

14.0 All-Terrain Vehicles (ATVs and Quads) ... 435

14.1 | Risks and Hazards ... 436

14.2 | Responsibilities (Due Diligence) Regarding ATVs....436

14.3 | Safe Operating Guidelines for ATVs....437

14.4 | Equipment Lists for ATVs.... 440

14.5 | Inspection, Maintenance and Fuelling Guidelines 442

14.6 | Training for ATV Operators 445

14.7 | Safety Precautions 446

14.8 | Basic Safe Riding Skills 448

- 14.8.1 | Correct Riding Posture....448
- 14.8.2 | ATV Controls 448
- 14.8.3 | Loads 450
- 14.8.4 | Towing Trailers....450
- 14.8.5 | Transporting ATVs.... 451

14.9 | Safe Riding Strategies 453

- 14.9.1 | General Strategies....453
- 14.9.2 | Tips for Crossing Obstacles....454
- 14.9.3 | Tips for Turning 454
- 14.9.4 | Tips for Climbing Hills 455
- 14.9.5 | Tips for Descending Hills....456
- 14.9.6 | Tips for Traversing Slopes....457
- 14.9.7 | ATV Retrieval Tips 458
- 14.9.8 | Riding in Various Terrains....459
- 14.9.9 | Riding in Water....460
- 14.9.10 | Riding in Sand (Deserts or Beaches).... 461

14.10 | Utility Vehicles 461

15.0 Snowmobiles 464

15.1 | Risks and Hazards 464

15.2 | Responsibilities (Due Diligence) Regarding Snowmobiles 465

15.3 | Safe Operating Guidelines for Snowmobiles 466

15.4 | Equipment Lists for Snowmobiles 468

15.5 | Inspections, Maintenance and Fuelling Guidelines 471
15.5.1 | Inspections 471
15.5.2 | Maintenance 472
15.5.3 | Fuelling Procedures 473
15.6 | Training for Snowmobile Operators 474
15.7 | Safety Precautions for Snowmobiles 475
15.8 | Safe Riding Skills 479
15.8.1 | Riding Positions 480
15.8.2 | Visibility and Light Conditions 480
15.8.3 | Towing 481
15.8.4 | Transporting Snowmobiles 481
15.9 | Safe Riding Strategies 482
15.9.1| Weather and Terrain Tips 482
15.9.2 | Retrieving a Snowmobile 483
15.9.3 | Hazards on Land 484
15.10 | Working on Ice 485
15.10.1 | Risks and Hazards 485
15.10.2 | Ice Terminology and Features 486
15.10.3 | Hazards Related to Ice 487
15.10.4 | Ice Testing Equipment 494
15.10.5 | Planning and Preparation for Working on Ice 496
15.10.5.1 | Guidelines for Testing and Assessing Safe Ice Thickness 496
15.10.5.2 | Guidelines for Testing Ice Thickness on Foot 500
15.10.5.3 | Guidelines for Safe Snowmobile Ice Crossings 501
15.11 | Cold Water Immersion Hypothermia – Falling Through Ice 502
16.0 Aircraft 506
16.1 | Risks and Hazards 506
16.2 | Responsibilities (Due Diligence) Regarding Aircraft 507
16.3 | Aircraft Charters 509
16.4 | Safe Operating Guidelines for All Aircraft 510
16.5 | Pilot Fatigue 512
16.6 | Float Planes 513
16.7 | Helicopters 514

16.7.1 | Safe Operating Guidelines for Helicopters 515
16.7.2 | Additional Safety Guidelines for Helicopters 518
16.7.3 | Guidelines for Hover and Toe-in Manoeuvres 520

16.8 | Safe Loading Guidelines for All Aircraft 523

16.9 | Transportation of Dangerous Goods 523

16.10 | Training 525

16.10.1 | Aircraft Safety Induction Meetings 525
16.10.2 | Regular Pre-Flight Safety Briefings 526
16.10.3 | Safety Briefings for Special Operations 527

16.11 | Responsibilities Regarding Aircraft 529

16.11.1 | Pilots 529
16.11.2 | Project Manager or Supervisor 530
16.11.3 | Passengers 532

16.12 | Slinging 533

16.12.1 | Risks and Hazards 533
16.12.2 | Causes of Slinging Accidents 534
16.12.3 | Safe Slinging Guidelines 535
16.12.4 | Planning for Safe Slinging Operations 536
16.12.5 | Slinging Responsibilities 541
16.12.6 | Guidelines for Drill Slinging Operations 543

16.13 | Temporary Landing Sites 546

16.13.1 | Helicopter Landing Sites 546
16.13.2 | Landing Strips 550

16.14 | Commonly Accepted and Known Hand Signals 551

16.15 | Emergency Procedures 552

16.15.2 | Ground to Air Emergency Signals 554

17.0 Boats, Canoes and Inflatables 556

17.1 | Risks and Hazards 557

17.2 | Responsibilities (Due Diligence) Regarding Boats, Canoes and Inflatables 558

17.3 | Safe Operating Guidelines for Boats, Canoes and Inflatables 559

17.4 | Safe Loading Guidelines 560

17.5 | Equipment – Required and Recommended 561

17.5.1 | Required Equipment ... 561
17.5.2 | Recommended Equipment ... 564
17.5.3 | Information about Specific Equipment ... 566

17.6 | Communications Guidelines for Boats, Canoes and Inflatables ... 569

17.7 | Guidelines for Motors and Fuel Handling ... 572

17.7.1 | Motors ... 572
17.7.2 | Fuelling Procedures ... 573

17.8 | Maintenance and Inspection Guidelines ... 574

17.9 | Training ... 575

17.10 | Safe Boat Handling Guidelines and Techniques ... 576

17.11 | Recognition of Boating Risks and Hazards ... 577

17.12 | Water Survival ... 583

17.12.1 | Risks and Hazards ... 583
17.12.2 | Prevention and Preparation ... 583
17.12.3 | Cold Water Immersion Hypothermia ... 584

18.0 Camp Set Up and Management ... 588

18.1 | Risks and Hazards Associated with Exploration Camps ... 589

18.2 | Jurisdictional Regulations and Company Policies ... 590

18.2.1 | Alcohol and Drug Policies ... 590
18.2.2 | Firearms Regulations and Policies ... 591
18.2.2.1 | Risks and Hazards ... 591
18.2.2.2 | Company Owned Firearms in Canada ... 591
18.2.2.3 | Company Firearms Policy ... 592
18.2.2.4 | Essential Safe Firearms Practices ... 593
18.2.3 | Workplace Hazardous Materials Information System (WHMIS) ... 596
18.2.3.1 | Responsibilities of Suppliers, Employers and Employees ... 597
18.2.3.2 | WHMIS Hazard Classifications, Symbols and Labels ... 597
18.2.3.3 | Material Safety Data Sheets (MSDSs) ... 600
18.2.3.4 | Site Specific WHMIS Training Requirements ... 602

18.3 | Responsibilities (Due Diligence) and Camp Management ... 603

18.4 | Camp Management Guidelines ... 607

18.4.1 | Site Selection and Location....607
18.4.1.1 | Site Layout and Organization....608
18.4.1.2 | Communications....609
18.4.2 | Fire Safety....610
18.4.2.1 | Fire Extinguishers....612
18.4.2.2 | Firefighting Basics....616
18.4.3 | Fuels and Fuel Handling....617
18.4.4 | Lanterns, Heating Stoves and Appliances....622
18.4.4.1 | Carbon Monoxide Poisoning....626
18.4.5 | Generators....628
18.4.6 | Electrical Safety....630
18.4.6.1 | General Guidelines for Electrical Safety....630
18.4.6.2 | Lockout and Tag Out procedures....632
18.4.6.3 | Batteries....634

18.5 | First Aid....636

18.5.1 | Emergency First Aid Planning and Preparation....636
18.5.2 | First Aid Kits and Supplies....638
18.5.3 | First Aid Training....639

18.6 | Health....639

18.6.1 | Employee Hygiene....640
18.6.2 | Guidelines for Kitchen Safety, Food Handling and Food Storage....640
18.6.2.1 | Kitchen Operations Safety....642
18.6.2.2 | Food Preparation Safety....643
18.6.2.3 | Kitchens: Animal and Insect Controls....645
18.6.3 | Drinking Water Safety....646
18.6.4 | Waste Management....648
18.6.5 | Diseases....652
18.6.5.1 | Diphtheria....652
18.6.5.2 | Giardiasis....653
18.6.5.3 | Hantaviral Diseases....654
18.6.5.4 | HIV/AIDS....656
18.6.5.6 | Measles....659
18.6.5.7 | Mumps....660
18.6.5.8 | Polio....661
18.6.5.9 | Rocky Mountain Spotted Fever....661
18.6.5.10 | Rubella....662
18.6.5.11 | Tetanus....663
18.6.5.12 | Tuberculosis (TB)....664
18.6.5.13 | West Nile Virus....665

18.7 | Manual Handling....666

18.8 | Housekeeping....669

19.0 General Safety Principles....670

19.1 | Risks and Hazards....671

19.2 | Responsibilities (Due Diligence) Regarding Communications....672

19.3 | Equipment Selection....673

19.3.1 | Equipment Considerations....673
19.3.2 | Satellite Telephones....675
19.3.3 | Two-Way Radios....677
19.3.4 | Mobile or Cellular Telephones....679
19.3.5 | Emergency Locator Devices (ELTs, PLBs, EPIRBs)....679

19.4 | Training....682

19.5 | Communications Routines, Schedules and Protocols....683

19.5.2 | Radio Use Protocols....685

19.6 | Emergency Communications....686

19.6.1 | Project Emergency Call List....687
19.6.2 | Company Hotlines....688

19.7 | Communications Tips Regarding Transportation....688

20.0 Drilling Sites....691

20.1 | Risks, Hazards and Common Injuries Related to Drilling....691

20.2 | Responsibilities (Due Diligence) Regarding Drilling Sites....695

20.3 | Drill Site Location, Planning and Preparation....698

20.3.1 | General Preparations....698
20.3.2 | Drilling Near Power Lines....701
20.3.3 | Drilling on Ice....702

20.4 | General Safety Guidelines for Drill Sites....709

20.4.1 | Emergency Response Plans (ERPs)....709
20.4.2 | Communications....711
20.4.3 | Pre-Program Safety Meetings....711
20.4.4 | Inspections....712

20.4.5 | Reporting 712
20.4.6 | Employee Conduct 713
20.4.7 | Site Visitors 713

20.5 | Guidelines for Safe Work Practices 714

20.5.1 | Personal Protective Equipment (PPE) 714
20.5.2 | Working at Height – Fall Protection 715
20.5.3 | Housekeeping 717
20.5.4 | Manual Handling 718

20.6 | General Hazards Associated with Drills and Specific Equipment 719

20.6.1 | General Safety around Drill Sites 719
20.6.2 | General Safety Tips Regarding Drilling Methods 720
20.6.3 | Specific Hazards Regarding Drilling Methods 722
20.6.3.1 | Specific Drilling Methods 722
20.6.3.2 | Exposed Machine Parts 724
20.6.3.3 | Mechanical Failures 725
20.6.3.4 | Hydraulic Systems 725
20.6.3.5 | Compressed Air Systems 726
20.6.3.6 | High Pressure Hoses 726
20.6.3.7 | High Pressure Pumping Systems 728
20.6.3.8 | Fire 728
20.6.3.9 | Waterline Heaters 730

20.7 | Health Hazards 730

20.7.1 | Noise 730
20.7.2 | Respiratory Hazards 731
20.7.3 | Radioactive Mineral Sampling and Storage 731
20.7.4 | Hazardous Materials 731
20.7.4.1 | Silica Dust 732
20.7.4.2 | Asbestos and Amphiboles 732
20.7.4.3 | Drilling Additives and Fluids 733
20.7.4.4 | Other Hazardous Materials 734

20.8 | Guidelines for Safe Drill Moves 734

20.9 | Core Facilities and Sample Preparation 737

20.9.1 | Risks and Hazards 737
20.9.2 | General Safety Practices 738
20.9.3 | Core Facilities 739
20.9.4 | Sample Preparation 740
20.9.5 | Core Logging 741
20.9.6 | Toxic Substances used for Mineral Identification 742

20.10 | Selecting a Drill Contractor – Evaluation Criteria 745

20.10.1 | Suggested Drilling Contract Requirements 746

21.0 Advanced Exploration Sites, Trenches and Access Routes 748

21.1 | General Risks and Hazards 749

21.2 | Responsibilities (Due Diligence) and Advanced Exploration Sites 749

21.3 | Heavy Equipment....752

21.3.1 | Specific Risks and Hazards....752
21.3.2 | Training....753
21.3.3 | Prevention and Preparation....754
21.3.4 | Working Near Power Lines 760

21.4 | Access Routes to Advanced Sites....764

21.4.1 | Specific Risks and Hazards....764
21.4.3 | Winter Access Routes 766
21.4.3.1 | Specific Risks and Hazards 767
21.4.3.2 | Planning and Preparation for Winter Access Routes 768
21.4.3.3 | Construction of Winter Access Routes....772

21.5 | Trenches and Pits....777

21.5.1 | Specific Risks and Hazards 777
21.5.2 | Jurisdictional Regulations 777
21.5.3 | Prevention and Preparation....778

21.6 | Explosives 782

21.6.1 | Specific Risks and Hazards....782
21.6.2 | Jurisdictional Regulations....783
21.6.3 | Prevention and Preparation 783

22.0 Abandoned and Old Sites 785

22.1 | Risks and Hazards....786

22.2 | Responsibilities (Due Diligence) with Regard to Old or Abandoned Sites....787

22.3 | Guidelines and Preparations for Exploring Old or Abandoned Sites 789

22.4 | Surface Hazards at Old Workings 791

22.4.1 | Abandoned Surface, Pit or Strip Mines....791
22.4.2 | Surface Structures and Machinery 792
22.4.3 | Tailings and Water-Filled Areas....792
22.4.4 | Surface Subsidence 793
22.4.5 | Explosives and Chemical Hazards....794
22.4.6 | Wildlife 795

22.5 | Preparation Requirements to Enter Old Workings 797

22.5.1 Exploration Team Requirements 797
22.5.2 | Equipment 798
22.5.3 | Tests and Procedures Prior to Entry 799
22.5.4 | Underground Lighting 799

22.6 | Ventilation 800

22.7 | Gases 800

22.7.1 | Oxygen O_2 801
22.7.2 | Carbon Dioxide CO_2 802
22.7.3 | Carbon Monoxide CO 803
22.7.4 | Hydrogen Sulphide H_2S 803
22.7.5 | Methane CH_4 804
22.7.6 | Nitrogen Oxides NO and NO_2 805
22.7.7 | Sulphur Dioxide SO_2 806
22.7.8 | Radon Rn 806

22.8 | Shafts, Adits, Tunnels and Declines 807

22.9 | Common Hazards in Old Underground Workings 809

22.9.1 | Timbers 809
22.9.2 | Ladders 809
22.9.3 | Water 811
22.9.4 | Muck Piles and Mine Fill 811

22.10 | Sampling on Abandoned Mine Sites – Surface and Underground 811

22.11 | Confined Spaces 812

Appendix I: References 817

LIST OF FIGURES

Figure 2.1: Fishbone diagram 39

Figure 2.2: Fishbone diagram for specific problems 40

Figure 2.3: Fishbone diagram for risk of a fatal accident while drilling 41

Figure 4:1: Correct lifting procedures 90

Figure 5.1: Ice auger with an extension in place © Iain Mitchell 102

Figure 5.2: Kickback Zone 108

Figure 6.1: Sample with care when others are nearby and hold discussions away from traffic. © Tony LeCheminant 159

Figure 7.1: 406 MHz Emergency Locator Transmitter (ELT) mounted in a helicopter. Know the location and how to manually activate the ELT whenever you fly in charter aircraft. © Great Slave Helicopters 171

Figure 8.1: Survival kit for day pack © Matt Turner 186

Figure 8.2: Survival essentials for pockets © Courtney Mitchell 186

Figure 8.3: Finding your direction 188

Figure 8.4: Creating shade in the desert using a canopy 190

Figure 8.5: Examples of a lean to shelter 194

Figure 8.6: Example of a simple shelter 195

Figure 8.7: Example of a tree base shelter 196

Figure 8.8: Example of a quinzee © Jamie Bastedo 197

Figure 8.9: Creating ventilation in a snow tunnel 197

Figure 8.10: Example of a platform fire 200

Figure 8.11: Transpiration bags 203

Figure 8.12: Example of a solar still 204

Figure 8.13: Using a signal mirror without a sighting hole 207

Figure 9.1: Crouch with your feet touching together. 222

Figure 9.2: Use caution when crossing on foot or by vehicle when water is flowing across a road. © Bill Mitchell 233

Figure 9.3: Map of the annual number of tornados 239

Figure 10.1: Grizzly bear © Matt Turner 278

Figure 10.2: Empty can of bear spray chewed by a grizzly bear. © Michelle Pond 293

Figure 10.3: Choosing the correct deterrent during a bear encounter 297

Figure 10.4: Train your eyes to see the shapes, colours and patterns of snakes. © Dr. Kate Jackson 309
Figure 11.1: Ground magnetic survey traverse © Erika Tamboline 337
Figure 11.2: Geochemical samples are often small. Wear gloves to protect your skin. © Erika Tambolinea 340
Figure 11.3: Stream sampling © Erika Tamboline 344
Figure 12.1: Fluid Replacement Therapy 373
Figure 13.1: Follow safe procedures when changing a flat tire. © Courtney Mitchell 412
Figure 13.2: Backing a trailer 424
Figure 13.3: The road is flooded and may be damaged. Test the quality of the road bed by walking across before driving through water. © Bill Mitchell 431
Figure 14.1: Check the tire pressure before setting out each day. 443
Figure 14.2: The correct way to unload an ATV from the bed of a pickup truck. 452
Figure 14.3: Keep weight uphill when ascending a slope. © Kim Bilquist 456
Figure 14.4: Keep weight uphill when descending a slope. © Kim Bilquist 457
Figure 14.5: Keep weight uphill when traversing a slope. © Kim Bilquist 458
Figure 14.6: Ride safely and responsibly. A breakdown or running out of fuel may strand you in a remote area. 460
Figure 14.7: Utility vehicles are usually safer to use than ATVs. © Courtney Mitchell 463
Figure 15.1: Commercial ice rescue picks © Courtney Mitchell 470
Figure 15.2: Using commercial ice rescue picks © Courtney Mitchell 471
Figure 15.3: Wear a helmet and follow at a safe distance. © Lorne Burden 476
Figure 15.4: Pressure ridge, snow covered ice on Great Slave Lake, Northwest Territories © Jens Pedersen 488
Figure 15.5: Pressure ridges may hide thin ice and open water. © Jens Pedersen 489
Figure 15.6: A stream flowing underneath a cover of fractured ice and snow presents a risk of falling through and being swept away despite the shallow depth near the bank. © Bill Mitchell 490
Figure 15.7: Overflow on a trail crossing a swamp © Jens Pedersen 492
Figure 15.8: Crack with open water in a pressure ridge © Jens Pedersen 493
Figure 15.9: Ice auger with extension © Iain Mitchell 495
Figure 15.10: Computing the "effective ice thickness" 499
Figure 15.11: Surviving a fall through ice 503

Figure 16.1: Float Plane propeller danger zone 513
Figure 16.2: Maintaining eye contact with pilot to approach a helicopter 515
Figure 16.3: Approaching a helicopter 516
Figure 16.4: Helicopter blades can dip down in wind 516
Figure 16.6: General helicopter safety....519
Figure 16.7: Helicopter landing sites 520
Figure 16.8: Drill slinging 546
Figure 16.9: Elevation and plan views for suggested minimum dimensions of a temporary helicopter landing area 547
Figure 16.10: Try to verify the condition of a remote landing strip; this aircraft had to be towed to firmer ground before departure. © Bill Mitchell 551
Figure 16.11: Marshalling signals for helicopters 551
Figure 17.1: Wear PFDs and line boats through rapids. © Iain Mitchell 582
Figure 17.2: Heat Escape Lessening Posture (HELP) 587
Figure 18.1: Keep copies of MSDSs in a convenient location for easy referral. © Bill Mitchell 602
Figure 18.2: Site specific emergency response equipment: eye wash station (left) and spill kit (right). © Bill Mitchell 603
Figure 18.3: Class of fire, letter symbol and pictographs. The pictograph is not always present on fire extinguishers. 613
Figure 18.4: Refilling a (BC) fire extinguisher with extinguishing powder (sodium bicarbonate) © Courtney Mitchell 615
Figure 18.5: Firefighting practice – extinguishing a fuel fire © Erika Tamboline 617
Figure 18.6: Correctly stored compressed gas cylinders – upright, secured with safety caps in place and off wet ground to prevent corrosion. © Courtney Mitchell 622
Figure 18.7: A refillable heating oil tank and berm lined with chemical resistant fabric. © Bill Mitchell 625
Figure 18.8: A large camp kitchen – clean, organized and with food tightly covered that can remain at room temperature. 646
Figure 18.9: Burn barrel © Trauma TechIncinerator © Bill Mitchell 650
Figure 18.10: A dangerous pile of geofabric rolls: provide adequate end support to prevent collapse. © Courtney Mitchell 668
Figure 19.1: Emergency Locator Transmitter © Great Slave Helicopters 681

Figure 20.1: Drilling on steep slopes requires attention to drill pad stability and fall prevention. © Hy-Tech Drilling Ltd. 701
Figure 20.2: Building a thicker drill pad by flooding the ice to create lifts that freeze in 12-24 hours. © Chris Pedersen....709
Figure 20.3: Survival shack adjacent to a drill. © Hy-Tech Drilling Ltd. 710
Figure 20.4: Hose clamps are locked correctly into the stem groove. 727
Figure 20.5: Standard whip check (left) and cable stocking whip check (right) © Bill Mitchell....728
Figure 20.6: Unexpected visitor in a tool box. © Kim Bilquist....740
Figure 21.1: Do not stand or work downhill from heavy equipment in case it rolls or knock debris downhill © Matt Turner....756
Figure 21.2: Guards and cages protect employees from moving parts of this rock crusher. © Ron Breadmore 757
Figure 21.3: Light truck with track conversion towing ground penetrating radar (GPR) ice profiling equipment © Iain Mitchell 772
Figure 21.4: Wide tracked Sno-cats are used to clear ice roads and runways on ice. © Iain Mitchell 773
Figure 21.5: Measure the thickness before using heavy equipment on ice, especially on frozen rivers and streams where ice thickness is always variable. © Steve Millar....774
Figure 21.6: To create a thicker safer ice road, the ice is flooded to create "lifts" that freeze solidly within 12 to 24 hours. © Chris Pederson 776
Figure 21.7: Trenches should have one end with a gentle slope for easy exit. © Lorne Burden....781
Figure 21.8: Pile the excavated material at least one metre back from the edge of the trench. © Lorne Burden 782
Figure 22.1: Residues in drums of unknown, unidentifiable chemicals © Courtney Mitchell....787
Figure 22.2: Unstable loose rock above a pit wall, dangerous footing, and a risky place to sample. © Courtney Mitchell 791
Figure 22.3: Slumping ground on the surface above underground mine workings © Courtney Mitchell....794
Figure 22.4: Old chemicals. The contents may not be identifiable. © Lisa Dyer 795
Figure 22.5: Coyotes den in these abandoned pipes. Other animals may also be present. © Courtney Mitchell 796
Figure 22.5: This ladder was removed due to its deteriorated condition. © Courtney Mitchell....810

LIST OF TABLES

Table 2.1: Likelihood Categories 34
Table 2.2: Severity Categories 34
Table 2.3: Risk Assessment Classifications 35
Table 2.4: Example of a Failure Modes Analysis table 43
Table 8.1: Flare Comparison Table 210
Table 8.2: Standardized ground to air emergency signals 211
Table 9.1: Beaufort wind scale 236
Table 9.2: Tornado risk by country 236
Table 9.3: Wind chill calculation chart 254
Table 9.4: The Lake Louise consensus on the definition of altitude illness 268
Table 15.1: Safe ice thicknesses for slow moving light loads on clear blue ice. 500
Table 16.1: Aircraft emergency assistance symbols 555
Table 17.1: Wind Descriptions 579
Table 17.2: Wind Warnings 579
Table 18.1: WHMIS Classifications and Symbols for Hazardous Chemicals 598
Table 18.2: Example of a workplace lable 600
Table 18.3: Classifications of Fire 614
Table 18.4: Fuel characteristics 630
Table 19.1: International Phonetic Alphabet 686
Table 21.1: An example of jurisdictional minimum clearance distance requirements when working near overhead power lines 761
Table 21.2: Comparison of weights in different units of measurement 771

1.0
GENERAL SAFETY PRINCIPLES

Introduction

Any person in authority in an exploration program or company should be aware of the laws and regulations that cover occupational health and safety in the region where the program takes place. The comments below are for Canada and the structure regarding regulations of health and safety may be different elsewhere.

Occupational health and safety (OHS) legislation and regulations, which cover mineral exploration activities, are provided at the federal, provincial and territorial levels. Federal legislation, the Canada Labour Code Part II, covers all employees working under federal jurisdiction. Provincial and territorial OHS legislation and regulations are modeled on the Canada Labour Code Part II. In addition, provincial and territorial jurisdictions have legislation that includes Mines Health and Safety Codes, Acts and Regulations. The rights and responsibilities of various workplace parties are similar across Canada, although the specific requirements of the laws and regulations vary between jurisdictions. It is important for each mineral exploration company to be familiar with the legislation and regulations of the jurisdictions where they conduct work as the material provided herein contains only statements of general principles, not legal opinions, and should not be acted upon without first consulting a lawyer qualified and competent to provide analysis and advice on specific matters in your jurisdiction.

Exploration staff often do not realize that in some Canadian jurisdictions, the definition of a mine for health and safety purposes includes exploration. The following is from the Mines Act and Regulations in the Northwest Territories of Canada:

Definitions

Mine – a place where the ground is mechanically disturbed or an excavation is made to explore for or to produce minerals, other than a place where persons use only hand tools to explore for minerals.

Note also that these guidelines frequently refer to “employees”. Many points made with regard to employees may also apply to other people on an exploration work site. These other people may include:

- Casual business visitors who are not employees of the company
- Casual non-business visitors who are not employees such as community representatives and possibly relatives of employees visiting a camp
- Contractors’ and subcontractors’ employees

Acronyms

AHJ – Authority Having Jurisdiction
ERP – Emergency Response Plan
IRS – Internal Responsibility System
JSA – Job Safety Analysis
OHS – Occupational Health and Safety
PPE – Personal Protective Equipment
SOP – Safe Operating Procedure
WHMIS – Workplace Hazardous Materials Information System

1.1 | Health and Safety Programs

Each company should have a health and safety program in place with the aim of preventing accidents and occupational related diseases. In Canada, general occupational health and safety legislation and mines health and safety codes, acts and regulations require a company health and safety program to be in place. As no single program can be developed that is applicable or appropriate for all organizations, it is the responsibility of each exploration company to develop a suitable program for their own use. As the employees are most familiar with the risks and hazards associated with their work, their input and involvement is recommended when developing safety plans. As a minimum, an exploration company health and safety program should include the following elements, which must conform to local jurisdictional regulations.

1. **Occupational Health and Safety Policy:** Develop a policy statement that includes a commitment by management to health and safety, the company objectives, responsibilities, principles and general rules regarding the importance of health and safety. This should be a written document signed and dated by the Chief Executive Officer. It may be part of a larger document covering ethics, corporate social responsibility and or sustainable development.
2. **Responsibilities:** Individual responsibilities for management, supervisors, and workers should be clearly designated in writing. Assign appropriate levels of authority and accountability.
3. **Implementation and Operations:**
    - **Safe operating procedures (SOPs):** Develop written health and safety guidelines and safe operating procedures that are meaningful and relevant. To do this, it is necessary to perform job safety analyses (JSAs) and risk assessments (refer to Chapters 2.1.4 Job Safety Analyses and 2.1.5 Risk Assessments).
    - **Provide facilities and equipment:** Make sure adequate first aid facilities are available and conform to jurisdictional requirements. Provide required personal protective equipment (PPE) and make sure employees use it correctly.

- **Training:** The provision of adequate training for employees is an important factor in demonstrating a company's due diligence with respect to health and safety. Training should include induction sessions, job related skills and techniques, PPE use and maintenance, use of communications equipment, and competency certification for supervisors and workers. Hire employees who have the highest qualifications and certifications whenever possible.
- **Supervision:** Provide responsible supervision to make sure employees understand and utilize the training they receive and carry out their jobs safely.
- **Emergency procedures:** Each company should develop an emergency response plan (ERP) for each project and/or camp site. Projects should be in compliance with jurisdictional requirements for emergency response plans and all employees should be familiar with general and specific emergency procedures at the work site. Hold appropriate practice drills and check that the communications contacts work. Refer to Chapter 3. Emergency Response. Typically an emergency response plan will be developed to take into account the following:
    - Hazard identification and analysis from risk analysis
    - Emergency resources (e.g. first aid, availability of medical, hospital and other emergency services, firefighting equipment, emergency transportation)
    - Communication systems
    - Emergency response procedures
    - Training including roles and responsibilities
    - Recovery and mitigation
- **Documentation, investigation and reporting:** Document employee training and certification, safety meetings, maintenance, inspections and follow-up actions when corrective measures are required. Keep injury records for first aid, medical aid, lost time accidents and disabilities. Develop written procedures for reporting and investigating accidents, near misses, occupational diseases, and corrective actions. Report serious incidents to the proper authorities.
- **Contractors:** Bind contractors to your company's health and safety policy. Prior to letting a contract, assess the contractors' employees' health and safety training. Work with your contractors to develop a safe workplace. Monitor the application of safe practices during field work, drilling etc.

4. **Employee involvement:** Hold regular safety meetings and create a formal notification system to report safety concerns. Arrange for safety representatives and/or a joint occupational health and safety committee, as required. Employees must know they will not be penalized for reporting safety concerns. Where applicable include contractors in these meetings.
5. **Inspections and corrective actions:** Develop procedures for work site inspections and audits, monitoring, follow-up measures for corrective actions, and methods that manage employees or contractor employees who repeat violations.
6. **Communication:** Develop a plan for communicating and promoting health and safety within the company and include a system to utilize employee feedback.
7. **Management review:** Assess the safety program annually and set annual safety objectives.

8. **Continual improvement:** Track accident and incident investigation corrective actions and analyze the information to find ways to improve safety. Investigate "near misses" to reveal potential accidents and implement corrective actions.

1.2 | Due Diligence with Respect to Safety

Definition: "Due diligence with respect to safety" is the term applied to the level of care and caution that people are required by law to exercise when carrying out their work.

"General duty clause" from the Canada Labour Code Part II

125. (1) ... every employer shall, in respect of every workplace controlled by the employer and, in respect of every work activity carried out by an employee in a work place that is not controlled by the employer, to the extent that the employer controls the activity,
(s) ensure that each employee is made aware of every known or foreseeable health or safety hazard in the area where the employee works;

A general duty clause is present in OHS legislation in every province and territory and is the basis for due diligence with respect to safety. Interpretive information regarding the general duty clause is found via the Canada Labour Code.

Scope of Due Diligence

Federal, provincial and territorial OHS legislation requires mineral exploration companies to practice due diligence with respect to safety at all times and in all places. Due diligence is required when the work "site" is in the field – on land and on water – wherever mineral exploration is carried out. Due diligence should be practiced at project localities, in camps, at drill sites, while traversing, when travelling to and from site locations, when mobilizing and demobilizing remote work sites, as well as in an office, laboratory or plant facility. Companies are required to protect the health, safety and well being of all employees, including contractors' employees working at any site.

Ways to Demonstrate Due Diligence

Every company must take all reasonable precautions to protect the health and safety of all its employees, contractors and visitors to the site. Employees must be made aware of the risks and hazards even if these cannot be absolutely controlled. Due diligence also requires all employees to work and act with all reasonable precautions while performing their job and to watch out for the safety of co-workers.
The greater the risk, the greater the level of required due diligence. Addressing the elements described in Chapter 1.1 Health and Safety Programs helps a company establish due diligence.

Due diligence should encompass the following by taking every reasonable precaution to:

- Comply with legislation and regulations of the authority having jurisdiction (AHJ). AHJ means the government agency or sub agency with regulatory powers and it is often the mines inspector with the authority to (1) inspect the exploration operation to verify compliance with jurisdictional legislation and (2) issue compliance orders, if necessary. Other examples of AHJs are Department of Mines, Workers' Compensation Boards, and other provincial, territorial, state or federal agencies that regulate exploration activities.
- See that employees comply with company safe operating procedures, and policies etc.
- Protect employees from risks and hazards not covered by the above.
- Encourage employees to take ownership of safety and become as self reliant as possible when working in the field.
- Additional information regarding due diligence is available from the Canadian Centre of Occupational Health and Safety.

Defence of Due Diligence

Due diligence is the legal defence available to companies and individuals charged under OHS laws. To prove due diligence, an accused must prove that all reasonable precautions were taken to comply with the law in an effort to prevent the accident. Therefore, all efforts to prevent incidents should be appropriately documented.

The due diligence defence is related to the facts of each case. A defendant must be able to show that the precautions taken were appropriate for and specific to the hazards that exist at the workplace.

1.2.1 | Employees' Rights with Respect to Due Diligence

Employees at all levels have rights and responsibilities under OHS legislation.

1.2.1.1 | Right to Know

Every employee has the right to be informed about the risks and hazards present in the place they work. These include actual as well as potential dangers. 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 on traverses, and whether or not the actual land is under the control of the company.

1.2.1.2 | Right to Refuse Unsafe Work

Any worker has the right to refuse to perform a job, operate any tool, appliance or piece of equipment if they have a reasonable cause to believe that their actions might create an undue hazard to their health or safety or to that of another person. They may feel they require training to do the job or that additional training is required to feel confident to perform the job. There are correct procedures to follow when an employee refuses to perform unsafe work, which vary depending on the jurisdiction in Canada.

1.2.1.3 | Right to Participate

Employees have the right to participate in occupational health and safety activities at their work site. In most provinces and territories, work sites that regularly employ more than 20 people are usually required by OHS legislation to have a joint health and safety committee composed of equal numbers of workers and management representatives. Work sites with fewer than 20 employees should have a health and safety representative for the employees. The health and safety representative or the committee should act as an advisory body. Some of their roles include the following:

- Make recommendations to management regarding ways to prevent accidents and improve safety performance.
- Assist to develop and implement health and safety activities and programs.
- Identify hazards and investigate how to mitigate them.
- Receive employee complaints and suggestions regarding health and safety and participate in accident investigations.
- Participate in work site inspections.
- Confirm and follow up recommended actions regarding accidents and hazards. Make sure records are maintained regarding injuries and corrective actions for workplace hazards.
- Assist to help resolve work refusals.

1.2.1.4 | Right to a Violence-Free Workplace

The activities of any person, whether it is a co-worker or visitor, should not endanger the health and safety of employees at a work site. An act of workplace violence includes any act where an employee is abused, intimidated, harassed, threatened or assaulted on or off the work site when the location is work related. Examples of an off site location related to work activities would include a business or social event or a threatening telephone call made outside of work hours. Other examples include travel safety and hotel safety (refer to Chapter 12. Travel Safety and Security).

Each company should set clear standards of behaviour with appropriate responses and consequences for violent behaviour. These include but are not limited to the following:

- Provide a concise statement regarding the company position on workplace violence and commitment to its prevention.
    - Define what is meant by violent behaviour.
    - Provide examples of behaviour that fit the category of violent behaviour.
    - Provide examples of circumstances where workers must be protected from potential violence.
    - Provide consequences for perpetrators of violent behaviour.
- Encourage the reporting of incidents and potential incidents of workplace violence.
- Provide any necessary violence prevention orientation and training.
- Monitor and review the company procedures and policy at appropriate intervals.

Include workplace violence when performing risk assessments of hazards at the project or work site. The following are a few examples of violent acts that an employer should address by developing procedures and policies to protect employees.

- Physical attacks – hitting, shoving, kicking or pushing
- Threats, including any threatening behaviour – direct, conditional or veiled
- Verbal abuse – swearing, insults and disparaging language
- Harassment – racial, sexual, religious
- Pranks – especially those that involve tools, equipment or transportation
- Theft and property damage

1.2.2 | Responsibilities with Respect to Due Diligence

All employees, including senior management and the Board of Directors of exploration companies have duties with respect to due diligence that may be defined within a particular jurisdiction. Some suggested recommendations or “best practices” for companies to try and address these duties or responsibilities include but are not limited to the following:

1.2.2.1 | Board of Directors

- Consider employee health and safety as an important aspect of the company and allocate resources toward developing and maintaining a health and safety program. Make sure the program includes a written OHS policy.
- Make sure the company complies with OHS legislation and regulations in the jurisdiction(s) where the company works.
- Make sure the company complies with orders and directives issued by inspectors and the chief inspector of mines of the jurisdiction.
- Make sure the company carries appropriate and sufficient insurance.
- Understand the federal Bill C-45 and how it impacts the responsibilities and liabilities of members of the board with respect to health and safety. Information is available from the Canadian Centre for Occupational Health and Safety.

1.2.2.2 | Managers

Senior Managers

- Take all reasonable precautions to see that the health and safety of every worker is protected at every work site including off site work areas such as traverse routes.
- Make sure the company complies with OHS legislation and regulations of the jurisdiction.
    - Make sure machinery, equipment and PPE are maintained in good condition.
    - Appoint qualified and competent supervisors.
    - Make sure employees are supervised adequately by qualified supervisors.
    - Make sure employees receive information, training and supervision to protect their own health and safety and that of their co-workers.
- Make sure that safe operating procedures (SOPs) and emergency response plans (ERPs) are developed and implemented.
- Establish a health and safety committee or authorize an employee health representative, as required.

Project Managers

- Take all reasonable precautions to see that the health and safety of every worker is protected at the project work site(s) and wherever workers are performing their jobs.
- Develop and implement site specific SOPs and guidelines.

- Hold site induction meetings as necessary, and see that visitors and new employees receive induction training when they arrive at the site. Everyone on site must be made aware of the risks and hazards of the area and trained in the safe operating procedures, emergency response plans, company and site policies, transportation safety, communications, employee tracking and other relevant requirements. Refer to Chapter 2.1.2.1 Pre-Program Induction Safety Meetings.
- Make sure that the ERP procedures are prepared and tested. Post all relevant contact information and train employees to use the communication equipment and employee tracking system. Refer to Chapter 3. Emergency Response and Chapter 19. Communications.
- Make sure employees are trained regarding the risks and hazards at the work site. Training should include but not be limited to the following:
    - Workplace Hazardous Materials Information System (WHMIS) and how to handle, dispose, store hazardous substances (refer to Chapter 18.2.3 Workplace Hazardous Materials Information System)
    - Tools and machinery and how to use them safely (refer to Chapters 5. Field Equipment Safety, 18. Camp Set Up and Management and 20. Drilling Sites)
    - Personal protective equipment (PPE) and its correct use, storage, and limitations (refer to Chapter 4. Personal Safety)
    - Emergency response (refer to Chapter 3. Emergency Response)
    - First aid (refer to Chapter 18.5 First Aid)
    - Wild animals (refer to Chapter 10. Wildlife)
    - Terrain and location hazards (refer to Chapters 6. Safe Traversing Practices and 9. Weather and Environmental Risks)
    - Transportation related hazards (refer to Chapters 13. Vehicles, 14. All-Terrain Vehicles, 15. Snowmobiles, 16. Aircraft and 17. Boats, Canoes and Inflatables)
- Make sure supervisors are trained and certified, as required, and are competent to do their job properly.
- Enforce relevant jurisdictional OHS regulations and guidelines.
- Immediately report reportable accidents to the proper authorities.
- Hold regular safety meetings (refer to Chapters 2.1.2 Safety Meetings and 16.10 Regular Pre-Flight Safety Briefings).

1.2.2.3 | Supervisors

- Take all reasonable precautions to see that the health and safety of every worker is protected.
- Make sure that employees comply with applicable OHS regulations and the company and site specific SOPs.
- Develop and implement site specific SOPs, as required.
- Advise workers of hazards in the work place – actual and potential

- Make sure employees are supplied with and trained to use the correct PPE.
- Be trained and competent.
- Immediately correct unsafe acts or conditions.
- Set a good example with behaviour that reflects a responsible attitude toward safety.

1.2.2.4 | Individual Employees and Workers

- Take all reasonable and necessary precautions to protect his or her own health and safety and that of co-workers.
- Comply with the jurisdictional OHS regulations and the company SOPs and guidelines.
- Refuse to carry out work and activities that threaten health and safety in the workplace.
- Take training to know when and what PPE to use; know how to wear the proper PPE for the task. Learn to care for PPE properly and replace it when it no longer functions to protect you as it is designed to do.
- Report all unsafe work conditions, hazards, accidents and incidents to the supervisor and take action to correct them when possible.
- Set a good example to all co-workers and help orient new employees and visitors to potential hazards, concerns, procedures, policies and safe work practices.
- Work with co-workers and supervisors to "engineer out" unsafe designs and work practices. Mitigate safety and health risks when possible.
- Be trained to use equipment correctly and be familiar with the risks and hazards associated with the use of equipment.
- Accept and/or request training for the job:
    - Make sure to be properly trained before starting a new job or task.
    - Ask questions if the required procedures are not understood and request additional training if the procedures are not clearly understood.
    - Be trained for emergency response situations (e.g., know what to do when there is a fire, a bear in camp, a transportation related accident).

1.2.2.5 | Health and Safety Committee Members or Safety Representatives

- Identify and recommend solutions to health and safety problems.
- Promote safe work practices and compliance with regulations and company SOPs and guidelines.
- Hold and/or attend safety meetings.
- Respond to the safety inquiries and concerns of employees.
- Assist in job safety analyses and risk assessments, as appropriate
- Assist in work refusal situations.

1.2.3 | Training

Training for all employees is an essential part of a safety program. Training also provides a means for a company to demonstrates due diligence. Companies should consider the following important aspects of training.

- Project supervisors are required to be competent; therefore they need training, which may include documented certification to prove and maintain competency.
- Training should be at a pace such that employees can comprehend and assimilate the information.
- Projects should include a site safety induction session at the beginning of the field season or drill program. Attendance should be mandatory for all employees, including contractors' employees. Upon arrival at a project site, all visitors should be made aware of relevant risks and hazards before they receive a tour. Depending on the risks, it may be acceptable to have a summary orientation for visitors staying a brief time; however, those staying for 24 hours or longer should receive a full safety induction. All new employees should receive the induction before they begin work; returning employees should receive the induction as well, especially if it is a different time of year than when previously employed. The topics covered by the induction should be modified to reflect the location and season of the year. Refer to Chapter 2.1.2.1 for an extensive list of suggested topics.
- Make sure employees who perform inspections are trained to carry them out correctly.
- Provide refresher training, as required.
- Provide training for new equipment, processes or procedures.
- Develop training that addresses specific accident issues.
- Employees should be trained in fire fighting techniques for remote sites.
- Review aircraft safety procedures when a new aircraft is used or a new pilot begins work.
- Train employees to respond correctly to emergency response plans of action.
- Maintain records of everyone who receives training throughout the year (e.g., WHMIS, site inductions, helicopter safety orientations).

1.2.4 | Inspections and Audits

Safety inspections should be part of an OHS program and exploration companies are required to conduct regular inspections at all work sites. People who conduct inspections should be familiar with the project work site, the work processes and equipment used on site. Employees who perform inspections should be trained to make accurate and relevant observations during the inspection process. In larger companies, senior management or executive should be informally inspecting health and safety procedures when visiting a project site. It is in the personal interests of the person in charge and the company executives to document that inspections take place.

- Individuals who are the authority having jurisdiction (AHJ) for provinces and territories may inspect exploration camps. This is often the mines inspector.
- In larger companies, people doing an inspection may be supervisors, members of the health and safety committee or the health and safety representative.
- In most junior companies, inspections will be done by the geologist or other person in charge of the project site.
- The inspector of mines has the final say regarding compliance to health and safety regulations at an exploration site.
- In some jurisdictions, such as in the Northwest Territories in Canada, mine safety inspectors who carry out exploration camp inspections are a part of the Workers' Safety & Compensation Commission.

Conduct inspections frequently enough so that unsafe work practices do not develop between inspections. Inspections should include:

- Buildings and structures
- Means of transportation (vehicles, boats, all-terrain vehicles, snowmobiles etc.)
- Project grounds, landing sites, excavations
- Equipment, tools and machinery
- Employee work methods and practices
- When a malfunction occurs
- Accident investigations

Document all inspections

- The frequency of routine inspections should conform to local regulations and company policy.
- Spot inspections should be conducted to check on follow-up corrective actions when a hazard or incident has been detected, and when changes in safe work procedures have been implemented.
- Continuously monitor all unsafe potentially life-threatening conditions, such as air quality in a confined space location, which includes when working in trenches, pits, or old or abandoned mine workings and even abandoned buildings.
- For the geologist in charge of a drilling project, a simple check list style of form is one way to conduct an environmental health and safety (EHS) check of a drill site. By checking tick marks on the list against the individual inspection criteria points, making any appropriate notes on EHS issues, signing and dating the form, it becomes a permanent record of the inspection.

Employees should develop the habit of carrying out certain inspections as an automatic routine.

- Employees should make pre-job inspections at the beginning of each job, each shift and each day to scan for hazards before entering their work area or using tools etc. This concept applies while traversing. A geologist on traverse scanning a scree slope to determine the safest route would be performing a pre-job inspection.
- Good supervisors perform ongoing inspections by doing a visual check whenever they pass through a work area.

When hazards are identified during inspections, make sure that the corrective actions takes place within the prescribed time limit for the severity of the hazard. Use a rating scale such as the one below that addresses the severity of the hazard:

- "A" hazard – requires immediate corrective action. A potential risk exists that could cause death, amputation, and/or extensive loss of structure, equipment or material.
- "B" hazard – requires attention as soon as possible. A potential risk exists that could cause serious injury, illness or property damage.
- "C" hazard – should be eliminated without delay and includes conditions or practices with a potential risk to cause a non-disabling injury or non-disruptive property damage.

Audits

Audits are a category of inspections that evaluate the effectiveness of a company health and safety program. An audit should indicate if a company is in compliance with jurisdictional OHS regulations and determine if the results of the safety program fulfil the company health and safety goals and objectives. An audit can be used to establish a baseline for identifying changes in performance. Audits should be performed at least annually. They may be performed by trained company employees or by trained external health and safety professionals. It is essential that members of audit teams receive appropriate training to perform audits correctly. Commercial audit systems are available.

1.2.5 | Documentation

Written documentation indicates that a company is in compliance with aspects of the company OHS program and that parts of the program are in effect. Written records are one aspect of evidence a company must provide to demonstrate defence of due diligence. The following records should be kept for the time specified by the AHJ:

- Employee safety induction records
- Training records:
    - Supervisor training and certifications that demonstrate competency
    - Worker training and certifications

- Training records should indicate the date, names of who attended, and topics covered by training (e.g., WHMIS, lockout, fall protection, first aid certification)
- Safety meetings: Routine weekly meetings and daily pre-work talks including a list of attendees and the topics covered
- Inspection reports and the follow-up corrective actions
- Usage logs and maintenance logs from vehicles and equipment etc.
- Records that show progressive discipline for safety infractions
- Joint safety committee meeting records and reports that address safety issues, if applicable
- Contractor and subcontractor pre-qualification documentation
- First aid records, medical records and tests that are appropriate for the employment (hearing, vision tests)
- Emergency response plan tests, fire drills
- Forms and checklists for procedures, such as confined space entry and lockout
- Safety statistics on the frequency and severity of accidents and near misses
- Sampling and monitoring records (air quality of a confined space or a core saw shack)

1.3 | Internal Responsibility System

The Internal Responsibility System (IRS) is the fundamental concept where individuals and groups of employees have input into the health and safety practices at their work site. Although occupational health and safety regulations are written with the aim of providing a safe working environment, "safety" is the responsibility of each person at a project site to work as safely as possible. Therefore, it is important that a company develops a safety program that encourages each worker to acquire excellent safety habits and attitudes and to share in the responsibility and accountability for workplace safety. The IRS incorporates due diligence where each person strives to improve aspects of safety related to their job and at the work site. When everyone participates in improving health and safety, a company will normally experience a reduction in accident rates.
It is recommended that safety committee members and health representatives be trained in the IRS philosophy to better promote safety attitudes. Workers' Compensation Boards usually offer training on the Internal Responsibility System (IRS). Information regarding the IRS is available through the Canadian Centre for Occupational Health and Safety.

Features of the IRS include:

- Workers share the responsibility to identify hazards in the workplace. Employees are more likely to recognize hazards associated with their own work and come up with solutions and hazard controls.

- It is impossible to have regulations that address all hazards in a workplace. It is the responsibility of employers to recognize and then eliminate, correct or control hazards that are not covered by regulations in order to protect the health and safety of the employees.
- Everyone should act as an "internal auditor" to promote compliance with OHS regulations at the same time as they look out for their own personal safety and that of their co-workers.
- Health and safety should not be adversarial between workers and employers; it should be a joint effort for the benefit and safety of every employee within the company.
- When a company increases due diligence using the IRS, they save money by reducing injuries, compensation, fines and other expenses associated with accidents.

2.0
GENERAL SAFETY

Introduction

Most accidents occur when people fail to recognize a potentially hazardous situation and do not take preventive measures. The goal of the Prospectors & Developers Association of Canada (PDAC) Health and Safety Guidelines is to increase safety awareness for people employed in the mineral exploration industry, especially those who work in a field environment. It is important to recognize situations where the risks and hazards at a project or camp location are higher than normal, which is typical at remote sites when first aid and medical treatment may be unavailable for hours or even days. Two noteworthy circumstances also increase the risk of accidents – working alone, and being a new employee at a site, especially if the worker is male and under the age of 25. Statistics indicate that 50% of all accidents that happen to young workers aged 15-24 (including students) occur during their first six months on a job.

There are numerous measures aimed at diminishing the occurrence and severity of accidents; they include company policies and procedures, safety meetings, and risk assessments and job safety analyses (JSAs). Company policies and procedures should include requirements for safety meetings, risk assessments and JSAs. Safety meetings take many forms. They may be lengthy and detailed with required attendance by all employees, such as pre-program site induction sessions, or meetings may be limited in focus and last only a few minutes, such as when employees perform a daily pre-job check.

At any safety meeting, the information has to be understood by the attendees. Therefore, translation may be an issue in places where companies hire local employees who speak a language other than the language the company normally uses. For instance, a first aid attendant has to be able to communicate with a patient, and employees have to understand safe operating procedures (SOPs), why and how to use personal protective equipment (PPE), and the safety instructions from a charter aircraft pilot when they are transported by air. At some sites the translator may be hired by a contractor. In any situation, critical information should be communicated in the local language when comprehension is necessary. Finally, risk assessments and job safety analyses (JSAs) can help identify risks and hazards so they can be mitigated, which should result in lower accident rates. Trained company personnel, competent contractors, and specialists (sometimes) who are familiar with the work site and the jobs should conduct risk assessments and JSAs.

Acronyms

AHJ – Authority Having Jurisdiction
ATV – All-Terrain Vehicle
ERP – Emergency Response Plan
FMEA – Failure Modes and Effects Analysis
JSA – Job Safety Analysis
MSDS – Material Safety Data Sheet
OHS – Occupational Health and Safety
PAL – Possession and Acquisition License
PFD – Personal Flotation Device
PPE – Personal Protective Equipment
RCA – Root Cause Analysis
RPN – Risk Priority Number
SOP – Safe Operating Procedure
WHMIS – Workplace Hazardous Materials Information System

Definitions

Companies should clearly define the terms they use – "accident", "incident" and "near miss" – so employees are aware of the significance and required response to an event. Below are some suggested definitions.

Accident: An occurrence that results in serious injury requiring medical aid. An accident may also be an unplanned event that causes damage to equipment or property. Some companies avoid the use of the word "accident" as it implies an "act of God", or something beyond human control; there are some in the health and safety field that believe there is no such thing as a negative event in the workplace that is beyond human control.

Event: A general term for accident, incident, near miss, mishap, occurrence, crash, collision

Hazard: Anything (object, situation or condition) that has the potential to cause harm to a person, property, machinery, or the environment. Examples of hazards include terrain (e.g., slippery or steep ground, cliffs, crevasses, dry stream bed), conditions in the work environment (e.g., cold temperatures, high altitude, carrying heavy loads), transportation routes (e.g., rough roads, thin ice) and exposure to potential occupational diseases (e.g., silica dust, radiation, bat droppings).

Incident: An occurrence that results in minor injury requiring first aid treatment only. An incident may also be defined as an unplanned event that does not have serious consequences (e.g., no injury, damage, or property loss).

Near Miss: An unplanned event that does not result in injury, but has the potential to cause harm to personnel and/or damage to property or the environment under slightly different circumstances.
Risk: The likelihood (chance) of injury, loss, damage, or occupational disease resulting from exposure to a hazard.

Risk Assessment: The process of identifying hazards and evaluating them to determine appropriate methods to eliminate or control the risks of injury, loss or damage

Root Cause: A root cause is an underlying reason in a sequence of events leading to an event (accident, incident or near miss). There may be more than one root cause.

Root Cause Analysis (RCA): A process that uses systematic techniques that focus on finding the underlying cause(s) of a problem (accidents, incidents, risks and hazards). Root cause analysis examines physical causes, human causes, and organizational causes in order to detect significant actions or situations that can be changed to prevent repeating an event.

2.1 | Preparations to Reduce Risks

A company should make sure that all people present at work sites, including contractor's employees and visitors, follow the same safe work practices, which include all regulations of the authorities having jurisdiction (AHJs), occupational health and safety (OHS) regulations, company policies, and standard operation procedures (SOPs) and guidelines etc. Cooperation between a company and its contractors is required if safety goals and objectives are to be achieved. In addition, employees should develop a strong sense of ownership regarding their personal safety and that of their co-workers to reduce the risks inherent in exploration work. Employees who traverse should strive to become as self-reliant as possible in case they become stranded or injured, especially if they traverse alone. In addition, it is essential that senior management follow safe practices when visiting work sites in order to set a good example that encourages and supports a positive attitude toward safety.

The following important measures will reduce risks while carrying out exploration field work and other project work.

1. All workers should be trained to work safely and to follow site specific safe operating procedures (SOPs). Appropriate training includes but is not limited to:
   - Safety induction training sessions at the start of the season or project and routine safety meetings (see Chapter 2.1.2 Safety Meetings below).
   - Certifications such as first aid, Workplace Hazardous Materials Information System (WHMIS), and Possession and Acquisition License (PAL) in Canada, as appropriate
   - Awareness of terrain and other site specific risks and hazards in the project area (refer to Chapters 6. Safe Traversing Practices, 9. Weather and Environmental Risks, and 10. Wildlife)
   - Relevant regulations and job skills, including required personal protective equipment (PPE)

2. All visitors should have a safety induction that addresses the site specific risks and hazards.
3. Students and other young workers should receive sufficient training and supervision, as they are statistically more likely to have accidents than older more experienced workers. Unlike a generation ago, students rarely start field work with experience or knowledge about the use of navigation equipment, field tools, firearms, communication equipment, or camping skills. Students and young workers should be trained for the specific jobs they will perform. Employers should be aware of the following generalizations in order to promote a greater awareness of safety among students and young workers:
    - They often believe an accident will not happen to them.
    - They may be afraid to ask questions for fear of appearing "dumb".
    - They are often unaware of their right to refuse work they feel is unsafe and/or that they may request more training if they are not comfortable doing a job.
    - They are often unaware of their own lack of knowledge i.e., "they don't know what they don't know".
4. Carry out a risk assessment of the project site and area so managers can prioritize which hazards are most important to address and provide relevant training. Performing risk assessments should be an ongoing process throughout the project. Weekly safety meetings provide an opportunity to identify new risks and hazards and educate employees about how to mitigate them. See Chapter 2.1.5 Risk Assessments below.
5. Develop an emergency response plan (ERP) for each project site. Some drill sites may need an independent ERP if the site could become isolated. Refer to Chapter 3. Emergency Response.
    - Train everyone to be sufficiently familiar with the plan and emergency procedures. Employees with assigned emergency duties should be competent.
    - Test the plan to be sure it works; test the emergency communication contact numbers and radio frequencies.
    - Hold fire drills, evacuation drills, bear sighting drills etc., as appropriate.
    - If a company hotline is not available, the people designated to receive calls and relay information during an emergency situation should be trained to do this job properly.
6. Fully equip project sites to address emergencies. Required equipment includes but is not limited to:
    - First aid kits and supplies at the first aid station including a spine board and basket stretcher for transportation, as required. Some jurisdictions dictate a minimum level of equipment and training.
    - Firefighting equipment
    - Survival supplies: Equip project sites, survival caches for employees who work off site, and vehicles or boats that transport employees to and from a work site. Refer to Chapter 8. Survival.
7. Communication equipment should be appropriate for the location and terrain and have adequate reception in the area (refer to Chapter 19. Communications).

- Everyone should be trained to use the communication equipment.
- Post operating instructions by the stationary communication equipment and supply instructions to be carried with portable equipment.

8. Provide translation when the employees do not speak the language of company operation. Training regarding company SOPs, ERPs, safety briefings and first aid procedures are among the most important information that requires full understanding by all employees.
9. Provide training regarding transportation safety. Most fatalities in the exploration industry are related to transportation.

2.1.1 | Working Alone Versus the "Buddy System"

2.1.1.1 | Risks and Hazards

The following list identifies some of the increased risks of working alone:

- Delayed emergency response resulting in increased severity of injury or death.
- Inability to administer essential first aid to oneself in the event of an accident.
- Inability to self-rescue, which results in drowning
- Inability to recognize the signs of hypothermia, frostbite, heat illnesses, dehydration, altitude illness etc. These symptoms are often identified by a co-worker.
- Attack by an animal (or human) that might not attack a group of people.
- When lost or in a survival situation, a person working alone may have a greater tendency to panic or "give up" than when with a co-worker

2.1.1.2 | Jurisdictional Requirements

Working alone or in isolation is defined in some OHS legislation as working in circumstances where emergency assistance might not be easily available should the worker become injured or ill. For exploration companies, examples of working alone include: traversing alone, working at some distance from the camp, project or office without easy access to help, and travelling alone to or from a site via ATV, snowmobile, or four-wheel drive vehicle (4x4) etc. Depending on the jurisdiction and circumstances, OHS regulations usually require special procedures to be in place when employees work alone. Such procedures usually include a job safety analysis (JSA) and communication provisions specific to the job and work site to make certain the worker will be checked at frequent intervals, for example a minimum of every 2.5 hours. Even with excellent communication equipment, an accident or incident may leave the employee unable to communicate with base camp, the project manager or the office when he or she requires assistance.

Working Alone

When a company decides that working alone is necessary, the company should:

- Identify all risks and hazards to the employee and take measures to eliminate or mitigate the hazards to the lowest practical level.
- Provide appropriate training to address any additional and increased risks and hazards that result from working alone.
- Provide written safe operating procedures (SOPs). Set up and implement tracking and check-in procedures. The emergency response plan (ERP) should include required actions to address a missed check-in and appropriate emergency rescue procedures.
- Provide excellent communication equipment in good working order and with adequate local coverage.
- Provide top quality, appropriate safety equipment, such as bear deterrents, emergency shelter, survival caches etc.

Employees should realize that if they are asked to work alone, it is imperative to do the following:

- Realistically evaluate their level of experience and capabilities before making a decision.
- Be informed about and carefully evaluate all the risks and hazards.
- Ask advice from more experienced workers.
- Work with extra caution.
- Confirm that all equipment is in good working order. Verify that communication equipment functions by initiating communication at the onset of the job as soon as they are dropped off or reach the work location.
- Strictly adhere to tracking and check-in procedures and immediately notify the contact person whenever there is a change of plans.
- Remember that they have the right to refuse work that they perceive to be unsafe and/or for which they feel inadequately trained.
- Additional information regarding working alone is available from the Canadian Centre for Occupational Health and Safety.

The PDAC advocates the "buddy system" and recommends against working alone in the bush.

Working in pairs – the "buddy system" – is safer than working alone.

2.1.2 | Safety Meetings

The importance of regular, well planned safety meetings cannot be overemphasized. Safety meetings provide an effective tool for promoting safety awareness, raising concerns about safety at the work site, and communicating safe work procedures to all company and contractor employees. Safety planning should start at office meetings before project work begins in the field. At the project site, formal scheduled safety meetings provide an excellent way for management, supervisors or project leaders to demonstrate leadership and commitment to working safely. Informal safety meetings can provide the opportunity to emphasize safety on the job. For instance, a hands-on demonstration of how to safely perform a particular task can be given. Informal meetings can be in small groups or on a one-to-one basis as necessary. Both types of safety meetings are important in order to implement and continuously improve safety procedures, safety awareness and safety performance.

At all safety meetings employees should be encouraged to discuss safety issues with the aim of developing a sense of proactive involvement and ownership of the idea that safety is everyone's responsibility. By requiring contractor's employees to attend safety meetings, a company emphasizes their commitment to occupational health and safety for all employees and promotes a culture of safety at a work site.

Obviously, the level of formality or informality of safety meetings at work sites will depend on the size of the operation. For example, a larger project with a greater variety of workers, contractors and frequent visitors may require a very formal rigid meeting system. Smaller work sites may rely on very informal systems of meetings. No matter the size and formality of safety meetings, there still needs to be mechanisms for workers to express concerns.

Tips for the person conducting a safety meeting

Whoever is responsible for running a regularly scheduled safety meeting should show his or her personal commitment to the company safety program. Sufficient care should go into planning the meetings. The PDAC Health and Safety Guidelines are a major source of information on many aspects of exploration safety and they are intended to be a resource for agendas at safety meetings.

- Cover topics that directly relate to conditions at the project site.
- Prepare and organize the agenda.
- Employee attendance should be mandatory. Encourage them to discuss their concerns, "near misses" and observed hazards. Ask for suggestions for solutions to safety issues.
- Keep good records of attendance, discussions, hazards and issues that are raised.
- Follow-up: Report topics of concern that require the attention of management to the appropriate management personnel. When issues have been addressed, report back at the next safety meeting with updates on corrections, hazard mitigation and unresolved issues.

- One possible way of engaging site workers is to assign a different person a specific topic to research and present at each meeting, rotating gradually through all workers at the site.
- Set a firm time limit (and agenda) to change the atmosphere if safety meetings become confrontational or are unproductive.

Meeting Minutes

Document all safety meetings with minutes that include the agenda, issues discussed, proceedings and a list of attendees. Forward a copy of the completed minutes to the project supervisor or manager.

- **Schedules:** Whenever there are 24 hour operations at a project, it will be necessary to hold at least two separate safety meetings covering the same topics to access all employees.
- **Minutes:** Minutes should be a succinct summary of the important points discussed at the safety meeting. Review minutes of the previous meeting to make sure relevant topics are addressed and follow-up actions are discussed. Maintain a record of the minutes for all safety meetings.
- **Record the following:**

1. Date
2. Location
3. Attendee list
4. Agenda items discussed
5. Specific safety concerns raised by attendees
6. Decisions reached and follow-up
7. Persons responsible for follow-up actions and reporting of progress

2.1.2.1 | Pre-Program Induction Safety Meetings

An induction safety meeting should be held at the beginning of a project for all employees working at the site. It is recommended that individuals sign off that they have attended and understood the induction information. These records should be maintained by the senior person on site. The induction should be supported by ongoing safety meetings at regularly scheduled intervals.

Frequency

- Every company should require a pre-program safety induction prior to commencing work on any project or at the beginning of the season on a multi-year project.
- Any new employee, contractor, visitor or other individual visiting the site during the project should receive the same induction information as received by employees at the start of the season. The individual should be taken through the induction by an experienced person on site.

- Identify the hazards before visitors are conducted around the site. Depending on the location, it may be acceptable for people who stay less than 24 hours at a site to receive a summary induction if it includes stressing the risks and hazards they will be exposed to during their work or visit. Anyone staying at the site for longer than 24 hour should receive a full induction.

Goals

- Employees should be made aware of all aspects of risks and hazards and SOPs at the site. Aim to reinforce the highest level of safety awareness and make sure all SOPs and safety equipment are in place to accomplish all jobs in a safe manner.
- Site safety inductions should be modified to address relevant issues according to the location and season of the year. Hold an induction for all employees when there are significant seasonal changes, such as summer vs. winter or dry vs. wet season. Any employee who has received a site induction at one time of year (summer) and then returns to work at another time of year (winter) should be required to undergo another site safety induction, as the risks and hazards will have changed.
- Attendance at a pre-program safety induction should be mandatory and include all contractor and company staff.
- Emphasize that safety is a team approach among all people on site (refer to Chapter 1.3 Internal Responsibility System).
- Promote a positive attitude toward safety among the contractor's staff.
- Promote self reliance for employees who traverse.
- Confirm the status of employees' "tickets" such as WHMIS, PAL, and first aid certificates.

Suggested topics include:

- Company principles relating to health and safety
- Site specific rules, SOPs and guidelines
- Coordination of activities of all contractors
- Responsibilities and rights of workers, supervisors and management with respect to health and safety
- Emergency response plan (ERP) and the emergency contact numbers and radio frequencies: Emergency procedures should always be part of the induction agenda and should be thoroughly reviewed. Discuss specific emergency procedures that may be required and make sure that everyone is familiar with them. Refer to Chapter 3. Emergency Response.
- Emergency signals: Develop different signals for different emergencies. For example, workers should not mix up the signal for "fire" when everyone should muster to help, as opposed to the signal for "bear" when people should remain in a shelter unless they have specific duties.

- Site evacuation plans and muster stations
- Fire safety: Location of firefighting equipment, fire stations, posted fire procedures, muster stations, fire drills, safe fire prevention practices
- First aid and medical facilities, procedures to use a spine board and basket stretcher, injuries and illness procedures
- Accident reporting and investigation
- Communication equipment and instruction in the use of the equipment, as appropriate
- Communication procedures and schedules:
    - Required daily communications
    - Emergency communications
    - Between aircraft and camp
    - Between field crew members
    - Between project and head office
    - Refer to Chapter 19. Communications for additional information.
- Policies:
    - Smoking
    - Possession and use of firearms in compliance with AHJs
    - Alcohol and/or illegal non-prescription drugs
    - Fighting and violence
    - Horseplay and pranks
    - Destruction of property, fire alarms or other safety equipment
    - Recreational use of equipment and fishing/hunting activities
    - Use of audio entertainment systems
- Aircraft safety: The pilot should review SOPs and safety regarding the specific aircraft used at the site. Hold a new aircraft safety briefing for employees whenever a new pilot starts work or a new aircraft is brought in.
- Water safety: Required use of PFDs, safety on local water bodies, work related and recreational use of boats, if applicable
- Ground transportation: Vehicles, four-wheel drive vehicles (4x4s), ATVs, utility vehicles, snowmobiles, as appropriate; speed limits, fuelling procedures, specific safety issues including work related and recreational use, if applicable
- Climatic hazards: Hypothermia, frostbite, whiteouts, wind chill, heavy rains, dust or sand storms, dehydration, hyperthermia, heat stroke, as appropriate
- Terrain hazards: High altitude, cliffs, glaciers, avalanches, wet terrain, heavy vegetation, deserts, muskeg, swamps, as appropriate
- Hygiene: Handwashing facilities, kitchen and dining procedures, clothes washing facilities and procedures, waste disposal, including bathroom or privy facilities

- Slips, trips and falls: Location of the greatest risks and hazards, preventions
- Lifting and back safety
- Housekeeping practices
- PPE: Required, what is provided by the company and what is provided by the individual
- Safety regarding fuels, heaters, stoves, generators including the risks of carbon monoxide poisoning
- Safety regarding tools: Chainsaws, rock saws, augers, power tools, hand tools
- Electrical safety
- Confined spaces: Recognition of risks and hazards and entry procedures, as appropriate
- Environmental issues: Site preparation, site cleanup, hazardous materials, spill containment
- Site security
- Working near heavy machinery, if applicable
- Blasting procedures, if applicable
- Wildlife concerns: Feeding wildlife, bears, cougars, snakes, insects etc.
- Inspections
- Documentation: Requirements of the company, contractors and the AHJs
- Available general site services

2.1.2.2 | Routine Scheduled Safety Meetings

Following the pre-program induction, safety meetings should be held regularly i.e., monthly, weekly or even more often as conditions dictate. All employees and all contractors' employees should participate. Regularly scheduled formal meetings can be structured to include different types of training (e.g., hands-on training, practice, audiovisual presentations, demonstrations or instructional reading and exercises).

Suggested topics include:

- Safe operating procedures: General and site specific
- Refresher training for safety procedures that are not being followed
- Introduction of new safety procedures
- Importance of and the proper use of PPE
- Follow-up actions: Inform all participants so they understand any decisions or follow-up actions originating from previous recommendations.

- Near miss" incidents. Safety meetings are a good time to report, discuss and develop preventive actions regarding significant safety incidents that could have resulted in an accident. Follow-up actions, including modification of SOPs, may be required to prevent similar incidents in the future that could have potentially serious consequences.
- Review past accidents experienced by the company and contractors and emphasize the lessons to be learned.
- Housekeeping
- Emergency response procedures for potential emergency situations
- Accident reporting and investigation procedures
- Improvements in current procedures
- Discussing a difficult or rarely performed job

2.1.2.3 | Daily or Shift Work Safety Meetings

A short safety meeting should be held at the start of each shift or day's work.

- Highlight the safety issues associated with the task to be performed.
- Check that required written and verbal procedures are completed before daily work commences (e.g., fall protection, lockout, and confined spaces). Use appropriate permits and checklists.
- For some jobs it is advisable to hold the meeting when shifts change so the “off” crew can talk about shift issues with the “on” crew.
- Check that PPE functions correctly.
- Check that communication equipment is functioning and confirm the check-in schedule.
- Traversing crews should check to confirm their location – drop off and pick up points, the placement of any survival caches and the means of transportation (aircraft, boat, or vehicle). Do not leave your transportation unless you can accurately place yourself on your map.

2.1.2.4 | Drill Site Safety Meetings

A safety meeting for a drill program should normally be held at the drill rig. It is very important for geoscientists and employees who work in the area of a drill rig to be familiar with the risks and hazards associated with the drill and the sampling and drilling processes. Refer to Chapter 20. Drilling Sites for information about specific risks and hazards associated with drills, drilling methods and drill sites. Include potential environmental issues and emergency response plans at the same time as reviewing safety procedures at the drill.

Suggested topics include:

- Drilling safety issues for the specific type of drilling equipment used on site:
  - PPE: Requirements should include safety glasses with side shields, steel toed safety boots, hard hat and hearing protection at all times. Possible job specific requirements include gloves and dust masks or respirators.
  - Demonstrate exactly where each hazard is located at the drill rig.
    - Emergency shut-offs: Demonstrate the location and proper operation of every emergency shut-off on each piece of equipment. Everyone must know the location of shut off equipment and how to operate it.
    - Compressed air hazards:
      - Pressure relief valves: Location, direction of discharge, potential blockages and the consequences of being hit by an unexpected discharge
      - Whip checks: Inspection of attachment points and condition
      - Couplings: Inspection procedures
      - Booster compressor: Whip checks, condition of hoses, location of relief valves and emergency shut-offs
    - High pressure air hoses: Position, couplings, support and wear, check quality
    - Hydraulic hoses: Check the quality of hoses. Caution about potential pinhole ruptures, burns from hot oil and fluids, correct methods to determine the location of a leak and the potential for fluid embolism.
    - Pinch points: Indicate possible pinch points for fingers, hands, arms, and feet from sprockets, pipes, wrenches, drill rods etc.
  - Fall protection system: Demonstrate the difference between a travel restraint, which prevents an employee from approaching hazards, and a fall arrest system, which brings the employee to a complete stop when they fall. Demonstrate the correct use of the harnesses, shock-absorbing lanyards, attachment point and retractable or fixed cable in the fall arrest system.
  - Hoisting equipment: Cables, clamps and sheaves
  - Hazardous chemicals: Familiarize employees with the characteristics of the chemicals on site and with the use and content of the Material Safety Data Sheets (MSDSs).
  - Housekeeping:
    - The general layout should be efficient and as free of hazards as possible.
    - Maintain tools and equipment in good condition and store them in the proper place.
    - Slips, trips and falls: Point out the hazards and the avoidance techniques.
    - Keep the area around the drill clean to avoid slipping hazards (e.g., no lubricants etc., spilled on the ground, ice cleared away).
  - Manual handling: Demonstrate proper lifting procedures and techniques. Use lifting equipment whenever possible.

- Fire prevention:
    - Discuss possible fire hazards that may result from fuel or oil leaks, especially those near a source of heat or ignition.
    - Designated "No Smoking" areas
    - Demonstrate the correct use of stoves, tiger torches, propane etc. Refer to Chapters 18. Camp Set Up and Management and 20. Drilling Sites.
    - Discuss fire hazards that may result from vegetation and debris caught under mufflers and catalytic converters of vehicles, etc., in hot dry regions.

- Emergency response plan (ERP)
    - Post emergency procedures with contact numbers and radio frequencies. Employees must be able to access the information at a centrally located and accessible place at the drill site. Make sure every person can use the communication equipment required to contact base camp and beyond.
    - Indicate the location of fire extinguishers, first aid kits, eyewash stations, communication equipment, MSDSs etc.
    - Review the potential emergencies that may occur at the drill site, including spills, drill related injuries, fires, slips and falls, bears etc.
    - Some drill sites should have their own emergency evacuation plan in place in case they are isolated from camp when an emergency develops.
    - Make sure the first aid kit at the drill site is equipped to address potential injuries that may occur. Refer to Chapters 20. Drilling Sites and 18.5 First Aid.
- General topics:
    - Vehicles: Safe driving rules, daily inspection, loads, local hazards, driver fatigue, parking etc., which apply to ATVs and snowmobiles as well.
    - Review of accidents: Past experiences of company and contractor personnel
    - Environment: Oil or chemical spills including the use of correct cleanup and reporting procedures, use of bulldozers, site access trail building
    - First aid: Training, station locations, kit contents and requirements. Confirm that the contents are replenished, up-to-date, and are not expired, dull or worn out.

2.1.3 | Alcohol and Drug Policies

In the past, many mineral exploration companies have not been familiar with the definition of a "mine" according to jurisdictional Mines Safety Acts and Regulations. The definition includes "a place, where the ground is mechanically disturbed or an excavation is made to explore for or to produce minerals…" per the Northwest Territories Mines Health & Safety Act. Using this definition, all Mine Health and Safety Regulations apply to an exploration site, including those that address the presence and use of alcohol and drugs on a mine site.

A mineral exploration company should have a clear and concise policy to address the presence and use of alcohol and illegal drugs at a project work site or camp. In the past there have been "dry" camps and "wet" camps. The PDAC recommends that a drug and alcohol policy should address the following:

- The distribution, possession, consumption or use of alcohol at work sites
- The distribution, possession, consumption or use of illegal drugs at work sites
- Reporting to work or being at work under the influence of any drug or substance that may or will affect the employee's ability to work safely
- The operation of any vehicle, ATV, snowmobile or boat while the driver is under the influence of alcohol or drugs
- The misuse of prescription or non-prescription drugs while at work
- The option for an employee to successfully complete a rehabilitation program and then be allowed to return to work
- How to handle zero tolerance for alcohol while on a work site near a town where alcohol is available and the town is accessible
- Viable options for "dry" versus "wet" camps
- Workers who take a prescription or non-prescription drug for which there may be an unsafe side effect should report this potential to his or her supervisor. In addition, employees who require medication (e.g., insulin, epinephrine) should keep a sufficient supply (perhaps a three-day supply) with them at all times in case an emergency occurs away from the project or camp where their medication supply is kept. It is understood that many jurisdictions have privacy regulations relating to medical matters. It may be advisable for a company to have a lawyer address how this issue should be handled.

2.1.4 | Job Safety Analyses

A job safety analysis (JSA) is a procedure where observers carry out a safety evaluation of the required actions to perform a specific job with the aim of improving safety for workers. A JSA differs from a risk assessment (see Chapter 2.1.5 Risk Assessments below). The JSA procedures detect hazardous aspects of the job and then the employer undertakes to remove or mitigate the risks and hazards associated with it. The JSA procedure should be performed by experienced employees and/or specialists who are trained in specific job safety analysis techniques. While JSAs may not always be easy to perform, they are an essential part of an effective health and safety program.

Synopsis of the Job Safety Analysis procedure

1. Select or determine a job and use a standard format for JSAs.
2. Evaluate the job by breaking it down into a sequence of steps; there should be no more than ten steps (tasks) in the process. If there are more than ten, divide the job into two separate JSA procedures. The evaluators should be required to have a good working knowledge of the job being analyzed in order to break the job into appropriate tasks.
3. Analyze each task being performed in the correct sequence of steps. Special methods are employed to identify and evaluate the risks and hazards.
   - The "Change Analysis" method may be used to establish causes of accidents. "What if?" questions are asked to ascertain how various changes affect the outcome of a sequence of actions used to carry out a job. The questions are asked to determine what actions may result in injury to workers and damage to equipment etc.
   - The "Energy Barrier" method investigates how uncontrolled forms and various sources of energy impact the outcome of a sequence of tasks that may result in injury to workers and damage to equipment etc.
4. Determine preventive measures to reduce risks and hazards associated with the job. This can be done by:
   - Eliminating the hazard
   - Controlling or reducing the risks and hazards to employees
   - Minimizing the risks and hazards by protecting employees with PPE or machine guards etc.
5. Communicate the preventive measures to the employees who will perform the job that has been analyzed. Train the employees in the safer techniques and seek feedback from them to determine whether new hazards have been introduced by the changes.

Consider which jobs should be the subject of a JSA

- Prioritize jobs according to the rate and severity of the accident, injury or illness. The order should be:

    1. Jobs with a high accident, injury and illness incidence and/or severity
    2. Jobs where there is a high potential for severe injuries or illness
    3. Jobs where there are signs of (or the potential for) harmful exposure to substances
    4. Modified or new jobs
    5. Infrequently performed jobs, especially those with complex actions

- Repeat JSAs when a job is changed or when the equipment or a work process is changed.
    - Use JSAs to train employees in the safest way to perform a job.
    - JSAs can be used for accident or incident investigation.

Preventive measures

Preventive measures to reduce risks and hazards can be carried out without doing a formal JSA. However, without using the formal methodology to analyze a job, some consequences of implementing preventive measures might not be immediately evident (e.g., they may inadvertently create new hazards). While the ideal ways to reduce risks and hazards are listed below, it is always very important to use and wear PPE. Due to the locations and nature of mineral exploration work, it is often impossible to eliminate risks and hazards.

Recommended ways to reduce risks and hazards include the following measures and examples, which are covered in more detail in the next Chapter (2.1.5 Risk Assessments).

1. Eliminate the hazard.
    - Use a different process or use different equipment for the job.
    - Modify the process or the equipment. Modifications to equipment must meet both the manufacturer's and jurisdictional standards.
    - Lock out the energy source to remove the hazard.
2. Replace the hazard with less hazardous alternatives.
    - This approach is recommended when using hazardous materials.
    - Use up-to-date tools and equipment with better safety features.
3. Minimize the risks, depending on the hazard.
    - Train employees in safer work practices.
    - Reduce exposure to the hazard. Examples include:
        - Improve ventilation; block out noise.
        - Use a safer transportation method (e.g., use snowmobiles in winter rather than ATVs).
4. Use administrative controls.
    - Use job rotation (e.g., share core cutting duties to reduce exposure to silica dust and noise).
    - Designate that two employees should lift very heavy core boxes
5. Provide and require the use of appropriate PPE. For example:
    - Almost every job should require the use of safety glasses.
    - Respirators: Do not rely on dusk masks that are not designed for the job.
    - Appropriate gloves: Use the right type for the job.
    - Appropriate clothing: High visibility vests, coveralls for certain work
    - Fall protection, as required

Additional information about JSAs is available from the Canadian Centre for Occupational Health and Safety.

DRIVING RESPONSIBLE EXPLORATION

2.1.5 | Risk Assessments

Numerous types of risk assessments (also known as risk analyses) are employed by businesses. With regard to occupational health and safety, a risk assessment is the process of identifying hazards and estimating the likelihood or risk that an event (accident, incident) may occur and the potential consequences or severity of the event. The goals of risk assessments are to identify and then manage risks through the elimination or mitigation of hazards. Risk assessments provide a useful evaluation tool to help determine which preventive actions may result in fewer accidents, injuries and property losses. Risk assessments are a part of a good occupational health and safety program and should be carried out before beginning any substantial field work on a new project or when activities change. The risk assessment process should be ongoing, and a company should evaluate the need for additional risk assessments when there is an accident or a change in work environment (e.g., location, equipment, personnel). It may be advisable for a company to hire specialized expertise in risk management if the company lacks experience in the subject or is starting a project in a completely new area.

2.1.5.1 | The Risk Assessment Process

The risk assessment process includes the following steps:

1. Risk Identification: A team of people with appropriate expertise who are familiar with the project area should perform the risk assessments by identifying potential hazards and hazardous situations. The team should include participation by the company Joint Health and Safety Committee or a Health and Safety representative, as appropriate. Hazards may be identified through team observations, inspections, analyzing accident and near miss statistics, checklists, job safety analyses, audits, and the use of special techniques etc. Include the risks to new employees, site visitors and the public in the assessments. There are many options available to help employees determine and analyze risks. Two examples are presented in Chapter 2.1.5.2 Methods to Identify Risk Factors with detailed information about using “Fishbone Diagrams” and “Failure Modes Analysis” techniques to analyze the likelihood and severity of an event. A third method, the “5 Whys” is described in Chapter 2.2 Accident and Incident Investigation and Reporting.
2. Analyse the likelihood that a particular hazard will result in harm or loss. Likelihood may involve a specific timeframe or seasonal element depending on the types of hazards under evaluation. Analyse the hazards and work activities under normal and abnormal situations, including emergencies. Analyze those that are related to terrain, weather and transportation, and those that may occur during the day and/or at night. Analysis should consider the frequency of employee exposure, the percentage of employees exposed to the hazard, the seriousness the potential injury, as well as the probability of occurrence. The following table shows the “likelihood” of an event and a criteria description of the frequency of an event.

Table 2.1: Likelihood Categories

LIKELIHOOD	CRITERIA DESCRIPTIONS
Almost Certain	Almost certain to occur within a defined timeframe
Likely	Likely to occur within a defined timeframe
Possible	Possible to occur within a defined timeframe
Unlikely	Unlikely to occur within a defined timeframe
Very Unlikely	Very unlikely to occur within a defined timeframe

3. Determine the level of severity or impact. The table below is a typical severity index that can be used for health and safety. Sometimes the severity or consequences are defined using different terminology depending on the site and the types of hazards. The severity categories usually include a monetary value that may reflect jurisdictional or company specifications.

4. It is important to remember that severity or impact usually emphasises personal injury, and perhaps property damage. However, there are additional factors that may be taken into account – two examples are reputational loss and project delay. Also, when considering potential injury or property loss, assessment should take into account the general public as well as individuals and equipment at the site.

Table 2.2: Severity Categories

SEVERITY	CRITERIA DESCRIPTIONS
Low	No injuries; no property loss
Minor	Minor cuts, abrasions, bruises that may require first aid; minor property damage
Moderate	Injuries requiring medical treatment; moderate property damage
Major	Serious injuries e.g., broken bones, amputation, permanent disability; major and extensive property damage
Critical	Fatality; highest level of property damage

Risk Assessment Classifications: Form a risk matrix with "likelihood" on one axis and "severity" on the second axis. Once a simple matrix is designed, one can assign risk values to individual events, which are the potential accidents due to the identified hazards, hazardous situations, occupational illnesses etc. When risk values are assigned make sure they include all current controls that are in place at the time of evaluation. The resulting risk values will help responsible parties to prioritize the risks and then address and control the most severe ones and the events most likely to occur. It may be advisable to hire risk management specialists to help with this procedure.

Table 2.3 Risk Assessment Classifications

	CONSQUENCE SEVERITY				
LIKELIHOOD	LOW	MINOR	MODERATE	MAJOR	CRITICAL
ALMOST CERTAIN	MODERATE	MODERATELY HIGH	HIGH	VERY HIGH	VERY HIGH
LIKELY	MODERATE	MODERATE	MODERATELY HIGH	HIGH	VERY HIGH
POSSIBLE	LOW	MODERATE	MODERATELY HIGH	HIGH	HIGH
UNLIKELY	LOW	LOW	MODERATE	MODERATELY HIGH	MODERATELY HIGH
VERY UNLIKELY	LOW	LOW	LOW	MODERATE	MODERATELY HIGH

- Develop an action plan or strategy to manage the risks in order of priority. Risk assessments are useless if no action plan is forthcoming from the exercise. There are three critical elements to an action plan:
  - That a clear action is identified to prevent or mitigate the incident risk being considered
  - That someone is identified as responsible for implementing the action plan
  - That a review or audit is completed to make sure that the action plan has been implemented, and then subsequently that it is effective.

  Identify and analyze options to eliminate, control, or mitigate risks and hazards. Set goals and objectives. Determine what level of risk is acceptable, what level is unacceptable, and what level is acceptable if the risks are mitigated through changing the consequences or the likelihood that a consequence will occur. Assign time lines to follow for managing the risks.

- Events that fall in the **very high risk** category of the matrix should be addressed and/or controlled immediately. If risks cannot be controlled, a company should consider stopping the work or activity until the risks can be addressed.
- Events that fall in the **high risk** category should be considered urgent and addressed within a short time frame.
- Events that fall in the **moderate risk** category should require correction within a set number of days.
- Events that fall in the **low risk** category may be corrected when possible and some toleration may be acceptable if there is ongoing monitoring.
- What is considered a "tolerable risk" will vary between companies. The cost resulting from an accident may impact the budget of a small company more severely than a large company that has more funds available. An "it won't happen to us" attitude can be financially disastrous, especially for a small company.
- Reassessing risks: When an event falls into a high and very high risk category and mitigating measures are applied to bring it to a lower ranking, it is important to re-rank the risk after a short time to determine if the new controls are effective. If they are not sufficiently effective, additional controls or mitigation will be required to lower the risk to an acceptable level.

Hazard Controls: General OHS risk management strategies identify the following order as the ideal priority for controlling risks and hazards. This sequential approach is accepted practice in the manufacturing and construction industries, but it is harder to implement in the mineral exploration industry where there are many uncontrolled hazards (e.g., terrain, weather) and when work depends on transportation in remote locations. Exploration companies have a tendency to rely on PPE, which is the last of the preferred approaches. Whenever possible, companies should try to reduce employee exposure to hazards by using approaches one through three – as well as PPE. The ideal order for hazard control is:

- Eliminate the hazard: Try to remove a hazard or substitute a less hazardous product or system. As mineral exploration is done out-of-doors, physical hazards can rarely be removed although some hazardous systems or procedures can be eliminated. Examples include:
    - Locate a camp close to the work area to eliminate transportation risks (e.g., crossing a water body or driving a hazardous route to the work site).
    - Locate the camp at a lower altitude than the work site. The "work high and sleep low" concept is a good method to reduce the risk of altitude illness.
    - Eliminate the use of hydrofluoric acid by replacing it with a different method of measuring the angle of the hole during drilling (e.g., use single shot or multi-shot cameras, or magnetic and non-magnetic digital downhole survey techniques).
    - Where malaria and dengue fever are a risk, make a determined effort to eliminate the immediate breeding areas for mosquitoes by removing all standing water that accumulates in objects, ditches, tire ruts etc., at the site.

- Engineering controls may be made to redesign a machine or process if they meet the manufacturer's or jurisdictional standards. In addition, engineering controls may be applied to isolate machinery with an aim to diminish noise or redirect particulate matter or exhaust. Examples include installing noise barriers and extraction fans to remove airborne dust when cutting rocks. Sometimes the layout of a workshop can be modified by reorganization or placing approved guards to reduce risks to the operator or those who pass through the area.
- Administrative controls may be developed and implemented to reduce exposure to hazards and risks. Good examples include developing site specific SOPs, shift management to reduce the employee exposure time, training, and working with the "buddy system".
- Personal protective equipment: Use appropriately designed and properly fitting PPE to reduce exposure to hazards when other controls are not possible or practical. While it is important to try to use the previous approaches, PPE is a very important barrier between the employee and uncontrollable risks in the field. Examples include wearing a lifejacket when working on water, wearing a helmet, eye protection and appropriate clothing when riding an ATV, and wearing the correct type or respiratory protection. Refer to Chapter 4. Personal Safety for extensive information regarding PPE.

- Communications and continuous improvement: Companies should communicate action plans, safety policies, goals, and the results of risk assessments and JSAs to employees as a part of their OHS program. These efforts should be ongoing and supported with safety meetings. In addition, continuous improvement can be accomplished by performing additional risk assessments after tracking and addressing accidents and near miss situations and by adopting new safety procedures based on updated accident statistics.
- Monitoring and Evaluation
    - Risk assessment should be an ongoing process and new risk assessments should be initiated when there is a change in location, a change in equipment use, a change in personnel, or when there are accidents or near misses that indicate a breakdown in the methods of hazard control.
    - Even though risks fall into a tolerable category, the risks require ongoing management and monitoring to make certain they remain in that category.
    - Monitor employee behaviour, accidents and near misses to see if the corrective and mitigating actions are effective. Determine if new risks arise due to changes in procedures.
    - Keep records of the risk analyses, job hazard analyses and the actions taken to address the risks and hazards.

2.1.5.2 | Methods to Identify Risk Factors

Risk factors that may result in incidents may be identified by review of past data. Some sources include the PDAC-AME BC sponsored Canadian Mineral Exploration Health and Safety Annual Report surveys, statistics available from local Workers' Compensation Boards, or by consideration of the job at hand. It is very effective to use brain-storming methods with the people involved in the work to identify and assess risk factors. In order for this to be effective, one individual needs to be the facilitator (from either inside or outside the company) for the discussion and assist the group in reaching conclusions. This type of activity should be completed prior to the start of a field program, but may also be utilized during the field program, especially in the event of an incident at a project or a change in type of field activity.

Risk Analysis and Field Safety – Some Tools for the Project Manager

Many tools are available to help identify relevant risks, including those used by specialists. It is not the intention of this section to provide a comprehensive risk analysis methodology but to present two examples of simple tools for field project managers or small teams of individuals to assess the risks that require addressing prior to the commencement of a field project. In addition, the same tools may be used during a field program to increase team building and to encourage communication within a field program. They can also be used after an incident to address the issues that contributed to an accident or near miss.

Fishbone Diagrams

A useful tool for initial "brainstorming" on health and safety is the Fishbone diagram, also known as the Cause and Effect diagram or an Ishikawa diagram. Brainstorming, which generates a lot of ideas quickly, is a team tool and is effective because many persons' knowledge and ideas are always more effective than those of an individual. The principles of brainstorming are:

- Give everyone a turn to speak.
- At the first stages, listen and respect other's ideas = all ideas are good ideas.
- Focus on the issue at hand.

In cases where there are problems creating an equal opportunity to speak due to hierarchies present in the team, one method that has been successfully applied is to provide all participants with a number of "post-it" notes and let them write anonymously and post their comments onto a board. These are then sorted into topics by the team leader or facilitator.

The fishbone diagram has as its focus – the problem faced – which may be simply incidents at a project, or could be a specific type of incident. Then for the main cause, there is a classification of the types of causes, which may be, for example, "People" "Machines" "Location" etc. Then individual causes are listed on the first branch. It is useful to go into depth on each cause – some experts suggest that the question "why" should be asked a minimum of three times on each cause. For example, under the Main Category "People" there may be a cause "Lack of Training", and the subsequent questions would be:

1. Why is there lack of training? – answer because of insufficient funding.
2. Why is there insufficient funding? – answer because health and safety was not considered in the budget.
3. Why is health and safety not considered in the budget? – answer because management does not have a commitment to health and safety and the company has no health and safety principles.

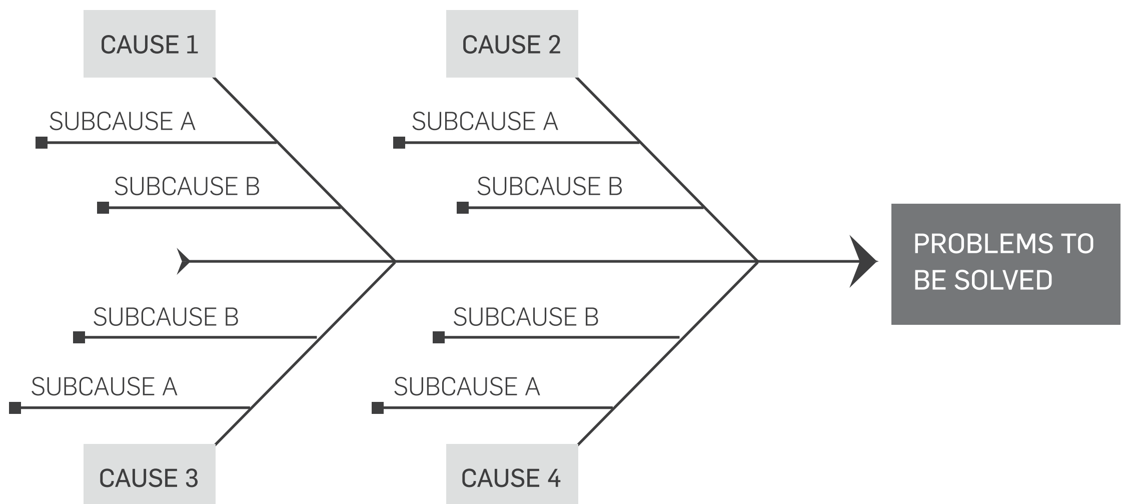


Figure 2.1 | Fishbone diagram

When the third question is asked and answered, the team is getting closer to what is considered the root cause of the issue. The program will be more successful if root causes are addressed.

It is useful at this point to then classify the causes as to "controllable" and "uncontrollable". For example, weather may be considered uncontrollable whereas wearing helmets when riding an ATV is controllable. You cannot change the weather, however you can prepare for it.

When reviewing the results of a fishbone exercise, it is useful to observe when common root causes occur. These can indicate where fundamental changes are needed in practice as the same issue is leading to multiple risks.

Fishbone diagrams are very effective methods of bringing multiple causes of a problem out into the open; however they are not very helpful for ranking risks.

Examples of Fishbone Diagrams for Specific Problems

The following diagram is an example of a fishbone diagram for a particular potential incident, in this case relating to health in a field project.

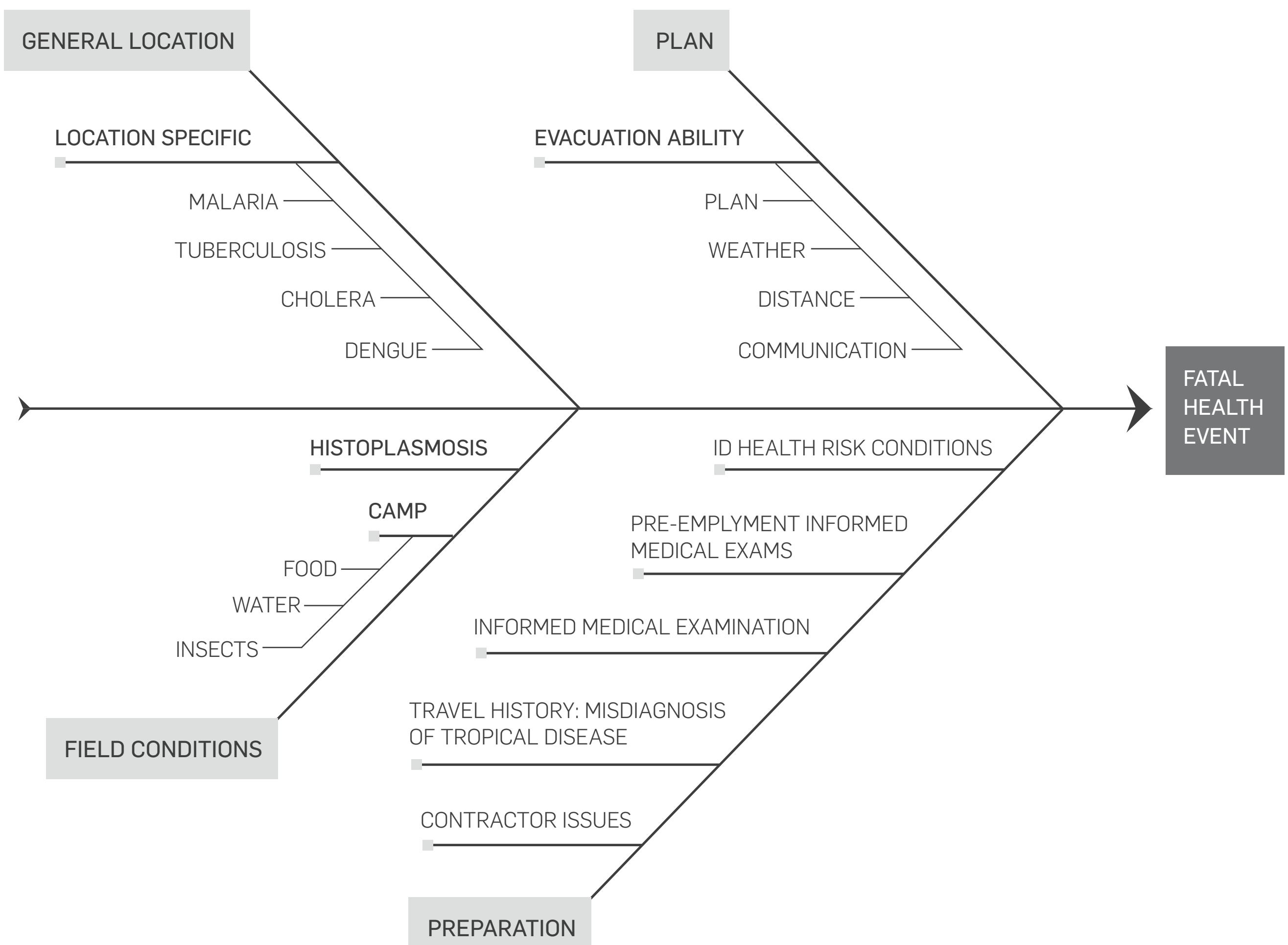


Figure 2.2: Fishbone diagram for specific problems

Another example is given below for risk of a fatal accident while drilling.

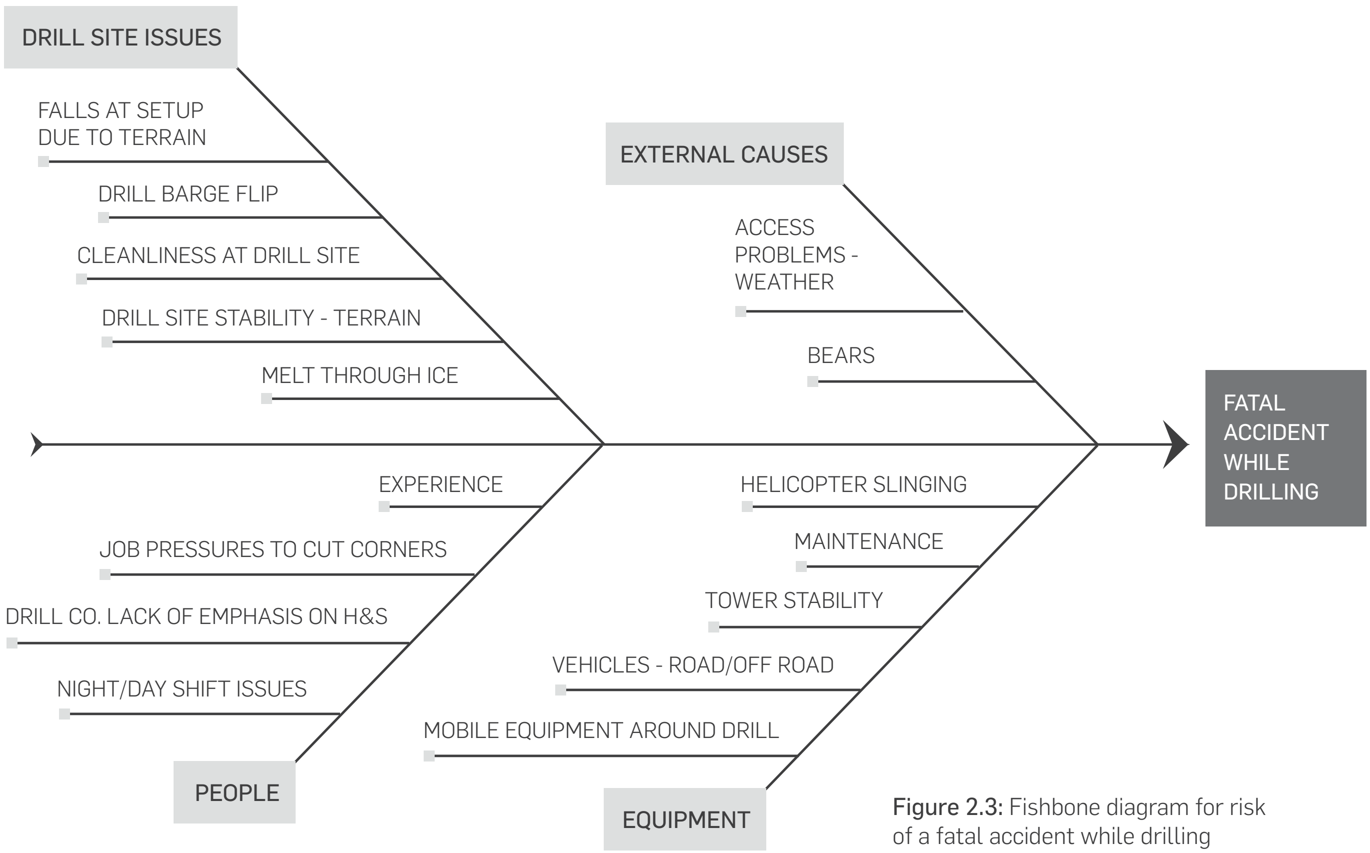


Figure 2.3: Fishbone diagram for risk of a fatal accident while drilling

In this diagram, those causes given in red and underlined were considered uncontrollable in the view of the team which generated the diagram.

These examples should be taken as just that, examples, and teams and field crews should generate their own fishbone diagrams starting from a blank sheet.

All of these brainstorming methods, although fast ways to obtain results, do have pitfalls. First of all, they are based on experience not on facts. Secondly, it is critical to have a diverse team present; otherwise the exercise can be dominated by "group think".

Procedure for Fishbone Diagram

- Step 1. Define the problem statement – for example, "helicopter slinging incidents at drill site".
  - The problem statement must be specific defining what, when, where does the problem (effect) occur.
- Step 2. Have the team brainstorm possible causes.
  - Flipchart or whiteboard may be used for this.

- Step 3. Review potential causes and attach to appropriate categories, for example:
  - Location
  - Machine, Materials, Measurement, Method, Environment, People
  - Weather
  - Policies, Procedures, People, Plant, Measurement, Environment
  - Or other category that will help people think creatively
- Step 4. During the review of each cause ask, "Why does this happen?"
  - Add as small branches off the main bone.
  - Up to three levels may be used.
  - Attempt to categorize into controllable and uncontrollable causes.
- Step 5. Analyze results, do any causes repeat?
- Step 6. Prioritize the potential causes.
- Step 7. Determine which causes you need to verify with data. Be careful not to overlook causes that should be reviewed with data.

Failure Modes Analysis

As introduced above, when addressing risks and considering whether they are important or not, usually two factors are considered – likelihood and severity. However, more thorough risk analysis would add an additional factor – "Detection" as requiring to be addressed:

1. Severity: What are the consequences of the event? Clearly a fatality is more serious than a minor finger cut. This is a method of ranking possible accidents as to their seriousness.
2. Likelihood or Probability of Occurrence: How likely is the event to happen? Is it likely to happen once every day, or every ten years? This may initially appear difficult to assess but perhaps historic data is available within a company, in the experience of the people involved in the ranking exercise, or in industry surveys, such as the PDAC-AME BC Canadian Mineral Exploration Health and Safety Annual Report surveys.
3. Detection: How well can the event be recognised and acted upon before it happens? If the causes are already apparent long before the actual event, then clearly this is a less risky situation than where it is only apparent after the event.

It should be apparent that the worst risks to contemplate are those that can cause a fatality, have a reasonable probability to happen in the field program and are not recognisable ahead of time. In fact, in any scoring exercise, any accident that could cause a fatality or very serious injury should rank very high irrespective of its ranking on probability and prior recognition.

There are many sophisticated brainstorming tools for specialists to use for assessing risk. One tool is presented here that may be useful for team leaders or project managers to utilize in assessing risks. The table below is adapted from more sophisticated Failure Modes and Effects Analysis (FMEA).

Table 2.4: Example of a Failure Modes Analysis table

ACTION	WHAT CAN GO WRONG?	POTENTIAL EFFECT	SEV	POTENTIAL CAUSE	PROB	PRESET CONTROLS	DET	OVERALL SCORE (RPN)
What activity is the event associated with	What is the actual event	How bad could the effect of the event be		What is the likely cause. If an event has multiple likely causes then additional lines are used		What present controls are there to prevent or foresee the incident		
Travel	ATV crash	Serious injury	7	Reckless driving	8	Management supervision	7	382
Travel	Helicopter crash	Multiple fatalities	9	Mechanical failure	3	None (trust in helicopter company)	9	243
Travel	Helicopter crash	Multiple fatalities	9	Poor weather	3	Weather reports from base	3	81

Notes:
SEV: ranking of severity from 1 to 9 where 9 is high.
PROB: ranking of probability of occurrence from 1 to 9 where 9 is high probability of occurrence.
DET: ranking of detection from 1 to 9 where 9 is high probability that the event would be undetected until after it happened.
OVERALL SCORE: SEV*PROB*DET

Such a table may be easily set up in a computer spreadsheet.

The objective would be to list as many possible accidents and causes, not in any particular order and rank them. Then the table would be sorted on the overall score and focus would fall onto those with the highest overall score. A fishbone diagram could then be created for the top few accident categories with the greatest impact. Note that there may be a decision to also address all those where SEV=9 as no number of accidents which may result in fatality will be tolerated.

The column on "Present Controls" refers to what systems are already in place that should either prevent or detect the incident. These could be for example, training courses, protocols, standard operating procedures, audits, or actual mechanical or other devices ("fool proofing") to prevent the incident. The team then assesses how well the system is likely to detect the event before it happens, enabling prevention, or how well the system can mitigate the effect after the fact if the event is unpreventable.

At the initial stages it is not worthwhile spending excessive time on details of the numerical severity, probability or detection rankings as the objective is to sort out the potential accidents as quickly as possible and eliminate those that are extremely unlikely to occur or that would cause very minor injuries and focus on the top few.

Whether action is required on potential incident categories can be considered two main ways – first of all by reviewing the actual total score, and secondly reviewing where the potential incident individual scores are high. For example, a company or team may decide that all of the following cases require action irrespective of the overall score:

- Any potential incident that may lead to a fatality (SEV = 9 in 9 point scale)
- Any potential incident that has high probability (PROB = 9 or close to 9 in 9 point scale)

Some cases may not require attention such as those that score "1" in all categories.

Procedure for Failure Modes and Effects Analysis (FMEA)

- Step 1. For each activity, determine the ways in which something may go wrong or an incident may happen (these are Failure Modes).
- Step 2. For each Failure Mode associated with the outputs, determine the Effects – what kind of negative impact may occur.
- Step 3. Identify potential Causes for each Failure Mode.
- Step 4. List the Current Controls for each Cause.
- Step 5. Assign Severity, Probability (sometimes referred to as Occurrence or OCC) and Detection ratings to each Cause between 1 and 9 where 1 is lower impact and 9 is higher impact.
- Step 6. Calculate RPN (Risk Priority Number = total score)
- Step 7. Determine Recommended Actions to reduce High RPNs
- Step 8. Take appropriate Actions and Document
- Step 9. Recalculate RPNs after X amount of time where X is an assessment to be made on an appropriate basis

2.2 | Accident and Incident Investigation and Reporting

Companies should clearly define the meaning of the words "accident", "incident" and "near miss". See the introduction of this section for the definitions of these terms as used in these Guidelines. Risk analysis is a procedure to investigate possible negative events prior to work commencing and before any accidents/incidents happen, whereas accident and incident investigation is an exercise to be conducted after an accident/incident has happened. That said, some of the same tools may be useful in both exercises – for example the Cause and Effect/Fishbone/Ishikawa diagram.

Accident and incident reporting

Depending on jurisdictional regulations, all serious accidents, fatalities, major structural failures, major releases of hazardous substances and any event so required by regulations must be reported to the appropriate jurisdictional authorities within a prescribed time, which is usually 24 hours. All work related accidents, injuries and diseases should be reported to the appropriate supervisor and to the first aid attendant immediately after the occurrence. An investigation should aim to find out the what? when? how? who? why? the accident or incident occurred and then make recommendations to prevent future events of the same type. The results of any accident or incident investigation should be made known to all personnel on the project site.

Investigators should ideally be from all levels within the company (management, supervisory, worker) and if the project site has a joint health and safety committee, investigating accidents is a part of their mandate. Good accident investigation requires training in accident causation and investigating techniques; Workers' Compensation Boards usually offer instructional classes. Investigators should be careful in their approach and remember the following points.

- Seek all the facts. Witnesses and others will have different perspectives so interviews are important to gain all the facts. Witnesses may remember only what they think is important and some may only remember what they think the investigator wants to hear.
- Do not prejudge the causes of the accident. Gather all the facts before deciding on the causes. Jumping to conclusions can affect the conclusions and influence the questions the investigators ask.
- Recognize that there are usually several causes of an accident. Be open-minded and look for root causes; don't focus on immediate causes or look for a scapegoat.
    - Root Cause Analysis (RCA): Root causes are the fundamental contributing factors that underlie the obvious reason for an accident (or incident). Root cause analysis uses systematic methods that focus on finding the underlying cause(s). Techniques that dig down to root causes include the "5 Whys", Ishikawa (Cause and Effect/Fishbone) diagrams, Failure Modes and Effects Analysis, and other methods. RCA can be used both after an event for investigation and proactively to predict potential events (risk assessments). By addressing the root cause of an accident, it is more likely that the fundamental cause will be identified. When root causes are mitigated, the likelihood or risk of repeating an accident is reduced.
    - The "5 Whys": This problem solving technique is good for trouble shooting and avoiding assumptions during accident investigations. When using the technique, the team should describe the accident and ask "why" it occurred. Then, ask "why" regarding that answer and continue repeating the "why" questioning process to each answer five times (more or less). By using multiple "why" levels of questioning, one is likely to arrive at a root cause of the accident. (Depending on the time available and the seriousness of the issue, it could be the "3 WHYs" or "5 WHYs").

  - Ishikawa/Cause and Effect/Fishbone diagrams and Failure Modes and Effects Analysis are other RCA techniques (see the previous Chapter 2.1.5 Risk Assessments).
- Monitor, investigate and report on accidents and incidents in a manner that encourages continuous learning and promotes improved health and safety performance.
- Accident investigations should begin as soon as possible. Credible accident investigation requires that a sequence of steps is followed.

2.2.1 | Securing the Site

Determine if the site is safe to enter. If there are injuries, administer first aid if it is possible to do so without endangering others. The first consideration is to prevent further injuries or damage. Consider restricting access to the site until emergency or rescue crews are finished. To secure the site, consider the following possibilities and be sure the surroundings are safe:

- Mitigate hazards (electrical, mechanical, chemical, fire hazards) to prevent further occurrences (injury and/or damage).
- Keep mobile equipment, vehicles and pedestrians away.
- Preserve evidence by restricting access to the site once victims are removed. If a fatality has occurred, notify appropriate authorities, restrict access and remove the victim according to the jurisdictional regulations.
- Collect names of witnesses and others who have knowledge of the accident or situation.

2.2.2 | Observations

Make observations and collect clues to the causes of the accident. There are various strategies to use when looking for information. Physical searching for evidence may be done by grid, by zone, or in strips or spiral search patterns.

- Note the location of evidence. Look at what items are in place and what is out of place.
  Look up as well as at the ground and at work level to note hazards that might have contributed to the event.
- Note indications of movement and/or items out of place. Note marks on or made by vehicles etc., such as skid marks or indications that some things are misplaced. Note tracks or footprints on surfaces. Note the absence of marks indicating removal – dusty outlines, clean or dirty outlines. Look for broken, frayed and snagged items.
- Note if physical evidence is normal or abnormal in appearance, which might indicate reasons the accident occurred.
- Follow logical sequences of events and processes to determine possible causes. Use root cause analysis as described above.

2.2.3 | Documentation

- Make clear detailed notes. Record detailed descriptions of the scene, the location of each piece of evidence and what is done with it. If outside authorities are a part of an investigation, share the notes and aid their efforts.
- Photographs: It is preferable to use a camera that requires colour film. Digital photos may not be allowed as evidence in a court of law as they can be "shopped". It is advisable to keep disposable cameras on a project site to use for documenting accident investigations. Record who takes photos, in what order, the direction the photo is taken and the date and time. Take both close-up and distance shots. Video cameras may be used as well.
- Sketches: Use drawings to indicate locations of major objects, dimensions and views from various angles. Measure the placement of items and evidence accurately. If drawing a map, be sure to indicate which direction is north.

2.2.4 | Interviews

Accident investigators should be trained to conduct good interviews and handle witnesses.

- List the people to interview: witnesses, anyone directly or indirectly involved, anyone in the area who could shed light on what happened, and first aid/ambulance attendants, fire or police personnel.
- Keep witnesses separated from each other until after their interviews; they should not compare ideas.
- Conduct interviews as soon after the accident as possible so people do not forget facts.
- The interviewer should be calm and relaxed; ask questions aimed to clarify what happened and cannot be answered with a "yes" or "no" answer.
- Before completing an interview with a witness, the interviewer should summarize the facts to be sure the information in the notes is correct.
- Take careful and thorough notes.

2.2.5 | Analysis

- Review the documentation. This includes but is not limited to:
  - Witness reports, photos, sketches and notes
  - Company documents such as permits, SOPs, employee job training records and certifications
  - Inspection and maintenance records
  - Previous or similar accidents and incidents in the same location

- Analyze the information.
- Be certain about the facts and list them in chronological order.
- Evaluate witness testimony.
- Consider the importance of the "lack of information" regarding any aspect of the accident.
- Compare witness accounts with the physical evidence.
- Assess the information in relation to (1) environment, (2) equipment, (3) procedures, (4) supervision, and (5) workers.
- Assess possible contributing factors such as weather, temperature, lighting, noise, housekeeping, footing, and stability of structures.
- Use investigative methods to determine the causes.
- Use root cause analysis (RCA) to look for the root cause of an accident or incident.

2.2.6 | Recommendations

Submit written recommendations in the accident or incident investigation report.

- Determine what was learned and what corrective actions (immediate and long term) can be made.
- Eliminate or control hazards that were revealed from the investigation.
- Retrain employees. Train employees in new procedures as needed.
- Evaluate the outcome of the recommendations after a period of time.

3.0
EMERGENCY RESPONSE

Introduction

As part of a Health and Safety Program, every mineral exploration company should have an Emergency Management Plan and up-to-date Emergency Response Plans (ERPs) to address potential emergency situations that could occur within the organization and at each project site. In the past, many exploration companies have mainly relied on common sense and experience to deal with emergency situations; the outcomes have been variable at best. When an emergency occurs, there is no time to decide who is in charge, what alternatives will best control a situation, who has training to help, and how to use the communication equipment to obtain help. An emergency response plan addresses these issues and provides information and direction for addressing the situation as quickly as possible. In critical situations the first hour during an emergency (the golden hour) is often the most important, and the outcomes for the people involved and the company will be more successful when a company has an ERP prepared in advance and appropriately trained staff and contractors.

This section addresses emergency response from the point of view of a mineral exploration company. However, individuals conducting geological fieldwork or mineral exploration on their own also need to have an emergency response plan. This may be simply ensuring a third party knows where they are, and when they are expected to return, so a rescue can be launched if the person is overdue. Refer to Chapter19.5 Communications Routine, Schedules and Protocols where notification of traverse routes and check-in schedules etc., are addressed. It is also advisable to be familiar with specific risks and hazards of relevant terrain and climate conditions when developing a personal emergency response plan. Refer to Chapters 6. Safe Traversing Practices, 8. Survival, 9. Weather and Environmental Risks and appropriate transportation sections.

Acronyms

AHJ – Authority Having Jurisdiction
ELT – Emergency Locator Transmitter
ER – Emergency Response
ERP – Emergency Response Plan
OHS – Occupational Health and Safety
PAL – Possession and Acquisition License
RCMP – Royal Canadian Mounted Police
SAR – Search And Rescue
SOP – Safe Operating Procedure
UTM – Universal Transverse Mercator

3.1 | Risks and Hazards

A project or camp may experience the following during an emergency:

- Injury or death to employees, site visitors, the public and/or those nearby caused by lack of appropriate emergency response planning and/or training
- Damage or loss of company property, assets, and/or reputation caused by the lack of an emergency response plan or emergency procedures, lack of staff training to handle publicity and the press
- Environmental damage caused by lack of or inadequate spill kits, lack of emergency response planning and/or training
- Delay in addressing an emergency situation caused by lack of emergency response procedures, lack of employee training, inadequate communication system

3.2 | Emergency Management Versus Crisis Management

Definitions

Crisis: A serious, present or potential event that causes harm to persons, the environment or assets of a company and may pose an actual or potential threat to the long term ability to do business due to the impact on the operation, image or liability of the company.

Emergency: A serious, present or potential event that causes harm to persons, the environment or assets of a company, but which will not affect the long term ability of a company to do business. An emergency develops suddenly and unexpectedly and requires immediate attention.

Emergency Management Plan: An integrated set of company policies and procedures created and prepared in advance to protect people, property and the environment from potential crises or emergencies that might occur at company work sites. The emergency management plan also describes the "what", "how" and "who" involved in creating emergency response plans. Emergency management is sometimes referred to as business continuity planning.

Emergency Response Plan: The specific plan that addresses emergencies that may occur within the organization or at a site (e.g., office, warehouse, field project site). The plan sets out details that include responsibilities of emergency response teams, communication plans (including setup and back-up communication), employee training, emergency provisions, resources, and actions to address potential emergency and crisis situations.

For additional definitions and a discussion of "accident versus "incident" please see the Introduction in Chapter 2. General Safety.

Emergency Management Plans

An emergency management plan should classify emergencies into severity levels and include emergency procedures that address the potential degrees of disruptions to the company. By doing this, a company is better prepared to handle potential emergencies and can improve the accuracy of communication regarding an emergency within the company and to the public.

- A low level emergency (accident or incident) is one that can be handled at the site and involves no serious injuries, no disruptions of operations and no publicity. There are no national or international implications.
- A moderate level emergency (emergency) may involve a single serious injury, temporary disruption of operations, some publicity or the likelihood thereof, with possible implications at the national level.
- A high level emergency (crisis) would involve one or more fatalities or multiple serious injuries, sustained disruption of operations, significant publicity or the certainty thereof, plus implications at the national and possibly international level. There might be a potential threat to the viability of a company.

For moderate and high level emergencies, which might quickly develop into a crisis, it is important to have one or more emergency management teams in place whose members know their assigned roles and who are fully trained to carry out their responsibilities.
Depending on the size of the company, employees and emergency response teams at a project or work site generally manage and resolve emergencies without the direct participation of corporate headquarters. A crisis requires additional handling or support at the headquarters level. The difference between emergency management and crisis management is one of degree.

NOTE: The impact of the same accident or incident on a small company will differ from the impact on a medium size or a large company. A good emergency response plan may mean the difference between financial survival and the demise of a small company.

3.3 | Guidelines for Developing Emergency Response Plans

An emergency response plan should be developed by a team of experienced people (e.g., company employees and perhaps emergency response (ER) consultants or skilled contractors). Team members should have a variety of skills and employees should represent different levels within the company. A site specific emergency response plan (ERP) should be developed with input from employees familiar with the specific site activities and services available in the immediate project area, rather than by one person or team at company headquarters.

1. Select competent team members to develop an ERP.
2. Team members or designates should perform risk assessments to determine potential risks and hazards and their severity and impact.
3. From the risk assessments, determine what emergencies the company is capable of handling and where improvements and additional help will be required.
4. Develop the overall ERP that addresses each risk and hazard.
   - Establish criteria for triggering the plan and appropriate alarm signals.
   - Each emergency will require defined response procedures and a sequence of implementation.
   - Assign responsibilities and back-up personnel for each activity.
   - Develop contact lists – general and specific contacts appropriate for the emergency.
   - Define and list required emergency supplies, equipment and communication devices.
   - Define clean-up, remediation and restoration procedures.
   - Train team members and back-ups and conduct practice drills to test the components of the plan, especially the communication equipment, telephone numbers and evacuation transport.
5. Communicate the ERP to all employees and train them to follow the plan as required.
6. Evaluate, test and improve the plan over time.

Risk Assessments

By using a risk assessment process, the resulting ERP will address events that rank as high and moderate risks with all levels of probability, and time and money will not be spent planning for events with low consequences and a low probability of occurrence. The risks and hazards will depend on the size and type of operation or project, the location, accessibility, security issues, climate, terrain of each site, and the numbers and training level of personnel.

- Aim to identify all hazards or safety risk factors including those unique to a particular exploration site.
- Assess all hazards in terms of the severity of consequences and the probability and frequency of exposure.
- Refer to Chapter 2.1.5 Risk Assessments and see Chapter 3.4.2 Risk Assessment of Site Operations

3.4 | Components of Emergency Response Plans

Emergency response plans are composed of several components. Some ERPs may require more and some fewer, depending on the size, location and activities of the project.

Responsibilities and Communications

When drawing up an ERP, consider and incorporate the following situations, as appropriate:

- Designate who has the authority to speak to members of the press during an emergency – at the project level and at headquarters. Have a basic news release prepared. See Chapter 3.5.12 Example of a News Release below.
- Determine the types of information that should be disclosed or kept private. This can be addressed by providing training for those who have been identified as having authority to speak to the media and family members.
- Determine at what stage the project site manager should contact headquarters for additional help and call in outside emergency aid such as search and rescue, RCMP etc.
- Designate who within the organization will interface with employees' family members in the event of a serious injury or fatality.
- Determine what company property requires protection in the event of certain emergencies and who is charged with the responsibility for implementing the protection procedures.
- Determine where emergency operations will be managed from – which room will function as headquarters; designate a back-up headquarters. Establish criteria and guidelines for the emergency operations centre.

3.4.1 | Site Operation Information

Every ERP should include the following basic information:

- Name of the "Mine" and the owner with a mailing address and contact information including telephone, fax and email
- Name of the Mine Manager (person in charge) as appointed by the jurisdictional Mines Act
- Mine number and permit number (or designation according to jurisdictional authorities)
- Type of operation: underground, exploration, surface, quarry, placer etc.
- Location: state UTM and/or latitude/longitude
- Number of employees: include management, field crews, contractors
- Accurate mine/site plans: These should identify areas where emergency response teams, personnel or agencies can set up and work, including a room that functions as emergency command headquarters.
- Establish criteria to account for all employees in the event of an emergency (i.e. par system).

- Access routes: Note the roads available to access the mine site and whether they are for seasonal or year round use, provisions for air access (e.g., air strips, float plane or helicopter landing facilities).
- List the nearest medical treatment facility, as required by authorities having jurisdiction (AHJs).

3.4.2 | Risk Assessment of Site Operations

Complete a risk assessment to identify potential emergencies that could occur on the site and assess the possible impacts on the operations and on workers. As a general guide, potential emergencies may be broadly broken into five basic categories.

1. Fire and explosion – types of fires and sources of explosions
2. Injury or illness of workers – on site, off site, multiple, fatality, including means of transportation to a medical facility, if necessary
3. Environment – spills of various types, water pollution, soil pollution, disposal of waste material
4. Climate and natural hazards – floods, potential storms in the region, whiteouts, extreme temperatures, winds, earthquake and other natural disasters, as appropriate
5. Equipment failure – power failures (long and short term), fuel shortages, transportation failures and accidents including on site and travelling to and from the site (vehicles, ATVs, snowmobiles, aircraft, boats)

3.4.3 | Emergency Equipment

In some jurisdictions the requirements for emergency supplies and equipment in camps are regulated by the authorities having jurisdiction (AHJs) and compliance with these regulations is required. The details will depend on the size and activity of the camp or project. List the emergency equipment available on site to address the identified potential emergencies and hazards. Develop checklists to keep inventory and inspection records. Also include other sources of equipment that may be necessary in some emergency circumstances:

- First aid supplies
- Firefighting supplies – pumps, extinguishers, hoses
- Forest and brush firefighting supplies
- Rescue equipment (e.g., basket stretcher that fits into a helicopter or vehicle)
- Equipment that can be assigned to an emergency task (e.g., a bulldozer or excavator used to build roads and trails that can be used to dam or dike a flood, or a water truck for firefighting operations)
- Emergency transport vehicle(s)

- Outside sources of specific equipment; mutual aid agreements
- Alternative drinking water supplies in case usual supplies are contaminated
- Rapid test kits for chemical spills, such as cyanide in the case of a gold operation
- Arrange mass evacuation transportation

3.4.4 | Trained Personnel

List the available trained personnel who are capable of dealing with the identified potential emergencies and hazards.

- Contact information for all personnel on site who can administer first aid, firefighting and/or security duties
- Identify other sources of trained personnel:
    - Back-up teams
    - Agencies: local fire department, provincial/territorial/state ambulance, RCMP or police, local SAR (search and rescue may require separate groups for land/water)
    - Charter aircraft companies (for help with evacuations, searches)
    - Possible help available from nearby sites and whether a written mutual aid agreement is in place

3.4.5 | Implementation of Emergency Response Plans

Clearly define how and when people involved in an emergency are to access and implement the plan.

- First steps – who to call, how to call, when to call
- Identify responsibilities:
    - Designate who is responsible for implementing the ERP and who is second in charge.
    - Designate who is in charge of conducting the emergency operations (depending on the type of emergency).
    - Define all communication systems to be used (i.e., two-way radios, cell phones, satellite phones).
    - Assign tasks by function and how the function will be filled. Examples include:
        - Call-outs and communication with other users ofaccess roads (e.g., logging companies, ice road companies)
        - Arranging assistance from other agencies or operations
        - Required notifications: Workers' Compensation Board, Mines Inspectors, provincial/territorial/state ER personnel, RCMP or police

  - Include an Emergency Notification and Mobilization Chart that identifies who and in what order the key personnel are to be notified (see Chapter 3.3.7 Contact Lists below).
- Evacuation procedures: List the circumstances for declaration, optional routes and modes of transportation.

3.4.6 | Directions to the Site

Provide clear written directions to the site. Include maps that can be used for navigation. This is particularly important in remote areas.

- Clearly define how the directions to the site will be communicated to those who are called to assist but who may not be familiar with the area or the roads.
- Provide copies of directions in advance to parties who are expected to provide emergency response. Indicate who has received them in the plan.
- Establish and identify helicopter landing areas.
- If using radio controlled logging roads, include radio frequencies and call-out procedures.
- On long road transport of injured workers, identify and mark on the map possible transfer sites for ambulances. Note in the plan at what stage of emergency to arrange for helicopter evacuation of an injured worker rather than opt for ground transportation.
- Keep informed about the state of remote roads so that you DO NOT direct emergency vehicles to the project via impassable routes. Depending on the season some roads may be impassable due to snow, washouts, slides etc.

3.4.7 | Communications and Contact Lists

Communication – or the lack of it – during an emergency can impact the severity of the emergency. Assign and train personnel within the company to communicate with employees, families, communities and the press regarding various emergencies. At each project site:

- Maintain appropriate fully functioning communication equipment.
- Train everyone to use the communication equipment.
- Post contact lists with the communication equipment and in other appropriate and accessible places. Post the instructions for use at the communication centre.
- Post what information to include when relaying emergency information.

Create and post a stand alone page(s) with complete contact information for all emergency contacts listed in the ERP. (The following lists are not all inclusive):

General Contact List

- Project/Mine Manager
- Corporate head office – appropriate names and telephone numbers
- Company hotline, if applicable
- First aid – full telephone number and/or radio channel
- Emergency services personnel
    - Fire
    - Police
    - SAR (for both land and water, as required)
- Expeditor – full telephone number and/or radio channel frequency
- Outside agencies: federal, provincial/territorial/state, local government (all necessary AHJs)
- Transportation companies including air service (fixed wing and/or helicopter)
- Back-up rescue team, if applicable

First Aid Contact List

First Response

1. First aid attendant – name and full telephone number and/or radio frequency
2. Project/camp person in charge – name and full telephone number and/or frequency

Transportation

1. Contact office (closest location) – full telephone number
2. Expeditor – full telephone number and/or radio channel frequency
3. If expeditor/office cannot be reached: Contact aircraft contractor in the nearest airport – full telephone number and/or radio channel
   Initial transport to camp and medical facility is by__________________ (state means)
   In addition, list the time required to transport a patient to the medical facility by each potential mode of transportation. For example:
   Time required by vehicle by road _______________
   Time required by off-road vehicle___________________
   Time required by boat__________________
   Time required by helicopter______________
   Time required by fixed wing aircraft____________________

Emergency Telephone Numbers and/or Radio Channels and Frequencies

List what is appropriate for the location, region and country.

- General hospital – name and location
  - Emergency – full telephone number
  - Outpatient – full telephone number
- Nursing station – full telephone number
- Health centre – full telephone number
- Poison control – full telephone number
- Police – full telephone number
- Military – full telephone number
- Workers' Compensation Board (or equivalent) – full telephone number (day/night)
- Forest Fire Report – full telephone number
- Environmental Agencies – full telephone numbers for appropriate agencies
- Chemtrec or similar HazMat communication centre
- Welfare agencies
- Civil Defence teams
- Red Cross/Red Crescent
- Public works and highway departments
- Port or Airport authority

3.4.8 | Training and Testing Emergency Response Plans

Establish a minimum time frame (annually, bi-annual, quarterly etc.) for the completion and testing of the ERP. Prepare a written test scenario of the objectives and components of the practice drill and randomly select participants not affiliated with the ERP to complete the tasks. Include provisions for training all persons on site regarding application of the ERP. These may include:

- Fire drills
- Evacuation drills
- Spill control drills
- Testing the communication equipment under various weather and terrain conditions
- Earthquake drills
- Table-top exercises
- Adjust the plan to improve it from the lessons learned from drills and experiences.
- A substantial change in site, activities, or personnel may necessitate a revision and repeat testing of the ERP.

3.4.9 | Documentation

Keep records that pertain to ER planning, preparation, training and testing.

- Training records – practice drills, table-top exercises, equipment tests
- Equipment checks – first aid, survival equipment, firefighting equipment etc., use and replenishment
- Implementation – records of actual incidents, if applicable
- Incident debriefing – as applicable

3.4.10 | Recovery

Develop policies that will reduce disruption to the company following an emergency or crisis. Polices should address:

- Injured workers and their return to work
- Back-up office and communication plans
- Clean-up and remediation plans for spills etc.
- Provision for assistance to employees for stress
- Replacement of lost or damaged equipment etc.

3.5 | Guidelines for Developing Emergency Response Procedures

Emergency response procedures list basic actions to follow in the event of a specific emergency. The sections below are examples that should be adapted by projects to be site specific. Within each procedure, the following should be defined and addressed, as appropriate.

- What constitutes an emergency
- How to alert employees of the emergency
- Potential need for evacuation and the evacuation routines and routes
- Muster stations: (Have a back-up muster station in a second location if there is a chance the main muster station could be the site of the emergency.)
- Required first aid and medical assistance
- Emergency contact lists – comprehensive and/or specialized
- How to report the emergency to authorities
- Clean-up and remediation

3.5.1 | Medical Emergency

1. Assess the situation. Assure your own personal safety and the safety of others.
2. Summon help if necessary.
3. 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.
4. If required, immediately contact an ambulance or Medevac 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.
5. Report the accident to the supervisor as soon as possible (contractor foreman, project geologist, senior geologist etc.).
6. 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.
7. 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.

3.5.2 | Vehicle Accident or Incident

1. Assess the situation. Assure your personal safety and the safety of others.
2. Administer first aid, if practical.
3. Call for an ambulance (or air charter) if necessary.
4. Place reflective warning triangle signs, flares or both behind and ahead of the accident scene away from vehicles (beware of fuel spills).
5. Move the vehicles off the road to the shoulder if there are no injuries and the vehicles can be driven. Turn off the ignition and do not smoke.
6. 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.
7. Report the accident or incident to the supervisor as soon as possible.
8. 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.

3.5.3 | Missing Persons

1. Confirm that the person has failed to check in at the predetermined time.
2. Contact the person's supervisor and provide details such as where the person was working, how late they are, if he/she is alone.
3. Do not endanger yourself during a rescue.
4. 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.
5. Every search team must carry a first aid kit, communication equipment and appropriate provisions.
6. Go to where the person is most likely to be found (i.e., where his/her truck is parked).
7. 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.
8. Notify all authorities when the missing person is found so all search and rescue participants are informed and can cease their efforts.

3.5.4 | Survival – Stranded Crew

Field crew on traverse

1. 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).
2. Contact the camp office by radio and inform them of your position and conditions.

3. 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.
4. When it is not feasible to return to camp, the survival cache and personal survival kits should provide temporary shelter and supplies.
5. Remain at the site until transportation arrives.
6. 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.

1. Assemble the drill crew and keep everyone together at the survival cache location.
2. Contact the camp/office and inform them of the conditions.
3. 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".
4. 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.
5. Remain at the site until transportation arrives.
6. Maintain communication abilities; do not waste battery power.

3.5.5 | Aircraft Accident

At the site of the aircraft accident:

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

At the project site or base:

1. 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. If near civilization, phone places along the planned flight route for information.
2. Relay contact attempts through other aircraft in the area.
3. 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.
4. 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
5. Notify appropriate company contacts.
6. Record all actions taken.
7. Share information ONLY with the aircraft/helicopter company and the rescue coordination centre. Do not speak to media.
8. If necessary, contact an ambulance or Medevac aircraft or equivalent as soon as possible.
9. Provide first aid, as required, upon arrival at the site.
10. 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.
11. Complete and submit an accident report forms to the appropriate company personnel.

3.5.6 | Boat Accident

At the site of a boat accident:

1. Assure your own personal safety and the safety of others.
2. Stay with the boat. Be familiar with and follow procedures in 17.12 Water Survival.
3. Once on shore, administer first aid, as required.
4. Build a fire and shelter in a visible location near shore and make everyone comfortable.

Remain near the accident scene or shoreline.

5. Make signals that are visible from the air to aid in the search (e.g., fires, signal mirror, large symbols). Refer to Chapters 8.6 Search and Rescue Guidelines and 16.15.2 Ground to Air Emergency Signals.

At the project site or base:

1. Attempt to reach the boat by normal means when it is one hour overdue. Use local resources when possible. Use (1) the base radio, (2) a cell phone to reach the satellite phone on the boat if equipped, and (3) a radio in an aircraft if available. If near civilization, phone places along the known boating route for information.
2. In addition, after 60 minutes overdue, report the overdue boat to a supervisor (foreman, project geologist, senior geologist etc.) and the project manager. Brief the manager on the action taken and the following information:
   - Captain's name
   - Type of boat, registration, size and colour
   - Number of crew/passengers
   - Planned route
   - Departure time, estimated time of arrival
   - Last known position
   - Hours of fuel on board
   - Emergency equipment on board
3. Notify appropriate company contacts.
4. Record all actions taken.
5. If 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.
6. Complete and submit an accident investigation forms to the appropriate company personnel.

3.5.7 | Fires

Fire in camp is one of the most serious risks.

1. Try to put out the fire only if it is safe to do so.
2. Sound the fire alarm
3. Assure your own personal safety and the safety of others.
4. Evacuate all persons to the muster point and hold a roll call.
5. Locate any missing or injured persons and organize a rescue, as required.
6. Arrange for camp evacuation, if necessary.
7. If required, contact an ambulance or Medevac aircraft immediately.
8. Provide first aid, as required.
9. Call the 24 hour local forest fire telephone number.
10. Report the fire to a supervisor as soon as possible (foreman, project geologist, senior geologist etc.).
11. Arrange for temporary shelter once all persons are accounted for, as required.
12. 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.

13. 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).
14. Complete and submit an accident/incident investigation forms to the appropriate company personnel.

Forest Fire

1. 1. Assure your own personal safety and the safety of others.
2. If safe, return to camp as soon as possible.
3. Arrange for camp evacuation, if necessary.
4. If required, immediately contact an ambulance or Medevac aircraft.
5. Provide first aid, as required.
6. Call the 24 hour local forest fire number.
7. Report the fire to a supervisor (foreman, project geologist, senior geologist etc.) and to the forestry company in the area as soon as possible.
8. 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).
9. Complete and submit the appropriate accident investigation forms to the appropriate company personnel.

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.

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 Chapter 10.3 Bears for recommendations.
    - Employees should be trained to recognize bear behaviour and correctly respond to bear encounters. Refer to Chapter 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 employee 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 Chapter 18.2.2 Firearms Regulations and Policies.
- Attempt to scare a bear away by making noise and using appropriate deterrents (refer to Chapter 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 defence.

Wolverines

- Attempt to scare the wolverine away by making noise.
- Make sure a wolverine has an escape route. Never corner a wolverine as it will fight; they are ferocious and will attack humans and an animal much larger than itself.

Reptiles

- Obtain local expert advice to develop appropriate emergency response procedures to remove large or venomous snakes or crocodiles. Avoid killing reptiles whenever possible.

Emergency procedures when an animal enters camp

1. Verify that a threatening animal (e.g., bear) is sighted approaching or within the camp boundaries.

2. 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.
3. 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.
4. 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).
5. Notify appropriate wildlife officials to capture and relocate the animal, if required.
6. 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.

3.5.10 | Spills

1. Assure your own personal safety and the safety of others.
2. Assess the situation without risking employee safety. Determine the substance of the spill, if possible.
3. Safely stop the spill/leak, if possible.
4. Take immediate action to minimize the effects of the spill (containment) if it is safe to do so.
5. 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.
6. Record detailed notes:
   - Time of occurrence
   - Who was contacted and when
   - Actions taken to contain spill
7. 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
8. Complete and submit an environmental spill report or appropriate investigation form to the company and government authorities within the specified time.

Refer to Chapters 10. Hazardous Material and 11.0 Spill Management in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit for information regarding specific hazardous substances and spill containment procedures.

3.5.11 | Bomb Threat and Security

1. It is most important to keep people safe.
2. Evacuate people from the building or site quickly and in an orderly way.
3. If the message is from a caller, try to find out when the device is set to detonate.
4. Contact the police as soon as possible.
5. If there is a suspicious package or item in the mail or an opened item revealing suspicious material:
   - Immediately place it aside with all content and wrappings.
   - Evacuate the room and close the door.
   - Turn off the building's air heating and air conditioning system to prevent the spread of potential contamination. Contact the appropriate building manager or site manager for this to be done.
6. Do not re-enter the building or the site until the police advise that it is safe to do so.

3.5.12 | Example of a News Release

The following basic news release can be adapted to cover numerous emergencies when it is necessary to release information to the news media. The priorities are:

- Release the news quickly once the basic facts are known. Keep the news release factual and brief.
- It is best to have one spokesperson reporting for the company. This person should set the place and time for update reports.
- Note: It is best for the company to name the incident in the initial news release – i.e., this will aid to manage how the incident is "named" in third party reporting. It is best to use location names and focus on recovery type activities (i.e., the ABC Mine Rescue Operation, rather than the ABC Exploration Company Ltd. Mine Disaster, in order to encourage the adoption of this naming by other agencies.

Briefing Note

ABC Exploration Company Ltd., {LOCATION}

Time: {TIME of news release}
Date: {DATE}
Issue No: {#}

INCIDENT NAME and {LOCATION}

ABC Exploration Company Ltd. confirms that an incident has occurred at {LOCATION} on {DATE} at around {TIME}.

Right now, we have few precise details concerning the incident, except that {VERY BRIEF DESCRIPTION OF WHAT OCCURRED BASED ON CONFIRMED FACTS AND INFORMATION ONLY}.
We can also confirm that {INSERT SPECIFICS: E.G., SEVERAL PERSONNEL WERE INJURED AND A QUANTITY OF CONDENSATE HAS BEEN SPILLED}.
Our full incident response team has been mobilized to assist local (and list other) emergency services {INSERT NAMES AND STATUS OF EMERGENCY SERVICES THAT ARE ON SITE, MOBILIZED and/or ON STANDBY}.
At this stage, we can provide no more information, except to stress that our immediate priorities are {INSERT IMMEDIATE PRIORITIES E.G., ENSURE THE SAFETY OF ALL PERSONNEL AND CONTAIN THE SPILL, PROVIDING ASSISTANCE TO AFFECTED FAMILIES}. We will provide additional details concerning the incident as soon as they become available.
Notes to media

{IF THIS IS KNOWN}. A press conference will be held at {VENUE} at {TIME}.

{Meanwhile} a media response service is available on {provide COMPANY MEDIA RESPONSE CONTACT and NUMBER}.

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 defence 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

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)

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 Chapters 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.

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.

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

Hard hats

Both Canadian and US Occupational Health and Safety legislation specify that everyone should wear a good quality, appropriate, government approved hard hat when working in any location where there is a risk from falling objects, flying debris, or where one might be harmed by machinery in operation, unsecured equipment and sharp edges etc. Some examples of locations and situations where a hard hat should be worn include:

- Mine sites – all active, abandoned, surface and underground mines
- All drill sites
- Open pits, trenches, quarries
- Sampling on steep slopes or cliff faces
- Slinging operations
- Construction sites and where heavy equipment is present
- Where your head might contact electrical conductors
- Using chainsaws or rock saws

Hard hat tips

- Use a hard hat that is correctly rated for the job and meets the appropriate CSA, ANSI or standards of the authority having jurisdiction (AHJ). There are several types and classes of hard hats. The webbing inside hard hats should provide shock absorption from falling objects, lateral impacts and help protect your head during a fall.
- Use a face shield attached to the hard hat for protection from chemicals, dust or electrical sparks etc., as required.
- Inspect your hard hat every day before use. Replace it if the shell is damaged, i.e., cracked, brittle, dented, discoloured or flaking, or if the strap system is frayed or torn. Hard hats should be replaced at least every three to five years as they can become brittle. The strap system should be replaced annually if it is used frequently.
- Make sure the hard hat fits properly; it should stay on when you bend over but not be so tight that it marks your forehead. There should be 2.5 cm (1 in) between the shell of the hard hat and the strap system that absorbs the shock.
- Never wear your hard hat backwards; in that position it cannot protect your head as it is designed to do. Do not insert anything between the webbing and the shell or the suspension will not be able to absorb an impact properly.
- Seasonal issues: In winter, wear a hard hat liner for warmth during very cold temperatures but make sure the hard hat fits over it correctly. In summer, hard hats may have fabric attached to protect the worker's neck from sun, but the hat must fit correctly.
- Use a chin strap to secure the hard hat when it is windy or when working at or near a helicopter landing area.
- Care for the hard hat correctly. Clean and store it correctly. Do not paint it or apply solvents as these can make the shell either soft or brittle.

Additional information regarding hard hats is available from the Canadian Centre for Occupational Health and Safety.

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.
- When traversing in mountainous terrain where falling rocks may be a risk, it may be advisable to wear a climbing or mountaineering helmet with a secure chin strap rather than a hard hat. Mountaineering helmets are designed with no brim to prevent them from catching on rocks should you slip and fall.
- Where legislation does not require the use of helmets, employees should use common sense and wear a helmet when conditions are hazardous.

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.
- Retinal damage (even blindness) may result from welding or the use of lasers or UV lights.

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.
- In the USA, industrial protective eye glasses must meet the ANSI Z87.1 standard.
- 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 from the Canadian Centre for Occupational Health and Safety.

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
- Drill sites
- Mine sites
- 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
- Blasting operations

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.

Addittional Information about the safety of wearing contact lenses in the workplace is available from the Canadian Centre for Occupational Health and Safety.

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 from the Canadian Centre for Occupational Health and Safety.

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 can be found in Appendix I.IV

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.
- Hot climate conditions: Feet will sweat heavily so keep your feet as dry as possible by washing them and changing socks frequently. This helps prevent infections.

- Traversing: Wear durable boots that have proper ankle support. The soles should provide appropriate traction for the terrain. Refer to Chapter 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.
- Wear high leather boots (snakeboots) and appropriate long pants when working in areas where poisonous snakes are a hazard.
- 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 in Appendix I.IV

4.2.7 | Lung Protection

Some aspects of mineral exploration may expose employees to poor quality air. While some hazards to the lungs may be immediately obvious (e.g., smoke, dust) and have immediate consequences, other hazards may be insidious (e.g., carbon monoxide) or cause damage that develops long after exposure (e.g., radiation). Working conditions that may present high and unsafe levels of airborne particulates include: (1) using rock or core saws and (2) confined spaces, trenches and old mine workings where toxic atmospheres or insufficient oxygen levels may be encountered. Carbon monoxide and carbon dioxide may also be a hazard in buildings or tents in camps due to inadequate heater ventilation (see Chapters 18.4.4 Lanterns, Heating Stoves and Appliances, 22.7.3 Carbon Monoxide and 22.7.2 Carbon Dioxide).

Risks and hazards to lungs

- Asphyxiation or suffocation may be caused by exposure to toxic or oxygen deficient atmospheres.
- Lung diseases and/or lung damage may develop from exposure to hazardous dusts, respirable silica, asbestiform minerals and hazardous chemicals etc.
- Radiation exposure may result from working with radioactive minerals under improper conditions.

Prevention and preparation

To provide safe air, mechanical ventilation (engineering controls) should be the first choice to reduce hazards to the lungs rather than relying on PPE alone. Rock saws and machines that produce air contaminants should be enclosed and properly vented to permanently extract airborne dust and contaminants from the work area. Gasoline powered motors must never be used underground, in trenches or pits, or in any confined spaces. Before entry, the atmosphere of old mine workings must be properly checked and ventilated, if necessary. In addition, there may be a risk of encountering unexpected airborne contaminants and gases, such as hydrogen sulphide (H_2S), carbon dioxide (CO_2) and carbon monoxide (CO) when examining buildings, surface tailings or rock waste piles on old properties or mine sites. It is essential for employees to be aware of these hazards and be trained in confined space recognition if their job has any potential for encountering such conditions. For additional information, refer to Chapters 21.5 Trenches and Pits, 22.4.3 Tailings and Water-Filled Areas and 22.11 Confined Spaces. Refer also to Chapter 5.4.2.1 Trenches in the Environmental Stewardship toolkit.

Certain jobs require respiratory PPE to protect your lungs because it is often impossible to reduce and/or remove contaminants to a safe level through other means.

- Often, a dust mask does not offer sufficient protection even if the filters are changed frequently. Disposable dust masks do not generally offer adequate protection even if they are changed frequently because the average dust mask is intended only for sawdust particles.

- Various types of respirators and cartridges are available. Careful analysis of potential contaminants is important in order to select the appropriate respirator, which depends on both the type and the potential concentration of the airborne contaminants. Professional expertise may be necessary to determine site specific requirements. Proper employee training is essential because a respirator must be fit tested to function correctly.

Respiratory Protection

Appropriate respiratory protection should be worn when working at some jobs or sites, such as when employees are required to:

- Enter any confined space
- Operate rock saws, core saws or core splitters
- Work in a crushing or screening room
- Work around cyclone drill outlets or exhaust hoses
- Work in dusty environments
- Work in some active underground mines
- Work with certain chemicals
- Enter old mine workings or caves
- Enter old buildings, especially if water is present
- Enter any situation where poor air quality may be encountered

Hazardous materials

The following specific materials associated with mineral exploration can cause potentially severe lung damage.

- Silica dust is very hazardous to your lungs. Fresh silica dust is much more reactive in the lungs than old silica dust.
- Exposure to dust and droppings in old underground workings (or caves) where bats are or have been present may result in Histoplasmosis – a potentially fatal lung infection. If this type of environment is suspected, do not enter the workings without careful consideration and preparation. Use all required PPE, which includes disposable clothing, gloves and a respirator equipped with a high efficiency particulate air (HEPA) filter capable of filtering particles down to two microns in size. A respirator needs to be fit tested to the individual wearer and it should be checked frequently to make sure it functions properly. For additional information refer to Chapter 12.8.5.5 Histoplasmosis.

- Uranium projects – see Chapter 4.2.8 Protection from Ionizing Radiation below
- Rocks containing amphiboles and other asbestiform minerals, including some ultramafic rocks and some kimberlites.
- Drilling muds and chemicals – wear a dust mask and pour powders etc., so the wind carries the dust away from your face.
- Hydrogen sulphide (H_2S) may be present in old workings, buildings and in or near tailings and waste rock piles. It can form through the reduction of sulphides. Refer to Chapter 22.7.4 Hydrogen Sulphide for information regarding exposure limits and occurrences.
- Carbon dioxide (CO_2) and carbon monoxide (CO) are often present in old mine workings. These gases can be present in low spots due to density and will not dissipate. They are odourless, colourless and fatal. Refer to Chapters 22.7.2 Carbon Dioxide and 22.7.3 Carbon Monoxide for information regarding properties and exposure limits etc.
- For additional detailed information, refer to Chapter 20.7.4 Hazardous Materials and Chapter 5.10 Rock and Core Handling and Cutting Equipment.

Additional information regarding respiratory PPE is available in Appendix I.IV

4.2.8 | Protection from Ionizing Radiation

Uranium exploration projects should develop a radiation protection program (RPP) that includes safety education, training and any required certification to use equipment, PPE requirements for sampling and working with core, and any requirements to wear a dosimeter to detect radiation exposure. For additional information, refer to Chapter 5.11 Portable Handheld XRF Analyzers in these Guidelines and Chapter 15.0 Guidelines for Radiation Protection during Exploration for Uranium in the Environmental Stewardship toolkit.

PPE:

Train employee to use PPE correctly. The aim is to keep radioactive material away from your skin and out of your eyes and lungs. To prevent contact:

- Wear cotton gloves to handle mineralized materials (samples, core) and coveralls. Leave coveralls and gloves at the work place and wash them according to RPP instructions.
- Wear appropriate respiratory protection when cutting core or samples to prevent breathing mineral particles. Wear safety glasses to protect against flying rock and radiation.
- Wear a lead apron when examining high grade core.
- Additional PPE should be worn as appropriate to address specific risks and hazards at the work site.

Core shack and sample handling routines:

Follow RPP procedures to reduce potential exposure to radiation when handling samples, while traversing and when logging core.

- Wear PPE – especially gloves, eye protection and coveralls, as required.
- Follow careful handwashing hygiene when through with work. Do not eat or smoke when handling samples or while in the core shack. Bandage all open wounds.
- Do not lick any samples.
- Keep outcrop samples in sealed, heavy poly bags.
- Where there is potential for collecting high grade samples, cache the samples at the outcrop – do not carry them with you in your backpack. Transport samples outside any enclosed passenger areas when travelling, i.e., not in the cabin of a helicopter or the cab of a truck. Transport them in the belly pod of a helicopter or in the back of a pickup truck.
- Locate the core shack and core stockpiles a sufficient distance away from the project living quarters and drill rig (at least 20-30 metres). Make sure mineralized core does not remain inside the core shack for more than 48 hours. Make sure the core shack is well ventilated, especially in winter.

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 devises 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.

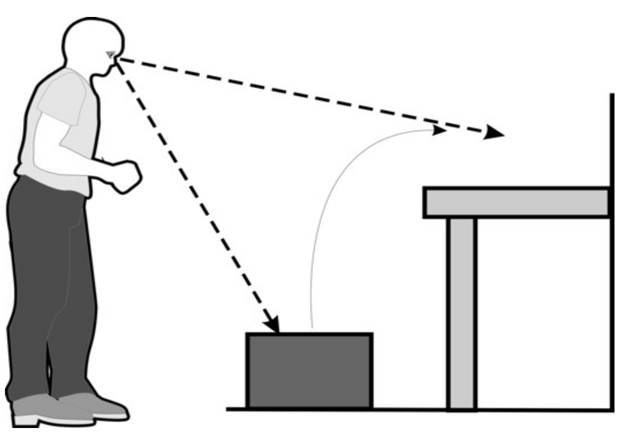


Figure 4:1: Correct lifting procedures

1. 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.
2. 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.
3. Bend your knees and get a good grip. Use gloves if your hands are sweaty or if the object is slippery.
4. 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.
5. 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.
6. 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.
7. If you hand off a load, make sure the next person has a good grip before letting go.
8. Do not carry a load in front of your face – you need to see where you are walking.

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.
- Learn to recognize poison ivy, poison oak, poison sumac (present in parts of North America) or any other skin irritating plants that may grow in the project area.
  - Avoid contact with any animals or clothing that may have come in contact with irritating plants, as the oils can be transferred to your skin.
  - If possible, wash exposed skin immediately after contact. Some sources suggest immediately applying rubbing alcohol or hydrogen peroxide to help prevent a rash. If possible, wash any exposed skin with soap and water within 30 minutes of exposure to reduce the likelihood that the oils will penetrate your skin. Wash all clothing and equipment that may have come in contact with the plants, as the oils remain active for months.
  - If a reaction develops, treat with calamine lotion or ointments containing zinc oxide or hydrocortisone. Cold compresses may help relieve itching. Avoid scratching as it can spread the rash or cause infection. Seek medical attention for severe cases and if the rash does not improve.
  - Note: DO NOT burn the plant material, as the oils may become windborne and if you breathe them you may develop a severe internal allergic reaction.
  - Additional information, including photos of the leaves of poison ivy, poison oak, poison sumac and associated rashes and blisters, is available online.

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 Chapter 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.

In warmer countries, insects may carry organisms that cause diseases such as malaria, dengue fever and yellow fever; they can transfer pathogens into your body with a single bite. Fortunately, by protecting yourself from mosquito bites, you also gain protection from ticks, sandflies, black flies, tsetse flies and leeches etc. To reduce insect bites, wear appropriate clothing, use insect repellent on your skin and apply insecticide to clothing.

For additional information:

- Refer to Chapters 10.7 Insects, Arthropods and Leeches and 12.8.4 Protection from Insect Bites for detailed information regarding protection from insect bites in all parts of the world.
- Refer to Chapter 12.8.5 Diseases for detailed information regarding diseases associated primarily with insects in parts of the world other than North America.
- Refer to Chapter 18.6.5 Diseases for detailed information regarding diseases associated with insects in North America.

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 Chapters 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.

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.

5.1 | General Guidelines for the Safe Use of Tools

Manufacturer's operator manuals

It is very important to refer to the manufacturer's operator manual for safe operating procedures (SOPs) when tools and field equipment are used for the first time.

- Keep the operator manuals in a safe place for easy reference; consider scanning them into a computer.
- Many manuals are available free as pdf files on the manufacturer's website.
- Check manufacturer websites for recalls or changes in design for safety reasons at least annually.

General guidelines for using tools and equipment

The directions in the PDAC Health and Safety Guidelines should not supersede instructions given in a manufacturer's operator manual.

- Use the correct hand tool or power tool for the job.
- Seek instruction if you are unsure about the correct use of tools and equipment.
- Securely store all hand tools and power tools in their designated storage places when not in use. Do not leave tools where they might fall, be knocked down or be a tripping hazard.
- Tools should not be modified in any way and all safety devices on the equipment must be attached and operational prior to use.
- Pre-job tool check: Inspect your tools before use each day. Check that the tools are in good condition and free of damage, dirt and grease.
    - Check that the head of a tool is securely attached to the handle (e.g., axes, hammers, machetes).
    - Check saws and other cutting tools to make sure the blades are sound and undamaged. They must be properly aligned and securely mounted. Use them only with the guards in place.
    - Check that electrical tools are complete; check the various parts, switches and guards. Check the cords and plugs for damage.
    - Check that gas powered tools are in good condition, properly fuelled and that the exhaust will not pose a health problem.
- Do not use defective or worn tools.
- Report all equipment breakages or malfunctions to a supervisor so tools can be repaired or replaced. Using worn or damaged tools may result in injury if it fails during use. Do not use a broken tool as a temporary means to get a job done. Follow lockout procedures; refer to Chapter 18.4.6.2 Lockout Tag Out.
- Never use electrical tools in wet conditions or near flammable liquids or gases where a spark may ignite fumes and vapors.
- Operate compressed air tools only through a pressure regulator.
- Use the correct tool rather than a “cheater” pipe to gain extra leverage while using a pipe wrench, etc. If the use is unavoidable, do so with caution.
- If it is necessary to push on the handle of a tool, do so with open palms and not with your fingers clenched around the handle.
- Follow the manufacturer’s instructions for the use, maintenance and storage of welding equipment.
- Wear appropriate personal protective equipment (PPE) as directed by the manufacturer’s operator manual and the project safe operating procedures (SOPs). Required PPE will vary depending on the risks associated with the tool being used, but the operator should always include the use of safety glasses with side shields for eye protection.
- Follow good housekeeping procedures and keep work areas free of clutter.

- It is common for manufacturers to improve tools over time, coming out with new models on a frequent basis. These improvements are frequently relating to safety features either driven by the manufacturer itself, public pressure or government regulation. An exploration company has a responsibility to be aware of improvements in tools, especially related to safety, though it may appear to be a dilemma as to how often to update tools. It is a false economy to keep using an outdated tool with outdated safety features, when a new improved version is available. The cost of an accident is likely to far outweigh the saved money. The old one should be scrapped so that it is no longer in use.

Equipment inventory and tracking systems

Keep a register of equipment along with inspection and maintenance records, which are required for due diligence (refer to Chapter 1.2 Due Diligence with Respect to Safety). Consider the following, depending on the size of the project or operation:

- Develop a system to inspect and maintain equipment and remove all defective equipment from service. Dispose of equipment that is beyond repair so it cannot be used inadvertently.
- Identify and record all portable electric equipment including cords, plugs and switches in a tracking system.
- When there is a large inventory, consider colour coding the equipment identification tags to indicate that the equipment has been inspected within the prescribed time period (e.g., every three or six months).

Training

- Train employees in safe work practices with regard to the project equipment they will use.
- Training should include making sure employees are familiar with SOPs in the manufacturers' operator manuals for project tools and equipment, as well as the general project SOPs and guidelines.
- Lockout training is essential for employees who use electrical or gas powered equipment, refer to Chapter 18.4.6.2 Lockout Tag Out.
- Make sure employees are certified who use equipment requiring certification.
- Gas powered equipment: Make sure equipment is kept in good repair, that portable fuel containers are government approved such as by the Canadian Standards Association (CSA), and that employees are trained to fuel the equipment correctly. If gas powered equipment is used where ventilation may be a problem, supply appropriate PPE and train employees to use the equipment correctly. In addition, be aware of the dangers of using gas powered equipment in a setting that might be a "confined space" (refer to Chapter 22.11 Confined Spaces).

- Compressed air and hydraulic fluids: Where relevant, make sure employees are aware of the risks and hazards associated with equipment that uses compressed air or hydraulic fluids. Workers should be trained to detect pinhole leaks by using cardboard or wood and never by using their hands for this task. High pressure air hoses should never be used for cleaning clothing or hair and never aimed at another person. Pranks and horseplay using hoses or tools that employ compressed air or fluids should be forbidden, as air, water, or oils can be injected through clothing and skin into the body, which may result in severe tissue damage, loss of a limb or a fatal embolism.

General fuelling procedures for gas powered equipment

- Carry out fuelling in a well ventilated area at least 3 metres from the place where the tool is used.
- Fuel with the engine or motor turned off.
- Refill only after the engine or motor cools a while.
- Use the correct fuel or correct fuel mixture. Some outboard motors and chainsaws require a mixture of oil and gasoline.
- Fill the tank before use and do not fill it too full. Leave room for the fuel to expand.
- Do not smoke while fuelling any motor or engine.
- Clean up any spills using appropriate absorbent materials and dispose of them correctly.
- Never fuel equipment (or fill a gas can) when it is placed on the vinyl bed liner of a truck. Vinyl bed liners prevent the grounding (earthing) of the equipment or gas can. Static electricity builds up when the fuel flows through the hose into the fuel tank. A spark may occur and cause vapors to ignite and explode when the nozzle is withdrawn. This may happen if the equipment is fuelled from a jerry can so place all equipment being fuelled on the ground.

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.

5.3 | Axes, Swedish Brush Hooks, Knives and Machetes (Pangas)

Risks and hazards

- Minor to severe cuts caused by striking yourself or others with sharp tools
- Cuts and bruises caused by falling on an axe, knife or machete
- Impact injuries may occur if an axe head flies off or someone is struck by a flying tool
- Slips and falls due to poor footing on slippery or rough ground, wearing inadequate footwear

Axes

- Keep others and bystanders at a safe distance when using an axe. Do not swing in the direction of another person even if they are out of range in case you lose your grip or the blade separates from the handle.
- PPE: Wear safety glasses and safety boots; wear good fitting gloves for gripping and to prevent splinters. Consider wearing a hard hat.

- Only use axes that are in good condition, properly sharpened and properly fitted with good handles. To fit the axe head and handle, soak the axe head area in water overnight and insert new pins (wedges) as required.
- A long-handled axe is safer to use than a short-handled axe. It is less likely to hit your leg if you miss your target. A single bit axe (one sharp blade) is generally safer than a double bit axe (two sharp blades). Do not use a single bit axe as a sledgehammer.
- Use both hands when chopping and maintain your body in a position so the blade will hit the ground if you miss the target.
- Create firm footing and clear the work area of branches and brush before beginning work. Look overhead for obstructions to be sure the blade will not be deflected into your back or head. If you are clearing a path, watch out for branches that will interfere with your axe strokes. Use a Swedish brush hook rather than an axe whenever possible (see below).
- Never use a dull axe as it can be more dangerous than a sharp axe. A dull axe requires more effort to use and is more likely to glance off a log and end up in your shin. To sharpen an axe: Wear leather gloves and use an axe file or sharpening stone to sharpen the blade.
- Carry an axe safely. Use an appropriate sheath and carrying loop or hold it by the handle close to the axe head. Point the blade down and away from your body. Do not carry an unsheathed axe over your shoulder. Do not carry an axe tucked through your belt.
- Keep the axe in a sheath when it is not in use and when it is transported. Insert the axe into a magazine or wrap the axe in paper or cardboard if no sheath is available.
- Do not use an axe to pull over a log or push over a standing tree.
- Follow these guidelines when using an axe for felling trees:
    - If you are felling a tree for the first time, have someone with experience train you in the proper techniques.
    - Before you begin, check that the area is clear and that no branches or other objects will hinder your swing. Make sure you have stable footing and a clear path of retreat.
    - Chop methodically and deliberately and let the axe do the work for you.
    - See Chapter 5.6.4 Safety Considerations When Felling Trees for additional information.

Swedish Brush Hooks

- Swedish brush hooks (Sandvik) have a short, replaceable enclosed blade and a long handle that offers better control and greater safety than an axe, machete or other types of brush hooks with exposed blades.
- Swedish brush hooks are recommended for use in place of an axe for clearing underbrush, especially hardwood branches and stems up to about 6-7 cm thick.
- Replace the blade when it is worn or nicked.
- Cut brush back far enough so that sharp stubs are not likely to spear someone.
- Wear eye protection, gloves and boots with good traction.

Knives

- The best knives have a steel shank extending to the butt end of the handle. This type of blade is less likely to break under stress.
- Carry a hunting style knife in a sheath.

Machetes (Pangas)

- Carry a machete or panga in a scabbard attached to your belt. Do not grip the side of the scabbard that houses the cutting edge of the machete.
- PPE: Wear safety glasses and boots or shoes and use a wrist loop when using a machete.
- Keep well away from others when using a machete. Never swing it in the direct path of someone in case you lose your grip.
- If you are working with an unsheathed machete in steep terrain, try to carry it on the downhill side of your body. Then your uphill hand is free to stabilize yourself if you lose your footing.

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 Chapters 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 Chapter 5.1.

For ice augers:

- Use ice augers that have a "safety arm" or an emergency stop 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 Chapters 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.

Figure 5.1: Ice auger with an extension in place © Iain Mitchell

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.

5.6 | Chainsaws

5.6.1 | Risks and Hazards

Severe injuries or death may be caused by the following:

- Cuts, lacerations or amputation caused by kickback or contact with the chainsaw blade
- Impact injuries from falling trees, limbs, snags, or dry, dead or rotten trees
- Slips, trips and falls caused by poor footing on rough, slippery or uneven ground, snow or ice, steep ground
- Burns caused by contact with hot motors
- Forest fires or bush fires caused by fuelling a hot motor, sparks generated while cutting, fuel spills
- Fuel spills caused by improper fuelling procedures, inadequate training

5.6.2 | Preventions and Preparations

Chainsaws are dangerous. Only employees who are thoroughly trained and certified by a qualified instructor should be authorized to use chainsaws. Training in the use of chainsaws builds good work habits and lessens the likelihood of developing lazy or dangerous cutting habits, which cause many accidents. It is advisable to contract out large or difficult cutting jobs to experienced woodcutters, especially when trees that require cutting are located on slopes, unstable ground, or when snags, dead or rotten trees are present.

The type of work involving chainsaws and cutting grid lines is often given to employees or contractors who are local to the project area – for example, Indigenous 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 that 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.

Safe Operating Procedures (SOPs) for chainsaws

Develop safe operating procedures (SOPs) for the use of chainsaws that include but are not limited to the following:

1. Companies and supervisors should be sure new employees have received adequate training by a qualified instructor before authorizing them to use chainsaws.
2. Companies and contractors should only permit the use of chainsaws that meet safety standards, such as the CSA Standard Z62.3-96: Chain Saw Kickback or ANSI Standard B175.1-1991: Safety Requirements for Gasoline Powered Chain Saws. Each chainsaw should be equipped with a kickback-reducing device, i.e., a chain brake, a low kickback chain, or a reduced kickback bar that is designed for the specific model of chainsaw.
3. Read the manufacturer's operator manual for the particular model (or consult a supervisor or trained technician) to determine if there are any special features to know about before operating a chainsaw the first time or if you have not operated one for a long time. Do not use a chainsaw if you have not been properly trained or if you feel the need for additional training.
4. Wear PPE:
   - Hard hat and eye protection: Wear safety glasses with side shields plus a face shield of wire mesh or clear safety plastic attached to the hard hat.
   - Hearing protection: Wear ear muffs and/or ear plugs.
   - Safety boots should have steel toes, good ankle support and slip-resistant soles that are in good condition.
   - Cutter pants or chaps
   - Lightweight gloves with latex webbing that provide a good grip
5. Follow inspection and maintenance routines in the manufacturer's operator manual.
6. Use the correct fuel or fuel ratio and know how to fuel the chainsaw safely.
7. Always keep a first aid kit nearby; the kit should include a large pressure bandage and ties.
8. Fire suppression equipment: Keep a fire extinguisher, extinguishing powder and/or at least 10 litres of water and a small shovel available to fight any fire you may start, especially if there is a fire hazard. Avoid using chainsaws if the fire hazard is high.
9. Start the saw on the ground or a stump – not on your knee.
10. Carry a chainsaw with the motor shut off, the blade pointing back and the chain guard in place. The blade will not get caught in brush when carried in this position.
11. Follow safe felling procedures. See Chapter 5.6.4 Safety Considerations When Felling Trees below.

Essential safety practices include the following:

- Use the correct size of chainsaw for the job. Only use chainsaws that are fitted with an automatic chain brake.
- Keep others at a safe distance.
- Inspection and maintenance: Because chainsaws are used continuously, it is important to maintain them in good condition. A chain can become dull immediately if it hits the ground or a rock. Using a dull chainsaw is dangerous as it requires additional effort to cut and control the blade. Check the chainsaw before work each day and during the day; perform maintenance on the chainsaw when problems develop.
    - Inspections: Look for:
        - Machine damage and fuel leaks
        - Loose or missing parts
        - The chainsaw should be clean, as dirt and sawdust affect cutting efficiency.
        - The spark arrestor should be present to reduce the risk of fire.
        - Check that the chain brake functions properly. Make sure the chain stops rotating when the chainsaw is idling and the chain brake is off.
        - State of the chain: It should fit snugly but move freely; it should be sharp and lubricated.
    - Maintenance:
        - Keep the teeth sharp; check the rakers; check that the chain is properly tensioned; all parts should be tight.
        - The bar should be rotated and lubricated.
        - Keep the guide grooves clean and remove all burrs on the guide bar.
        - Keep the air filter clean.
        - Fuel and oil the chainsaw according to the manufacturer's SOPs.
- Carry a chainsaw tool kit that includes: saw files, file guide, raker file, screwdrivers, spark plug wrench, spark plugs, sprocket, lubrication chain, pull cord.
- Cutting procedures: Maintain full control over the saw at all times.
    - Make sure you have secure footing and are well balanced when you cut. Do not work in an awkward position. Clear debris or deep snow away from your work area to improve footing.
    - Never stand directly behind the chainsaw or straddle the saw while cutting. Stand to one side as this will minimize injury from kickback.
    - Learn to use the chainsaw equally well with the right and the left hand to avoid awkward cutting positions.

Fuelling guidelines for chainsaws

The following guidelines are in addition to the general safe fuelling procedures in Chapter 5.1 General Guidelines for the Safe Use of Tools:

- Use the correct oil and gas ratio for the chainsaw. Mix and keep the fuel in an accurately labelled government approved container. Use a funnel and filter.
- Do not fuel a hot chainsaw. Let it cool a while, preferably up to 30 minutes. Clear the organic material away from the immediate area and set the chainsaw onto non-flammable material so nothing will catch fire if some fuel spills.
- Use oil with the correct viscosity for the season of the year.
- Do not fuel a chainsaw on a vinyl bed liner of a truck. Fuel the chainsaw on the ground. Vinyl bed liners prevent the grounding (earthing) of the chainsaw so static builds up when the fuel flows from a container through a hose or nozzle. A spark may occur as the nozzle is withdrawn and cause vapors to ignite.
- Check the level of the chain lubricating oil each time a chainsaw is fuelled.
- Clean any spilled fuel from the machine after fuelling. Make sure there is no gas left on the muffler.
- Move the chainsaw at least 3 metres from the fuelling site before starting the motor again.

5.6.3 | Chainsaw Kickback

Chainsaw “kickback” can cause severe injury or death. Kickback occurs when the blade suddenly jams or catches wood so the momentum of the chain causes the blade to spring back toward the operator. All chainsaws must have a chain brake that immediately stops the chain if kickback occurs. Learn the correct use of the chain brake. Use chainsaws with a reduced kickback bar and a low kickback chain.

To avoid kickback:

- Inspect the chain to make sure it is in good working condition. Check that the cutting teeth are properly sharpened. Dull chainsaws will kickback more frequently and with greater force. It is advisable to wear leather gloves to sharpen or manually move the chain.
- Check that the depth gauges are set correctly.
- Make sure that all parts are tight and the chain is at the proper tension.
- Adjust the idle correctly. The blade must stop when you release your fingers from the trigger.

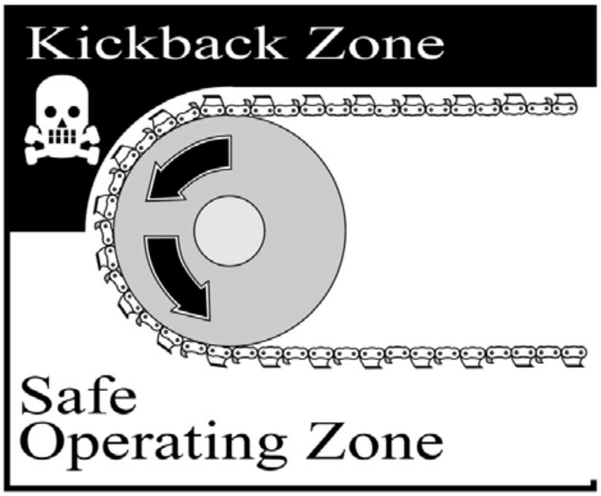


Figure 5.2: Kickback Zone

- NEVER CUT WITH THE TIP OF THE BLADE.
- CUT ONLY WITH THE UNDERSIDE OF THE BLADE.
- Never cut with the upper side of the blade unless it is absolutely necessary, such as when making an undercut on a limb to relieve tension or rarely, when making a back cut.
- When removing limbs, make sure the saw tip does not touch another branch. Make sure there are no hidden obstructions that the saw blade might hit and cause the tip to kickback.
- Never cut above shoulder height.

5.6.4 | Safety Considerations When Felling Trees

Line cutters and employees who are authorized to cut trees should be trained for the job and always follow safe falling procedures. Follow the safety regulations of the authorities having jurisdiction (AHJs). Seek advice from more experienced fallers when faced with a new and/or difficult situation.

Cutting Procedure

Plan the cutting procedure before you start. If you are felling a tree for the first time, have someone train you who has experience in the proper techniques. Keep onlookers or other workers at least two tree lengths away when felling a tree. Make sure they are aware of your activity.

1. Assess the tree and the site for hazards:
   - Accurately judge the lean of the tree.
   - Examine the ground, the crown, the trunk and roots to check if the wood is sound. Note if it is a dangerous tree with rot or potential root failure.

  - Identify whether the tree is under stress, as it may fall unpredictably when pressure is released as it is cut. Beware of branches and limbs that are bent or "pre-stressed", as they may spring back or break and cause kickback. This is especially true of young trees – the "spring pole effect".
  - Look above for hazards that may fall on you. Cutting a dead or rotten tree is especially hazardous. It may be leaning or the top may break off as you cut so that it falls onto you. Dead and rotten trees are referred to as "chicots" in several Canadian regions.
  - Note if the tree top tied to another tree.
  - Do not cut when winds are gusty or are strong enough to make the trees sway. Do not cut when the top is heavily loaded with snow. These conditions cause trees to behave unexpectedly during falling.
  - Do not cut trees if the tops are obscured by fog, snow and/or rain because it is impossible to make an accurate assessment.
  - Terrain hazards: Note if the terrain slopes so that falling will be difficult or dangerous. Be cautious when the terrain is slippery so that footing will be difficult during cutting or as you move along your escape path when the tree falls.
2. Plan your escape route – it is best to plan two routes in different directions. Clear and walk the paths to remove tripping and slipping hazards before cutting. The escape routes should be about 135° from the planned direction of fall. Make sure to have good footing.
3. Use proper cutting techniques. Keep your attention focused on the tree while cutting. Look upwards frequently to check the top and the adjacent trees in case overhead hazards such as dead branches fall unexpectedly.
  - Carefully make the proper undercut and leave an adequate hinge of wood to maintain control of the falling direction.
  - Cut to prevent hang-ups. Never leave a tree hung up among other trees or branches in case it falls on someone. Hung up trees cause many deaths in the forest industry.

Bucking and limbing fallen trees

Line cutters and employees who are authorized to buck logs must be trained and always follow safe bucking procedures. Seek advice from more experienced fallers and buckers when faced with a new and/or difficult situation.

- Good footing is essential. Stand on the upper side of a log that is felled on a slope. Do not step on chunks of logs.
- When bucking felled trees, determine where the sections will move when they are cut.
- Make sure logs are stable before bucking. Always have an escape route. Do not buck below previously bucked logs as any movement may cause a chain reaction and cause them to roll.
- Continuously assess the log's potential to roll, pivot or slide as cuts are made. Watch out for pivot points, scissor logs and trees or limbs that may whip back when stress is released.

- Do not stand on the whip side of a tree or limb. Tensioned or loaded limbs are dangerous and must be cut only after careful assessment.

Additional information regarding the use of chainsaws and felling trees specific to line cutting is found in Chapter 11.4 Line Cutting Safety. Additional information about the safe use of chainsaws and safe working procedures are available in Appendix I.V

5.7 | Brush Cutters

Gas powered brush cutters are often used for clearing underbrush; in many situations they are safer to use than chainsaws.

Risks and hazards

- Impact injuries caused by being hit by thrown objects or damaged blades
- Cuts from sharp blades may be caused by wearing inadequate PPE (gloves, safety glasses, hard hat without a visor, footwear).
- Hearing loss caused by using inadequate hearing protection
- Slips, trips and falls caused by working on slippery, rough ground, steep terrain, wearing inadequate footwear
- Fuel spills caused by following inadequate fuelling procedures, lack of training
- Fires may be caused by hot engine parts.
- Back strain caused by using the brush cutter in an awkward position

Prevention and preparation

- Refer to the manufacturer's operator manual for SOPs.
- Check that all parts (especially the blade) are secure and in the correct position. Replace worn, bent or broken blades.
- Check that guards are securely in place and do not operate the machine if they are missing.
- Wear PPE:
    - Safety glasses or goggles
    - Hard hat – a visor is recommended
    - Hearing protection – earmuffs are better than ear plugs

  - Heavy duty non-slip gloves provide a good grip and protect from cuts.
  - Long pants and shirt to protect limbs – chainsaw chaps are recommended
  - Safety boots with non-skid soles
- Be vigilant and watch out for others in the area. Do not operate a brush cutter when people are nearby, as they may be hit by ejected material.
- Be especially careful if operating the brush cutter on stony ground, as stones may be thrown and hit the operator or anyone nearby.
- Shut off the engine before removing jammed material and/or setting the tool down.
- Do not touch the blade until it has completely stopped rotating.
- Do not leave the brush cutter unattended with the engine running.
- Follow correct fuelling procedures as described in Chapter 5.1.
- Use the brush cutter appropriately; do not cut material that is too thick or in a position that might cause injury to yourself or others. Do not operate the machine to cut material above knee level.
- Consider wearing a harness to help hold the brush cutter in a comfortable position to lessen back strain. Stand upright when operating the machine.

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 Chapters 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 Chapter 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.

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 Chapters 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 Chapter 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.

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.

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

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.

1. 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.

2. 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. Information on PPE and silica is available through the Canadian Centre for Occupational Health and Safety.
   - 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.
   - 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 Chapter 20.7.4.2 Asbestos and Amphiboles.
   - Toxic elements in mineral: Refer to the safe handling guidelines in Chapter 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 Chapter 20.9.5 Core Logging.
3. 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 (CO2). 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.
4. 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.

5. 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.
6. 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.
7. 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 Chapter 16.12 Slinging for information regarding helicopter slinging safety.

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 Chapter 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.

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 Chapter 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 Chapter 5.10.2.

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 Chapter 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.

5.10.6 | Portable Rock Saws

Portable gasoline powered rock saws are also known as cut off saws, quick cut saws or channel cutting saws.

Significant risks and hazards include:

- Respiratory illness caused by inhaling rock dust and/or wearing insufficient PPE
- Back injuries caused by improper lifting or carrying the saw
- Severe injuries caused by kickback when the saw blade catches or the saw is used improperly
- Carbon monoxide poisoning caused by operating where there is inadequate ventilation
- Slips, trips and falls caused by working on slippery ground conditions, steep terrain, or with inadequate footwear
- Vibration injuries caused by the prolonged use of the saw

Prevention and preparation

- Operate the saw only with the shield in place.
- Wear PPE:
  - Wearing a face shield attached to a hard hat is preferable to wearing safety glasses alone.
  - Wear hearing protection and wear gloves for a good grip.
  - Wear a respirator if you are not using wet cutting methods.
  - Do not wear loose clothing that might get caught in the rotating blade.
- Follow the guidelines in Chapter 5.10.2 regarding ventilation and rock chemistry issues.
- Use correct lifting methods to avoid back strain. Carry the saw when the motor is off.
- Do not drop start a rock saw. They are very heavy and should be started while resting on firm ground.
- Kickback is a problem with these saws, as with chainsaws. The same principles apply – do not cut with the upper quadrant of the blade. Avoid standing directly behind the saw – stand to one side. Refer to Chapter 5.6 Chainsaws and to the Canadian Centre for Occupational Health and Safety for more information regarding kickback.
- Follow correct fuelling procedures as described in Chapter 5.1 and the additional fuelling guidelines for chainsaws in Chapter 5.6.
- Keep a fire extinguisher nearby if you are cutting where there may be a danger of setting a brush fire. Do not operate the saw without a muffler and be aware that the muffler becomes very hot during operation.

5.10.7 | Stationary Slab Saws

These saws are used for cutting slices off rocks that are larger than core sized samples.

Significant risks and hazards include:

- Eye injuries caused by rock dust or rock particles that enter the eyes
- Cuts caused by sharp rocks, flying rock pieces, or broken saw blades
- Foot injuries caused by dropped or falling rocks and/or wearing inadequate footwear

Prevention and preparation

- Make sure the saw is firmly mounted to the floor so it will not move when operating.
- Make sure the rock is firmly held in place according to the manufacturer's instructions.
- Wear appropriate PPE. See #4 in Chapter 5.10.2.
- Do not clear cuttings while the saw is operating.

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.

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.

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

6.2 | Responsibilities (Due Diligence) and Traversing

Exploration companies and their employees have certain due diligence obligations when traversing is part of project work (refer to Chapter 1.2 Due Diligence with Respect to Safety).

Exploration Companies

- Make sure the health and safety of each employee is protected at every work location – including field crews on traverse.
- Comply with occupational health and safety (OHS) legislation and regulations; this is particularly relevant regarding employees who traverse alone.
- Develop project safe operating procedures (SOPs) and emergency response plans (ERPs) that address the risks and hazards related to traversing. Should an accident occur, a company cannot demonstrate defence of due diligence when it lacks SOPs and ERPs.
- Training: Make sure employees have appropriate training by qualified personnel (trainers) to use their equipment and they know how to mitigate risks and hazards to traverse safely.
- Make sure supervisors are competent and trained and provide appropriate supervision of their employees.
- Consider hiring specialists when working in hazardous terrain (e.g., glaciers, avalanches). Consider hiring knowledgeable, experienced local people who know the land when it is appropriate (e.g., jungle, polar bears). They may help plan, train workers or participate on traverses.
- Provide sufficient and appropriate equipment to enable employees to traverse safely.
- Provide employees with current information regarding local health risks (e.g., hepatitis, malaria, Chagas disease). Inoculations should be up-to-date, especially for tetanus and those required for overseas work.
- Make sure employees are in good health and are physically capable of traversing safely.

Project Supervisors and Camp Managers

- Perform risk assessments of the project area and include analyzing traverse areas.
- Develop written site specific SOPs and ERPs that address the risks and hazards identified in the risk assessments.
- Provide training to make sure employees are competent in the use of their compass, GPS (global positioning system) unit, maps, communication equipment and are familiar with the SOPs and ERPs. Training should be a part of, but not be limited to, site induction meetings and daily routine planning sessions. Training should include other means that make sure traversing employees are aware of the risks and hazards they face.
- Provide appropriate supervision for employees on traverse. Provide a tracking system for traversing employees and make sure they record details of their planned traversing routes and check in when they change plans. Make sure employees follow the SOPs.
- Understand the duties of and work with employees hired for special work (e.g., trained bear guards, mountaineering or avalanche specialists).

Employees

- Be aware of the risks and hazards associated with the project site and traverse areas.
- Follow SOPs regarding traverse safety. Follow check-in schedules, keep track of your location and use personal protection equipment (PPE) while traversing.
- Be prepared. Know the weather forecast and always carry appropriate clothing and gear, including portable communication and survival equipment.
- Work within your physical limitations and do not take chances.
- Follow training provided by the employer and instructions provided by the supervisor.
- Build up physical stamina and endurance before starting field work to prevent injuries due to exhaustion and physical overexertion.

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 Chapter 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, Indigenous 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 Indigenous areas, check for sacred sites and try to plan traverses that avoid crossing such sites. Refer to Chapter 3. Archaeological & Cultural Sites in the Excellence in Environmental Stewardship Toolkit.

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 f ollowing measures:

1. 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.

2. 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.
3. 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.
4. Traverse in pairs using the "buddy system". Traversing alone is not recommended. Follow all applicable regulations when traversing alone is permitted (see Chapter 6.3.6 below and refer to Chapter 2.1.1 Working Alone Versus the "Buddy System").
5. 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.
6. 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.
7. 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).
8. 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.

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 Chapter 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.

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

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, (2) 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, as indicated in bold.

- **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

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.
    - Snakeboots: Although they are hot to wear in warm climates, high leather snakeboots are recommended as it is more difficult for fangs to penetrate leather than fabric. Combine high leather boots with gaiters and long pants for more protection.

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. Leading cold weather survival researcher 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.

Additional Information about clothing suitable for cold conditions is available from the Canadian Centre for Occupational Health and Safety.

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

Hot Weather Clothing Tips

- Wear a light coloured, long sleeved shirt and long pants for protection from sun, insects and prickly vegetation.
- Long trousers should be made of very sturdy fabric (e.g., Cordura) to prevent rips from sharp and spiked vegetation (e.g., cactus, cholla, agave, spinifex).
- Clothing should fit loosely to allow air to circulate on your skin and evaporate sweat.
- Cotton and some synthetic blends are good choices as they absorb sweat from your skin and evaporate slowly enough to create a cooling effect.
- Wear a wide brimmed hat to protect your face.
- Wear sunglasses with lenses that protect eyes from UV exposure, as required.

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 Chapter 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 Chapter 1.2.1.2 Right to Refuse Unsafe Work).

If an employee agrees to work alone:

- Carefully follow the relevant guidelines in Chapter 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.

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, (3) 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).

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

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

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.

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.

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 Chapter 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 Chapter 9.9 Cold Injuries
  - Refer to Chapter 9.10 Heat Illnesses and Solar Injuries
  - Refer to Chapter 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 Chapter 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.

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 t0:

- 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 Chapter 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 Chapters 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 Chapter 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.

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 Chapter 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 Chapters 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 Chapter 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.

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.

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 Chapter 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 Chapter 17.12.3 Cold Water Immersion Hypothermia.

Sampling Safety for Sediment or Water Samples

- Develop and follow SOPs for sampling and working on water. Wear a PFD when sampling from a boat.
- When sampling along steep shorelines above deep water, either wear a PFD or be securely tied with a rope.
- Do not collect samples while wearing a back pack; if you fall in it may push you under.
- Refer to 11.3.2 Stream Sediment Surveys and Chapter 17. Boats, Canoes and Inflatables

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 Chapter 9.9.6 Immersion Foot.
- See the previous Chapter 6.4.5 Traversing Safety and Streams, Rivers and Lakes.

6.4.7 | Deserts

Risks and Hazards

Specific risks and hazards include but are not limited to:

- Health risks caused by dehydration, hyperthermia, hypothermia, high altitude, sunburn, inadequate clothing, carrying inadequate water
- Slips, trips and falls caused by rough ground (sand, steep terrain, cliffs, canyons, sharp rocky surfaces), inadequate footwear
- Stranding (potential survival situation) caused by getting lost, transportation breakdown, inadequate communication equipment, loss of battery power, flash floods
- Drowning or injury caused by flash floods
- Risks caused by wildlife: scorpions, snakes, insects, and large animals (depending on region)
- Transportation risks: engine overheating, vehicle collisions on roads caused by poor visibility due to dust or sand storms

Prevention and Preparation

- Develop and follow SOPs that address traversing safety in deserts. Dehydration and hyperthermia may be the most serious risks. Hypothermia may be a risk at night.
- Develop an ERP. Be prepared for potential emergencies that could occur in the most remote area (injury, vehicle breakdown, stranding).
- Always traverse with a partner and do not travel long distances from transportation without careful planning and equipment, including extra water.
- Protect yourself from the environment. Wear appropriate protective clothing that includes long trousers, long sleeved shirt, a broad brimmed hat and sunglasses. Use sunscreen. If you become too hot and wish to remove clothing, apply sunscreen liberally half an hour before exposure and repeat applications frequently throughout the day. Protect your neck from sun with a neckerchief or a cloth extension on your hat. Boots should have thick soles to prevent heat transfer to your feet and rise up well over the ankles for protection from sharp vegetation and potential snakebite.
- Prevent dehydration. Consume water throughout the day to prevent dehydration. It is necessary to consume much more than the amount required for quenching thirst – about 750 ml per hour under hot, strenuous working conditions. Carry at least 7.5 litres of water per person per day in the vehicle plus sufficient for your traversing needs in your pack. Refer to Chapter 9.10 Heat Illnesses and Solar Injuries.
- Consider working during the cooler times of the day – early in the morning or later in the day.

- When using air support, consider dropping off a survival cache at the midpoint and/or at the end of the traverse route, depending on the terrain. Always take your fully equipped day pack as something may happen to prevent the aircraft from returning.
- Dangerous wildlife: Watch where you step to avoid snakes. Inspect the area before sitting down for scorpions and ants etc. – bare rock is safest. Shake out shoes and clothing before putting them on in case critters have crept into them. Refer to Chapter 10. Wildlife.
- Signalling: Carry several methods of signalling (mirror, flares, fluorescent orange helicopter cloth); dust and wind-blown sand may interfere with radio transmissions.
- Vehicles: Field work in hot deserts is usually carried out with a vehicle.
    - Follow SOPs and develop an ERP that addresses potential vehicle breakdown and stranding. In most circumstances it is best to stay with the vehicle.
    - Equipment: Fully equip each field vehicle with maps, GPS units, survival kit, first aid kit, food and lots of extra water. Vehicles should also be equipped with a radio, satellite phone or mobile/cell phone, as appropriate. Always carry a survival kit, compass, signal mirror and extra water whenever you leave the vehicle. On rare occasions, vehicles have caught fire while parties were on traverse stranding employees without any survival equipment, radio or water.
    - Stop and get out of the vehicle before driving across dry creek beds, streams or wet areas on a road. Check for sharp rocks, water, potholes, ditches, soft spots, or wash outs. Check upstream and downstream for a safer place to cross. Walk through standing water to find out the actual water depth and the quality of the road bed.
    - Do not use a dry creek bed for a road. Do not drive in dry creek beds unless you have a means of escape. The source of a flash flood may be many miles away and flash floods can happen at any time. Never camp in a dry creek bed.
    - Take a spare vehicle key or keep one inconspicuously attached to the vehicle.
    - Refer to Chapter 13. Vehicles for additional information.

6.4.8 | Heavy Vegetation or Jungle

Risks and Hazards

Heavy vegetation may occur in both temperate and hot climate regions. Specific risks and hazards include but are not limited to:

- Slips, trips and falls caused by rough or slippery ground, holes covered by vegetation, inadequate footwear
- Disorientation and getting lost caused by lack of visibility through heavy vegetation, lack of training in the use of navigation equipment, loss of battery power
- Transportation risks caused by vehicle breakdowns, impassable roads in the rainy season, inadequate training for the type of vehicle in use – including the use of 2-wheel motorbikes in developing countries, collisions – especially with pedestrians in developing countries

- Stranding (potential survival situation) caused by transportation breakdown, injury, greater difficulty being found by searchers due to lack of visibility through the vegetation or forest canopy
- Health risks caused by hyperthermia or hypothermia, soil-borne, insect-borne and waterborne diseases, infections in cuts
- Risks caused by wildlife: ants, mosquitoes, flies, leeches, snakes, and large animals such as bears, big cats, and crocodiles (depending on region)
- Cuts and abrasions caused by contact with sharp rocks, irritating and sharp vegetation, improper use of machetes

Prevention and Preparation

- Develop and follow SOPs that address traversing through heavy vegetation or jungle areas.
- For help on traverses, consider hiring local people who are experienced in bush clearing and are familiar with the fauna and flora. Some types of vegetation may cause skin irritation so learn to recognize and avoid contact with them. For information regarding hiring local people at project sites, refer to the Community Engagement section in the Social Responsibility in Exploration Toolkit.
- Know how to use maps, compass and a GPS unit, but remember it may be difficult to establish your location using GPS as heavy foliage may interfere with satellite reception.
- Follow your partner at a safe distance – no closer than three paces – to prevent branches from whipping back into your face. Wear eye protection.
- In very heavy underbrush, look carefully before each step to avoid hazards such as holes, sharp rocks, slippery rotting logs, or stream banks obscured by vegetation. Consider carrying a machete (panga) to clear vegetation.
- Consider leaving a trail of flagging tape to mark your way so it is easier to find the route on the return trip.
- Consider wearing logger's boots (caulked boots) with spiked soles when working in rainforests. Note, however, that these boots have limited grip on rock surfaces.
- Where there are venomous snakes, always step up onto a log when crossing it and check for snakes that may be hidden at the base on the other side. Watch for snakes in bushes and trees. Watch for snakes on the path; the second or third person to pass is often the one bitten after a snake is disturbed.
- Under some conditions, it may be necessary to construct ladders to obtain samples vertically on a rock face. When constructing ladders on site, use wood that is noted for its strength and notch the uprights to hold the rungs securely.
- Refer to Chapter 10. Wildlife and refer to the SOPs in Chapter 14. All-Terrain Vehicles that apply to the use of two-wheel motor bikes, as necessary.

6.4.9 | Tropics

Risks and Hazards

Specific risks and hazards include but are not limited to:

- Transportation safety risks caused by vehicle breakdown, impassable roads in the rainy season, inadequate training for the type of vehicle in use – including the use of 2-wheel motorbikes in developing countries, collisions – especially with pedestrians in developing countries
- Health risks caused by hyperthermia, foot fungus, infections, and soil-borne, insect-borne and waterborne diseases
- Risks caused by wildlife: ants, mosquitoes, flies, leeches, snakes, scorpions, and large animals such as large cats, hippos and crocodiles (depending on region)
- Stranding (potential survival situation) caused by transportation breakdown, injury, getting lost, difficulty being found by searchers due to lack of visibility through the vegetation or forest canopy

Prevention and Preparation

- Develop and follow SOPs that address traversing safety in the tropics. Take the wet and dry seasons into account.
- Take precautions against sunburn and heat stroke – apply sunscreen with a high SPF, wear a broad brimmed hat and light coloured clothing (long-sleeved shirt and long pants). Wear sunglasses and try to stay out of the direct sun at midday. Protect your neck with a neckerchief or cloth extension on your hat. Melanoma is a serious occupational hazard for field employees.
- When working at altitude, be prepared to prevent hypothermia, especially during the wet season.
- Consume at least 4-5 litres of fresh water throughout the day to stay hydrated.
- Do not drink from streams and rivers without following purification procedures, as the water may contain parasites, viruses or bacteria. Use a water purification method appropriate for the project area. Refer to Chapters 18.6.3 Drinking Water Safety and 12.8.3.3 Water Treatment in Remote Areas or Developing Countries.
- Wear gloves when sampling to avoid excessive handling of soil and forest debris. This material may be infested with parasitic worms or disease causing organisms. Use care when passing through thick foliage to avoid dangerous animals, reptiles, insects and sharp plants. Attend to cuts and abrasions promptly to avoid infections.
- See the previous section for additional information. Refer to Chapter 10. Wildlife. Refer to the SOPs in Chapter 14. All-Terrain Vehicles that apply to the use of two-wheel motor bikes, as necessary.

6.4.10 | Working Along Roads, Highways and Railway Cuts

Individuals or groups (including large parties on field trips) may stop to study rocks in road cuts or railway cuts.

Risks and Hazards

Specific risks and hazards include but are not limited to:

- Death or injuries caused by being hit by a passing vehicle or train
- Collisions caused by parked vehicles being hit by a passing vehicle
- Slips, trips and falls caused by rough ground, unstable rock underfoot, inadequate footwear
- Injuries caused by being hit by flying rock or loose rock breaking away when sampling
- Losing track of field trip participants

Prevention and Preparation

- Develop and follow SOPs that address traversing along roads, highways and railways.
- Park vehicles in a safe place well off the road. Do not park on a curve. Vehicles should not obscure the vision of drivers in vehicles on the road, and parked vehicles should not obscure oncoming traffic when those on foot wish to cross the road. Place traffic warning cones or reflective signs on the road to indicate where traverse work is in progress.
- Wear appropriate PPE including a hard hat, safety glasses and a reflective safety vest.
- Walk on the side of the road facing oncoming traffic.
- Be aware of the location of others while taking samples so they are not injured by flying rock.
- People on top of a road cut should avoid knocking rocks onto those below, and people below should take care not to pull off sections of rock when taking samples. Only by looking at the top of a cut can the stability of the rock face be determined. Fractures from blasting may be extensive so that large pieces of rock are very unstable and easily dislodged.
- Footing hazards: The risk of slips, trips and falls increases when the ground surface is smooth, wet and/or sloping.
    - Watch out for “blast bits” – small sharp pieces of bedrock blown outwards by the blasting process that rest on the surrounding rock surfaces. The bits are very unstable and will roll easily when stepped on. Blast bits may be found up to 50 metres from the road cut depending on the size of the blast.
    - Slippery surfaces: loose rock on slopes and trail, sloping areas of wet clay, glacial polish and rock surfaces under moss or thin layer of soil, tidal zones, stream banks

- Stay back from heights, steep edges and drop offs. The face of a road or railway cut is often fractured and very unstable.

- Tips for group field trips:
    - Communicate hazards to field trip participants before departure (e.g., terrain, temperature and weather to expect).
    - Have a basic ERP to cover potential emergencies that may occur given the terrain, temperature and weather, distance from medial aid, length of the trip, number of participants, physical abilities of the participants
    - Carry: emergency contact telephone numbers or frequencies, an adequate first aid kit for the size of group, extra water in vehicles
    - Provide or hire capable drivers. At least one leader/participant should be certified in first aid and CPR.
    - Hold group discussions well off the road.
    - When there are several vehicles or a bus for the group, do a head count before departing to make sure everyone is present.

Figure 6.1: Sample with care when others are nearby and hold discussions away from traffic. © Tony LeCheminant

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.

1. 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.
2. 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.
3. 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

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

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.

- 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.
- 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.

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 Natural Resources Canada website.

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.

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.

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).

Additional information about air photos, their use and purchase is available from Natural Resources Canada.

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.

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 Chapter 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.

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.
- 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.

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.

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 Chapter 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 online.

Figure 7.1: 406 MHz Emergency Locator Transmitter (ELT) mounted in a helicopter.
© Great Slave Helicopters

The "SPOT"

The "Spot Satellite Messenger" is a new device, a type of PLB that can send a message to check in with a designated receiver (office, family), or an emergency "911" signal 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 in the Arctic, Antarctic or central and southern Africa. It is not intended as – nor is it usable as – a navigational tool.

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 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 Tip

- 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.

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

8.1 | Risks and Hazards

The attitude that "it can't happen to me" is foolhardy and unacceptable, as no one is immune to accidents or unexpected risks and hazards. If you have previously worked in an area, it is important to guard against becoming complacent and presume conditions will be the same as before.
Injuries or death to individuals may result in a survival situation due to the following risks and hazards:

- Getting lost or disoriented caused by:
  - Lack of training to use a compass or GPS unit, poor map reading skills
  - Loss of battery power for navigation and/or communication equipment
  - Inadequate map coverage, old and/or out of date maps
  - Weather conditions (fog, whiteout), sudden storms
- Stranding caused by:
  - Injuries severe enough that one is unable to complete a traverse
  - Lack of preparation (e.g., poor map coverage, inadequate transportation, lack of training)
  - Loss of equipment (communication, navigation, day pack)
  - Transportation breakdown or crashes, bad weather
  - Not following SOPs
  - Adverse weather conditions: streams become impassable, water becomes too rough, fog grounds the air support, dust storms, avalanches
- Slips, trips and falls caused by inadvertently entering dangerous terrain or poor map reading skills, wearing inadequate footwear
- Hypothermia caused by working in cold, temperature and/or wet conditions, wearing inadequate clothing, failing to recognize and/or act regarding the signs and symptoms
- Hyperthermia caused by working in high temperature and humidity conditions, lack of acclimatization, dehydration, wearing inadequate clothing, failing to recognize and/or act regarding the signs or symptoms
- Dehydration caused by carrying and/or drinking inadequate quantities of water
- Search and rescue people who are placed at risk caused by:
  - Employees who are inadequately prepared and/or trained
  - Employees who do not follow SOPs and ERPs
- Aggressive animal attack (e.g., bears, moose, cougars, jaguars, leopards, snakes, crocodiles, elephants, Cape buffalo)
- Work at high altitude may cause minor or sudden and serious forms of altitude illness
- Personal risks caused by kidnapping, civil insurrection

Camp destruction caused by:

- Fire in camp caused by: fuel spills, exploding propane tank or generator, electrical short circuit, kitchen fire, careless smoking, fuel storage fire, forest fire or bush fire
- Weather related hazards (e.g., buried under a heavy snowfall, avalanche, flash flood)
- Natural disasters such as mudslides, floods, earthquakes, tsunamis, volcanic eruption
- Bear invasion when everyone is out of camp

8.2 | Responsibilities (Due Diligence) and Survival

Companies

- Make certain the health and safety of each employee at a project is protected.
- Carry out risk assessments and develop safe operating procedures (SOPs) that address the risks and hazards related to project work, including travel. Helpful information is available in the following sections of the PDAC Health and Safety Guidelines:
    - 6. Safe Traversing Practices
    - 9. Weather and Environmental Risks
    - 10. Wildlife
    - 12. Travel Safety and Security
    - Transportation Chapters: 13. Vehicles, 14. All-Terrain Vehicles, 15. Snowmobiles, 16. Aircraft and 17. Boats, Canoes and Inflatables
    - 19. Communications
    - 22. Abandoned Surface and Old Underground Mine Workings
- Make sure that emergency response plans (ERPs) and procedures are in place to address the potential survival situations that may occur. Refer to Chapter 3. Emergency Response.
- Provide employees with sufficient training that includes survival skills appropriate for the project location, work conditions and the time of year.
- Provide appropriate communication equipment.
- Provide appropriate survival kits for the season, terrain and work environment.
- Provide adequate emergency cache supplies.
- Evaluate charter aircraft companies for safety performance. In addition to flying hours, specify the required level of emergency training that charter air crews must have. Specify the requirement for survival kits, training and emergency procedures as part of a contract or agreement with the charter services company. Incident free flying does not qualify a pilot to lead a survival crisis after a crash, especially in Arctic conditions. Refer to Chapter 16.3 Aircraft Charters.

- It is advisable to set and enforce limitations and restrictions for work and travel in extreme weather conditions or with inadequate equipment. For instance a company may impose a "no work" order during whiteout conditions or if wind chill temperatures are below, say -45°C. This removes pressure for employees to push their luck to get a job done and end up in a c risis situation.

Project Supervisors

- Develop and implement site specific SOPs and ERPs and procedures.
- Make sure employees are aware of the local risks and hazards and have sufficient training to address potential survival situations.
- Provide appropriate communication equipment and survival cache supplies for employees working on traverse or at remote work sites away from a main camp or base. Make sure communication equipment is kept in good working condition so it is available when required. Make sure employees are trained and competent to use the equipment.
- Where air support is used, implement periodic reviews of emergency communication procedures, survival kit contents, emergency plans and cached supplies. Take into consideration the time of year and relevant requirements for emergency procedures, survival kits and supplies (e.g., extra warm clothing, bug jackets, bug spray).

Employees

- Follow established company and project SOPs, especially regarding traversing and transportation. Follow check-in routines
- Be aware of the project ERPs that address survival, search and rescue (SAR) and evacuations. Know what emergency procedures to follow and how to signal for help should you require it.
- Be trained in appropriate survival skills for the environment where you work. Practice survival skills when you have the opportunity. Complete a first aid and cardio pulmonary resuscitation (CPR) course and renew certification as required.
- Take your survival kit on every traverse and to each work location. It is your responsibility to take your survival kit with you every time a vehicle, aircraft, or boat drops you off. Do not send it ahead or leave it behind. Keep it with you so it is available. Know how to use your equipment.
- Carry sufficient essential medication in case you become stranded or delayed. Co-workers must know about allergies, understand the symptoms and how to treat a co-worker if they experience an attack (e.g., bee and/or ant stings, diabetes, asthma, food allergies such as nuts.)

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

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 affects 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.

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 Chapters 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.

1. 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 Chapter 8.4 Survival Equipment Lists.
- Carry a suitable first aid kit to deal with injuries. Refer to Chapter 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.

2. 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 Chapter 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.
3. 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.

4. 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.
        - Deserts: Carry water and a survival kit any time you leave the vehicle. Always carry extra water if you walk farther than 30 minutes from the vehicle. During hot days do not work too far from the vehicle as hyperthermia can set in quickly (and hypothermia at night).
        - 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 Chapters 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.
5. 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

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 Chapter 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.

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.

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 Chapter 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
- Insect head net, 1 per person (depending on region)
- 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.

Figure 8.1: Survival kit for day pack © Matt Turner

Figure 8.2: Survival essentials for pockets © Courtney Mitchell

8.5 | General Advice for Survival Situations

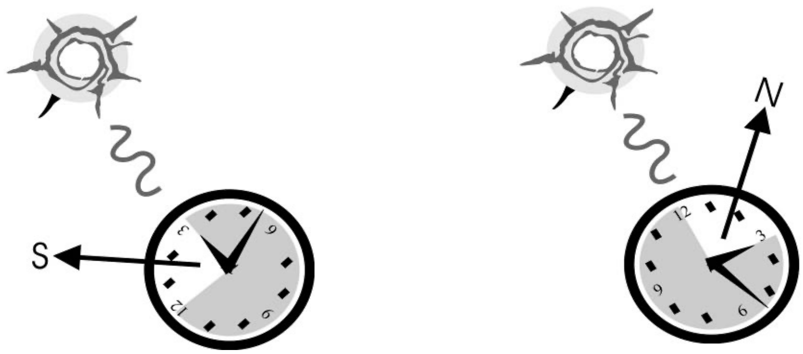
- If an accident occurs, assess the situation and if possible, contact others for help before attempting a rescue.
- Remain at the destination or pick up point if your transportation fails to arrive. Co-workers will know where to find you.
- Remain with your vehicle. If the vehicle becomes stuck or disabled, 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 break down in forest or jungle terrain where a vehicle is not visible from the air, it may be necessary to seek a clearing to signal for help if no road traffic is forthcoming.

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 Chapter 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.



1. Northern Hemisphere 2. Southern Hemisphere

Figure 8.3: Finding your direction

- 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.

8.5.1 | Survival Advice for Cold Climate Conditions

If something goes wrong, immediately go into survival mode. Do not wait to see if someone shows up or if the situation suddenly improves.

- Know how to prevent hypothermia and other cold related issues (refer to Chapter 9.9 Cold Injuries).
- Keep the vehicle fuel tank at least half full so you can run the engine intermittently to heat the interior should you become stranded.
- Ensure that the exhaust pipe is clear of snow or dirt to prevent asphyxiation when you use the engine to heat your vehicle. Leave a window slightly open for ventilation while the engine runs but do not allow exhaust to enter.
- Always tie a cord to yourself and the steering wheel or door handle if it is necessary to leave the vehicle during whiteout conditions.
- Create a tent within a vehicle using three space blankets.
    - Tape one edge of a blanket to the windshield. Bring the blanket over your head and behind your back.
    - Tape a second blanket over the inside of the window and door on the windward side to create a wind screen.
    - Spread another space blanket on the floor. Curl up on the seat inside the blankets.

- Use a coffee can candle, sterno "canned heat", or an emergency candle on the floor of the vehicle to generate heat once your fuel is gone. They are easily made one by filling a 1 kg coffee can with wax and two wicks.
- If a group is stranded in a vehicle, it may be warmer to huddle together. Coats spread out as blankets may provide the most warmth. Loosen any tight clothing.

When faced with a survival situation without a vehicle or transportation to use for shelter:

- Immediately recognize the need for action; do not delay and wait for help.
- Organize yourself or your group immediately. Use your strength and resources during the time left before darkness and build a shelter and a fire.

8.5.2 | Survival Advice for Desert Conditions

Seek shade when stranded in a desert. Keep activity to a minimum to control your body temperature and control your sweat rate. Follow these guidelines:

- Remain still in the shade, rest during the day and do required work at night. Know how to prevent hyperthermia and sunburn.
- "Ration your sweat, not your drinking water" (see Chapter 8.6.5 Water and Food).
- Cover as much skin as possible. Wear a long sleeved shirt, long pants and a broad brimmed hat. Loose fitting light coloured clothing is best.
- Do not sit and rest directly on the ground; the surface temperature is often much warmer than the air temperature. Find an elevated place 1-2 m off the ground to rest (e.g., a tree limb, a rock ledge). At night, it is advisable to sleep in the shelter of a stranded vehicle or up off the ground to avoid encounters with scorpions, snakes or other venomous creatures.
- A vehicle interior can become very hot during daytime hours, even with all the windows open. The shade cast by vegetation or rocks may be cooler than the shade cast by the vehicle. Nevertheless, during the day it may be coolest under the vehicle, especially if you can scrape away any loose surface material that has retained heat.
- If a vehicle is unavailable, dig a hole or trench to access cooler ground. Scrape away at least 25-50 cm of the surface dirt to create a cooler resting area. The deeper you dig, the cooler the hole – but this requires more energy and produces more sweat. Create a roof over the hole with two layers of plastic spaced 50 cm apart to create an air layer that will help insulate the hole from the heat of the sun.
- To create shade: Rig a canopy out from the side of your vehicle with a sheet of opaque plastic (white is best). Leave about 125 cm (4 ft) of open space below it for ventilation.

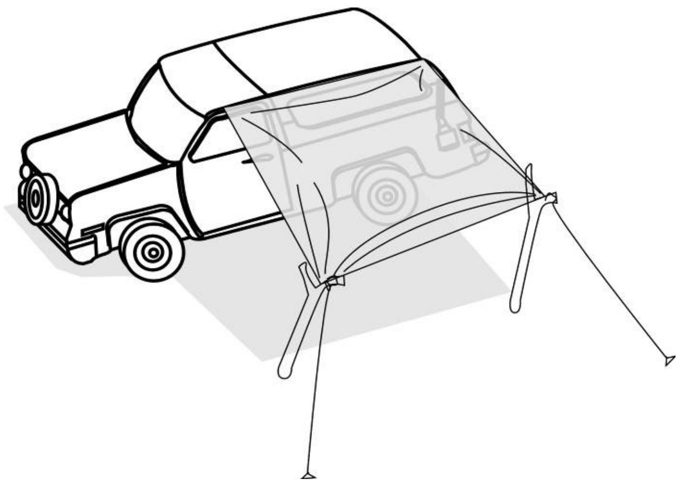


Figure 8.4: Creating shade in the desert using a canopy

8.5.3 | Survival Advice for Forested Areas

All forests

- Good map and compass skills are essential. Locating yourself is difficult when you are off a grid system or off a known track or road. It is difficult to find a point to take a sighting and it may be necessary to climb a tree or a hill to get your bearings if you are lost. Do not depend totally on GPS technology as battery power will disappear if you are stranded for any length of time.
- Make yourself visible for searchers. This is a challenge due to the dense underbrush and forest canopy. Go UP to be seen by aircraft – a ridge or hill. Try to find a clear cut or burned area. It may be dangerous to follow water courses downstream as they frequently become steep waterfalls. You will probably be invisible next to an overgrown water course with dense vegetation.
- Gauging the distance you have travelled can be difficult when it requires a lot of work to traverse dense growth. You may think you have gone much farther than you actually have.
- Depending on the season, starting a forest fire may be a serious concern; take care with signaling fires, especially if the torch tree method is used.

Temperate rainforests

In addition to the above, weather may cause transportation difficulties, especially when relying on air support, as clouds may sock in an area (sometimes routinely). Fog may affect the coast and disrupt boat schedules. Local knowledge regarding weather is important.

- Lighting a fire can be very challenging because tinder, kindling and fuel are likely to be very wet – and you will probably need a fire for warmth and to dry out. Always carry foolproof methods to light a fire.

Tropical rainforests

- It can get quite cold in mountainous areas, even near the equator so carry sufficient clothing to be dry and warm. Hypothermia is a risk at elevation, especially if you cannot keep dry.
- Survival kits and caches should include mosquito netting. Carry the means to make a hammock in order to make sleeping area up off the ground to help prevent insect and other bug bites.
- Rain flows into streams and tributaries so be prepared to move if water levels start to rise. Flooding can be sudden and deep; mudflows can be a hazard as well. Flash floods can develop in mountain stream beds and may be routine in some places.

8.6 | Priorities for Survival Situations

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

1. First Aid
2. Location
3. Shelter
4. Fire
5. Water and food
6. 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 Chapter 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 Chapter 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.

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 Chapter 18.5 First Aid for information regarding treatment priorities and Chapter 3.0 Emergency Response.

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.

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

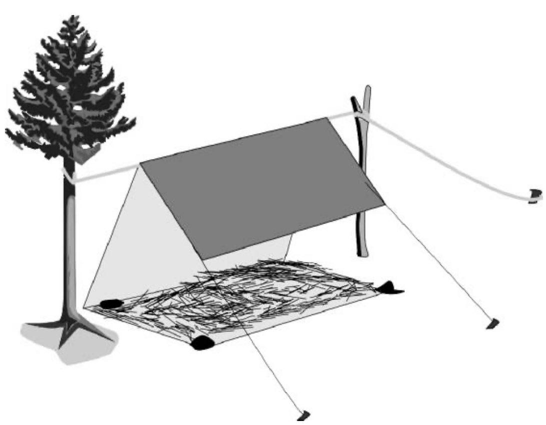
These are an essential part of a survival kit as they can be used for many purposes. Carry fluorescent or bright orange garbage bags for high visibility and signalling.

- 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



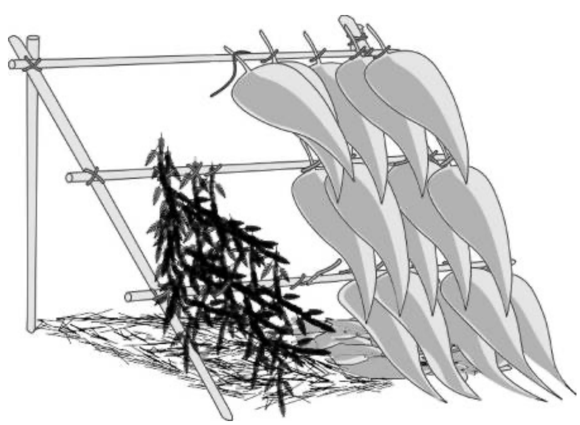


Figure 8.5: Examples of a lean to shelter

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.

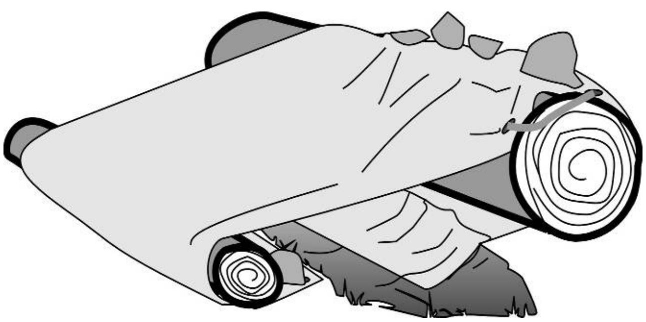


Figure 8.6: Example of a simple shelter

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.

Tree base shelter

Dig out accumulated snow near the trunk of an evergreen tree with spreading branches. Use the space beneath low branches for shelter. Insulate the sitting area and where your back will rest and line the area with a plastic garbage bag to stay dry when snow melts due to your body heat. It may be advisable to use available materials to create a small lean-to against the trunk to prevent snow dropping onto you

Figure 8.7: Example of a tree base 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.

Figure 8.8: Example of a quinzee © Jamie Bastedo

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.

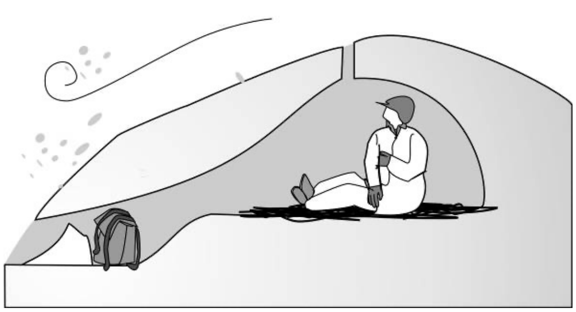


Figure 8.9: Creating ventilation in a snow tunnel

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.

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.

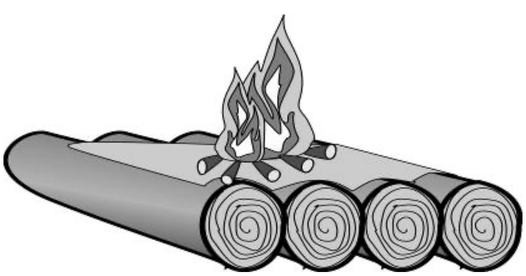


Figure 8.10: Example of a platform fire

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.

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.

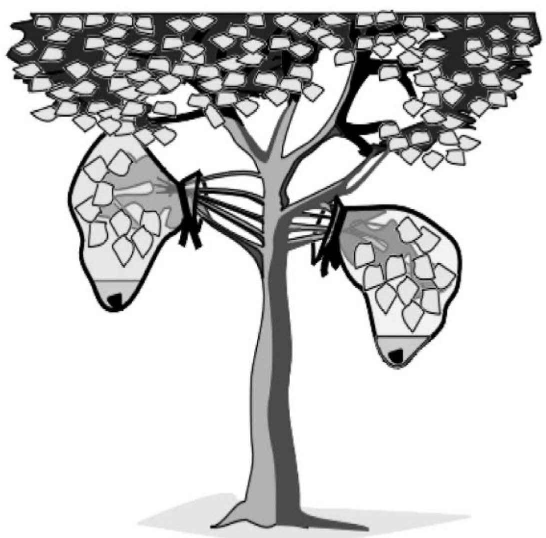


Figure 8.11: Transpiration bags

- 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.
    1. Dig a hole 0.75 m deep and 0.75 to 1 m wide. The sides should slope so they do not cave in.
    2. Place a container in the bottom and cover the hole with a 2x2 m piece of clear or white plastic.
    3. 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.
    4. 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.

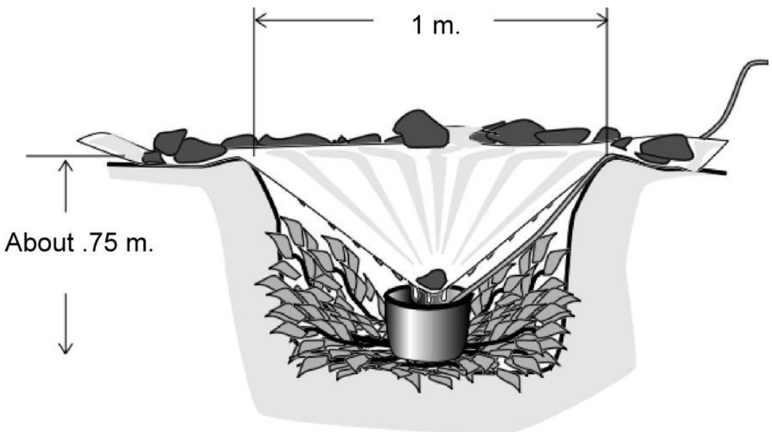


Figure 8.12: Example of a solar still

- 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.

8.6.6 | Signalling

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.

Figure 8.13: Using a signal mirror without a sighting hole

To use a signal mirror without a sighting hole:

1. Hold a mirror under your sighting eye.
2. Extend your arm outwards and form a "V" with two fingers.
3. Sight the aircraft or object in the point of the "V".
4. 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 Chapter 10.3.9 Bear Deterrents for additional information.

Table 8.1: Flare Comparison Table

TYPE OF FLARE	BURN TIME	INTENSITY	ALTITUDE	COMMENTS
PARACHUTE	25-40 seconds	10,000-30,000 candlepower	300 metres 1,000 feet	Incredibly bright. Use to attract initial attention. SOLAS flares have a self-contained launcher. A 25mm flare gun is required to launch other brands.
METEOR	10 seconds	10,000-30,000 candlepower	60-120 metres 250-500 feet	Use when rescuers are nearby and looking in your direction. Launch in pairs – first to attract attention, second to confirm. Launch from 12-gauge, 25mm flare gun or barrel launcher.
HAND-HELD	120 seconds	500 candlepower	ground level	Long duration, low altitude. Allows rescuers to home in on your location.
SMOKE	50-180 seconds	dense cloud of orange smoke	ground level	Day signal. SOLAS flares will not ignite oil or fuel on water.
DYEMARKER		bright yellow-green dye	ground level	Good for use on water, snow or ice for daytime visual signal to aircraft or boats.
SHELL CRACKERS & SCREAMERS			25-70 metres	Use to scare away bears or other threatening animals. Refer to Chapter 10.3.9 Wildlife regarding additional pyrotechnic devices.
ROAD	5-30 minutes		ground level	All vehicles should carry at least 3.

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 on their website.
- 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.

Table 8.2: Standardized ground to air emergency signals

NUMBER	MESSAGE	CORE SYMBOL
1	REQUIRE ASSISTANCE	V
2	REQUIRE MEDICAL ASSISTANCE	X
3	NO or NEGATIVE	N
4	YES or AFFIRMATIVE	↑
5	PROCEEDING IN THE DIRECTION	V
6	ALL IS WELL	LL
7	REQUIRE FOOD AND WATER	F
8	REQUIRE FUEL AND OIL	L
9	NEED REPAIRS	W

Source: TP 14371 – SAR-4.0 Aircraft Emergency Assistance, Transport Canada, 2007 (updated 2020). Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2008.

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.

8.7 | Search and Rescue (SAR)

When you are lost or injured, follow the priorities set out in Chapter 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

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 Chapter 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 Chapter 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.

DRIVING RESPONSIBLE EXPLORATION

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).
- No other employees must be endangered during search or rescue operations. Searchers should always use the "buddy system" and work in teams. Co-workers must not endanger each other or themselves.
- Searchers must carry their own maps and compass, GPS, survival kit, first aid kit, communication equipment, extra batteries, food and water.
- There can be no unofficial searches. Every team must be fully equipped, names logged and their designated search area recorded on a map before heading out.
- Formal SAR: When formal SAR groups are engaged, it is imperative that only one person coordinates all operations.

DRIVING RESPONSIBLE EXPLORATION

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.

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.

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 Chapter 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

9.2 | Lightning

Lightning is the electrical discharge between two clouds or between a cloud and the ground. When strong negative charges built up at the base of a thundercloud, they are attracted to positive charges in another cloud or on the earth's surface. Lightning will strike the most conductive object, which is usually a high object (e.g., a tall building, tree, rocky peak, metal tower). However, it is possible for a short object to be struck even when taller objects are nearby if that object provides the most conductive path to the ground. Although the relative risk of being struck by lightning is small, if you are working or sheltering in the wrong place at the height of a lightning storm, your chances of being struck are very much higher than average.

9.2.1 | Risks and Hazards

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

- Death or injuries caused by lightning strikes. Potential injuries include:
  - Hearing loss (temporary or permanent)
  - Burns on the skin surface or deep body tissue
  - Brain damage, amnesia, seizures, paralysis, coma
  - Heart attack
- Being struck by lightning caused by:
  - Lack of training, taking shelter too late, emerging from shelter too soon after a storm has passed
  - Sheltering in, near or under a conductive object (e.g., tree, power lines, cliff face, shed, open vehicle)
  - Contacting geophysical survey wires or fence lines, being on the water
- Fires caused by lightning strikes to company buildings or equipment, the surrounding area resulting in a forest fire
- Explosion caused by a lightning strike to an explosives magazine

9.2.2 | Prevention and Preparation

Safety precautions are essential where lightning is a hazard:

- The project supervisor should develop site specific SOPs and ERPs to address potential lightning risks and hazards. Train all employees to follow the procedures.
- Traversing employees should make plans that take into account potential lightning storms that may develop along traverse routes.

- Watch for changes in weather conditions throughout the day. Thunderclouds can form quickly but they will provide advance warning before the onset of an electrical storm.
- Use the 30 - 30 Rule. Seek shelter when you hear thunder within 30 seconds of seeing a lightning flash; remain in the shelter for at least 30 minutes after the last thunder is heard. Hearing thunder within 30 seconds means the lightning strike is less than 10 km away. Take shelter immediately. Many lightning strikes occur 30 minutes before and after a thunderstorm, and lightning can travel great horizontal distances before reaching the ground.
- Where lightning is a frequent risk, consider carrying a lightning detector or a radio set to an AM frequency, which will crackle and indicate when lightning is in the area.
- Advanced project sites subject to electrical storms should locate the explosives magazine at the base of a high bank. Ground the magazine to reduce the possibility of it being struck. When thunderstorms approach, close the magazine and vacate the area.

Follow these guidelines when a lightning storm approaches.

- Immediately disconnect the radio antennas; move them away from the radio and ground them. If the antenna is struck by lightning, the charge will travel through the wire into the radio, which could damage it and possibly start a fire.
- Stay away from satellite dishes.
- Disconnect computers, power tools, rock saws and extension cords etc., from their power sources. Employees should not continue working out-of-doors with metal tools such as hammers and wrenches.
- Move well away from drill rigs, as the mast may act as a lightning rod.
- Field geophysical survey crews should disconnect all wires from equipment and stay well clear of the wires and equipment for the duration of the storm. Crews must be especially alert for storms in the survey area, as the wires connecting equipment may stretch for kilometres. Refer to Chapter 11.2 Geophysical Survey Safety.

Seek shelter early – well before the storm arrives.

- Shelter inside a substantial building whenever possible.
  - Choose a large building. Avoid contact with anything metal or electrical, as lightning can travel into buildings through stove pipes or electrical wiring. Electrical outlets, plug-in appliances, radiators, open doors, windows and fireplaces all offer easy paths for lightning to enter a building.
  - Do not use a telephone with a cord – a cell phone or cordless phone can be used if indoors.
  - Avoid contact with water; do not bathe or wash dishes etc.

- Seek shelter in a vehicle with a metal body frame if no safe building is available. Roll up the windows and do not touch metal within the vehicle. Cloth-top vehicles, all-terrain vehicles (ATVs) or utility vehicles do not offer sufficient protection because the metal shell of a vehicle, rather than the tires, affords the protection for the occupants. After a storm has passed, watch out for downed live wires if wind damage has occurred. Do not leave the vehicle if downed wires touch the vehicle or you may be electrocuted when your feet touch the ground. Refer to Chapter 21.3.4 Working Near Power Lines.
- Unless it is designed as a lightning shelter, it is not advisable to seek shelter in an isolated shed, especially if it has a metal roof.

If no indoor shelter is available, seek the safest outdoor location.

You do not want to be the best conductor in the area, which is usually the tallest object. Avoid sheltering near tall objects such as trees, cliffs or promontories.

- Descend to a lower elevation if you are on a ridge or peak. Seek a bench below a peak and away from local promontories. If you must shelter below a peak or cliff, the cliff or peak should be at least five to ten times your height. You should crouch more than 2 m but less than 15 m away from the base of the cliff.
- Do not stand under isolated trees or in open spaces where you are the tallest object.
- If you are in an open area, a clearing or on an exposed slope, move into an area of small trees or bushes if possible.
- If you are in a forest, seek a stand of young trees of uniform height. Avoid trees with unstable roots or ones that stand significantly higher than other trees in the area.
- Do not shelter in small gullies and shallow caves. Rock overhangs, rocks with wet surfaces, patches of lichen, cracks that hold water, plant or tree roots are all likely to conduct current.
- Avoid water. Get out of the water and onto land if you are boating or swimming. Avoid open water. Avoid being near streams or swamps, as water increases conductivity. Remember to avoid tall trees and rocky promontories by the shore. Move inland at least 100 m from shore.
- Avoid metal and graphite objects (e.g., power lines, fences, tent poles and wires, ice axes, packs with metal or graphite frames). Graphite, like metal, is an excellent conductor.
- •Move away from (or avoid the area of) iron formations.

If you are outdoors when lightning is nearby:

- It is vitally important to assume a position that minimizes your contact with the ground. Choose the safest location available. If your hair begins to stand on end and your skin or teeth feel a tingle, you are in grave danger of being struck by lightning.

- The safest position: Crouch down with your knees drawn up and your feet touching together to minimize your contact with the ground. Never let your hands, shoulders or head touch the ground. Any current passing through these parts of your body will also pass through your vital organs. Never lie flat on the ground. Discard your pack, hammer, knife, compass, coins in your pockets etc. Crouch on insulating material, if available (e.g., dry sleeping bag, foam pad or coiled rope). Cover your ears if possible to lessen potential damage to your eardrums.
- If there are several people in a party, spread out at least 6 m apart so the group does not provide multiple paths for the current. Everyone should assume the crouching position

Figure 9.1: Crouch with your feet touching together.

Although direct hits by lightning are rare, a person can be severely injured by splash lightning or ground currents that spread out when lightning strikes a nearby object. Lightning rarely kills outright; it paralyzes body functions so recovery is common.

- You cannot receive an electrical shock from a victim of a lightning strike so do not delay administering first aid.
- If someone is struck by lightning, immediately check if they are breathing and have a pulse. Follow the ABCs – Airway: is it open? Breathing: is the victim breathing? Circulation: does the victim have a pulse? If not, immediately begin rescue breathing and/or CPR. Recovery is common even if some time has elapsed since the strike. Evacuate the victim to a medical centre as soon as possible.

9.3 | Whiteouts

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

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 Chapter 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 Chapter 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.

9.4 | Avalanches

Definitions

Loose snow avalanches start at a point on the surface of the snowpack. Snow at the starting point cannot be supported by underlying snow so it slides downslope incorporating more snow as it moves. Loose snow avalanches are usually fan shaped.

Slab avalanches start when a weak layer within the snowpack fails and a large rectangular block (slab) of snow slides down the slope. Slab avalanches are responsible for 90% of fatalities.

9.4.1 | Risks and Hazards

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

- Death from suffocation or trauma injuries caused by burial
- Impact injuries caused by burial in snow or debris (e.g., head and neck trauma, broken limbs, shock)
- Potential risk of a survival situation caused by:
  - Lack of safety equipment: avalanche safety devices, inadequate communication equipment (wrong type or battery failure)
  - Lack of training, lack or loss of survival equipment, lack of available help due to remote setting
  - Hypothermia and/or frostbite
- Stranding may be caused by: snowmobiles break down, battery failure (e.g., navigation or communication equipment), an avalanche blocking the route

9.4.2 | Prevention and Preparation

Avalanches are a serious safety risk and each year knowledgeable people die in avalanche accidents. No one should presume that by reading the PDAC Health and Safety Guidelines that they have gained sufficient knowledge to safely assess avalanche dangers.

When work is planned in avalanche-prone country, exploration companies should seriously consider hiring avalanche experts to help develop SOPs and ERPs and to help plan and carry out field work, including traverses. In addition to the aid and advice of experts, exploration employees should take formal courses to learn the essentials of avalanche safety.

As a minimum, formal training should include: (1) how to recognize avalanche terrain, assess snow conditions and recognize weather conditions that produce avalanches, (2) the types of avalanches and when each type is likely to occur, (3) understand how avalanches are triggered, (4) how to use avalanche safety equipment including a transceiver, avalanche probe and shovel, (5) how to safely cross an avalanche slope if a crossing is unavoidable, and (6) techniques to locate and rescue an avalanche victim.

Preparations for projects located where avalanches may occur:

- Hire knowledgeable experts familiar with the risks and hazards in the project area.
- Do not set up project work sites or camps in areas where avalanche dangers are present. Plan to do field work only after the seasonal risks of avalanches have passed.

- The project supervisor should develop site specific SOPs and ER procedures in consultation with knowledgeable experts to address potential avalanche risks and hazards. Make sure all employees are trained in the procedures.
- Training: Try to hire employees who have taken formal avalanche safety classes or provide the training to those who lack it. All employees should receive training regarding SOPs and ERPs and the use of avalanche safety equipment.
- Carry special avalanche safety equipment. Avalanche transceivers emit a signal that can be detected for about 60 metres. Each person traversing should be required to wear an avalanche transceiver around his or her neck – do not keep it in a pocket or a pack. Switch on the transceiver at the beginning of the traverse and check that all transceivers are working correctly. Leave transceivers turned on until the traverse is finished or until everyone is completely out of danger. Use alkaline batteries as they withstand cold temperatures better than regular batteries. Each party member should also carry a collapsible avalanche probe and a durable collapsible shovel for digging out a victim. Be trained and practice using the equipment in order to effectively locate and rescue a co-worker.
- Plan traverse routes to avoid exposure to potential avalanches.
- Use helicopter support whenever possible to bypass areas where avalanche risks are deemed high or are known to occur.
- Where avalanche risks are unavoidable, never traverse alone or even in pairs; always traverse with several crew members.
- Do not proceed into any area where you can hear avalanches occurring.

Typical Avalanche Terrain:

- Typical terrain: Avalanches frequently occur on broad treeless slopes and on slopes above cliffs. Ravines, gullies and narrow canyons also provide routes for avalanches.
- Slope factors: Most avalanches occur on slopes with a pitch between 25° to 60°. They occur less frequently on gentler or steeper slopes. Slopes between 35° and 40° avalanche most frequently. The slope profile contributes to the degree of avalanche danger. Convex slopes are the most dangerous. Straight slopes are somewhat less dangerous and concave slopes are the least dangerous. Avalanche danger will increase where a slope changes angle due to changing stresses that develop within the snowpack.
    - Northern hemisphere: South-facing slopes are the most dangerous in spring and summer, while north-facing slopes are the most dangerous in winter.
    - Southern hemisphere: North-facing slopes are the most dangerous in spring and summer, while south-facing slopes are the most dangerous in winter.
- Avalanches usually occur where they have happened before. Be constantly vigilant for indications of previous avalanches and avoid these areas when traversing.

Causes of Avalanches:

- Most avalanches that engulf people are triggered by members in the party – on skis, on foot or on snowmobiles.
- Weather factors: An accumulation of new snow, increased sunshine that causes a rapid rise in temperature, significant wind (both direction and speed), storms and rain all contribute to the risk of avalanche by destabilizing the snow pack.
- Snowpack factors: Snow builds up in layers. The layers reflect the conditions at the time of snowfall as well as changes in the snow granules over time. Some layers are much weaker than other layers. Snow will avalanche when a weak layer within the snowpack on a slope cannot withstand an external force. The force required to start an avalanche may be large or small, depending on the stability of the snowpack.
- Triggers are the forces that start the avalanche. They may be:
    - Additional weight from a new fall of snow
    - A person's body weight
    - A collapsing cornice
    - A rock fall
    - Falls of ice on a glacier
    - Noises or vibrations
    - An earthquake

Planning Safe Traverse Routes:

- Before proceeding, check out the snow conditions in a safe location. Test the snow whenever there is any doubt about its stability. Do not take risks. Conditions often change daily and what was safe yesterday may not be safe the next day.
- Do not make assumptions about avalanche conditions when planning a traverse route. Learn to recognize safe traverse routes. Note the following:
    - Traversing on wide ridges is safest. Travel on the windward side of a ridge well back from the edge, as cornices form on the leeward side. Cornices often collapse. Avoid ridges with double cornices.
    - Narrow valley floors are less safe as they may be the runout paths for avalanches. Wide valley floors beyond avalanche runout paths are generally safer.
    - Traversing gullies and slopes are the least safe routes. Leeward slopes are the most dangerous as they receive the most snowfall.
    - Avoid previous avalanche paths as indicated by damaged trees or the lack of trees.
- Be constantly aware of the changing nature of your surroundings when working in avalanche territory. During a traverse your body weight may provide the trigger for an avalanche when there is only a slight change in the slope or snowpack.
- Pay strict attention to the snow as you traverse. Hollow sounding snow is extremely dangerous. If cracks form where you are standing in snow, get off it immediately.

If you must cross a suspicious slope:

- Cross high on the slope so that most of the snowfield is below you.
- Put on gloves, your hat and extra clothing. Detach all pack or equipment safety straps so you can discard them immediately if caught in an avalanche.
- One person should cross at a time. Each person should trail at least 18 m of fluorescent rope. Then, one can be traced more easily if caught in an avalanche.
- Don't assume that because there are tracks on a slope that it is safe. The first person to cross does not always trigger the avalanche.

If you are caught in an avalanche:

- Shout to attract attention and get rid of your pack. Cover your face with your hood or hat to help prevent snow from entering your nose and mouth. Keep your mouth shut.
- Grab onto a tree or rock to stop being swept away, if possible.
- Make every effort to get to the edge of the avalanche. Keep to the upper surface of the avalanche if possible. Swimming motions may help.
- If you become buried, as you come to a stop make every effort to work your arms in front of your face to create as large a breathing space as possible.
- Your avalanche transceiver should already be activated. Rescuers will turn their transceivers to "receive" to detect your signal and locate you. Activate your Personal Locator Beacon (PLB).
- Try to work your way to the surface only if you can see light. Save your energy for shouting until you hear rescuers. Blowing an emergency whistle is better than shouting.

Additional information regarding avalanches: Refer to the Canadian Avalanche Association and the Canadian Avalanche Centre for extensive information about training and instruction, regional bulletins, and safe practices.

9.5 | Floods

Floods are caused by many factors including prolonged rainfall over several days or heavy rainfall over a short period of time (flash floods). Flooding may be routine in the spring when rain falls on melting snow and water runoff increases. Ice jams are a common cause of flooding in many parts of Canada and other northern countries. Beaver dams and spring snowmelt may cause flooding and affect remote roads so that the quality of the road may change from year to year. Storms and tropical cyclones can bring intense rainfall to coastal and inland areas at certain times of the year. However, intense rainfall is not directly related to the wind speed of a storm. Weak storms that stall or drift slowly over an area often result in the greatest amount of rainfall. Some statistics indicate that floods kill more people in North America than any other type of natural disaster. About half of all flood deaths are caused by people in vehicles being swept away by moving water.

Rivers and streams may flood during periods of high runoff caused by either large or small storms, from melting snow and ice, or from ice jams. Flooding may follow heavy rains when the ground is frozen, snow covered, or saturated from previous rains. Flooding may be local or widespread.

Flash floods develop over a short period of time and occur with little warning, often in dry river or stream beds. Flash floods are local in extent and are usually due to heavy rainfall from thunderstorms; they can also occur when a manmade dam or an ice or debris jam bursts.

A glacial outburst flood ("jökulhlaup") is the sudden release of water from a lake contained by a glacier, a subglacial lake, or the failure of a terminal moraine. This is a potential risk if setting up a camp downstream from glaciers. The event can vary from flooding to a debris flow.

9.5.1 | Risks and Hazards

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

- Drowning caused by high water, being swept away by moving water
- Impact injuries caused by collapsing structures, moving objects in waters
- Stranding (and a potential survival situation) caused by impassable flooding steams, road bed erosion or if a vehicle is swept away
- Urgent survival or life-threatening situations caused by flash floods
- Electrocution caused by contact with wet electrical equipment or downed wires
- Wild animal risks: snake or insect bites (especially from snakes and fire ants) that result after they are displaced from their normal habitat by high water
- Waterborne diseases caused by bacteria, viruses or parasites in flood waters
- Damage or loss of personal or project property and equipment may be caused by all types of floods.

9.5.2 | Prevention and Preparation

Preparations for projects located where flooding may occur:

- Take potential flooding into consideration when planning a camp location. Companies should consider the topography and be familiar with the local climate and weather patterns, especially during the wet season.
- Carry out a risk assessment of the area and develop site specific SOPs and an ERP to address potential flood risks and hazards. This is particularly important with regard to fuel storage areas where flooding might cause environmental contamination.
- Train all personnel to follow SOPs and the ERP procedures with respect to potential floods. Hold a practice drill if the ERP includes evacuation procedures.
- Traversing: When planning traverses, take into account the potential risks of rising streams, flooded roads and flash floods in the field area. While flash floods may be the greatest risk, you may encounter unexpected flooding on remote roads or streams with higher water levels than expected. General tips include:
    - Plan alternate routes and emergency procedures to follow in case flooding blocks your planned route.
    - Be aware of the potential for glacial-fed streams to become a torrent of meltwater in the course of a warm day. Do not be tempted to return to camp by crossing such a stream. Use another route or camp out for the night.
    - Do not walk through moving water. 15 centimetres of moving water can sweep you off your feet, especially on poor ground. If you have to walk in water, walk where the water is not moving and use a stick to check the firmness of the ground in front of you.
    - Avoid valley bottoms after a heavy rainfall.
    - Always carry survival equipment. Keep vital survival equipment on your person so it is not lost if you must abandon your vehicle or pack. Refer to Chapter 8. Survival.

Flash Floods

Flash floods may occur in many environments, sometimes where they are least expected, and by their nature they are almost impossible to predict. Small streams near the headwaters of river basins will fill quickly if there is a heavy rain (even in alpine areas). Small streams or dry stream beds in or near mountains, in deserts, or in the tropics can fill and flood even before a rainstorm stops. Desert dry washes near mountains are particularly susceptible to flash floods and may become raging torrents after a localized rainstorm occurs many kilometres upstream. Never camp in a dry stream bed because of this danger. Employees should be trained to be aware of the dangers of flash floods and recognize the signs of an impending flash flood.

The warning time is usually minimal when flash flooding occurs. Any of the following may be signs of an impending flash flood:

- Sudden increase in water level
- Water suddenly becomes muddier

- Debris appears in the stream
- Loud noises of rushing water from the upstream direction – this may occur in a dry wash or flowing stream, on flat or steep ground, or in a canyon.
- Thunderstorm or rainstorm nearby, especially if they are within the drainage system

Safe traversing tips with regard to flash flooding

- Listen to local radio stations that issue flash flood warnings and heed them.
- Be aware of your surroundings. If there are washes near mountains and you can see rain or storm clouds, leave the drainage areas immediately and stay out of them.
- If you encounter a flash flood while on foot, immediately move to higher ground and wait on safe ground for the flood to recede before continuing, which may take 24 hours.
- Flash floods sometimes come in quick succession. Once one has passed use extreme caution.
- Flash flooding occurs frequently – even daily – in some tropical areas (e.g., Papua New Guinea). Know the local weather patterns. Be cautious when using a dry stream bed for a temporary helicopter landing site. Always carry survival equipment.
- If flooding is in progress, stop and wait it out or find another route.

Vehicles and Flash Floods

- Never drive in a dry stream bed or dry wash unless there is an obvious escape route.
- Do not attempt to drive across flooded roads or washes without very careful assessment and a capable vehicle.
    - Do not overestimate the vehicle's ability to drive through flood waters: Water 15 cm deep is enough to reach the bottom of most passenger cars. Driving in water this deep is enough to cause a loss of control or stall the car. Water 30 cm deep will float most cars. Water that is .6 m deep has sufficient lateral force to float and sweep away most vehicles, including sport utility vehicles (SUVs) and pickups.
    - The water covering a flooded expanse of road may hide road bed damage such as a washout; if a wheel drops into one, the vehicle can easily tip over, fill with water and be washed away.
    - Before crossing remnant flood waters, check out the flooded road surface on foot. If the water is not moving, it may be advisable to walk through the flooded section, but only if you are holding a stout walking stick and probe ahead to search for washouts, ruts and holes. If crossing by foot, consider using an anchored rope for added safety.
    - Do not attempt to drive through partially flooded underpasses, including in urban areas. It is usually impossible to tell the depth of the water and they can fill very rapidly during a storm.
    - In urban areas where rescue is probable, occupants statistically have a better chance of survival by staying with the vehicle when it becomes stranded. They may climb on the roof to get away from the rising water if it is considered unsafe to leave the vehicle.

- Where help is unavailable, consider leaving the vehicle if it stalls in flood waters. Get out and go to safe ground if there is plenty of time and if you can do so safely. Undertow conditions create extremely lethal hazards for persons trying to traverse flash flood conditions. Do not waste time trying to restart the vehicle. Many people drown when their vehicle is swept away in waters as they attempt to restart it.

Figure 9.2: Use caution when crossing on foot or by vehicle when water is flowing across a road. © Bill Mitchell

9.6 | Mudflows and Landslides

Definitions

Debris flow – a type of landslide that develops when saturated slope material (rocks, soil, vegetation) slides into a stream channel and then follows the channel downslope. There is potential for destruction of roads and bridges crossing the stream channel and of settlements adjacent to the stream channel.

Glacial outburst flood "Jökulhlaup" – water released from a lake contained by a glacier, a subglacial lake, or the failure of a terminal moraine. The water may incorporate sediments and debris to form a debris flow or mudflow downstream.

Lahar – a mudflow and debris flow originating on the slopes of a volcano. Lahars may be very limited in extent or enormous and deposit material over many kilometres.

Landslide – ground movement of a mixture of soil, rocks, vegetation etc., with some water content. Gravity is the driving force. The trigger for the movement includes but is not limited to slope instability, heavy precipitation causing ground saturation and earthquakes.
Mudflow – rapid ground movement due to higher fluid content than a landslide

9.6.1 | Risks and Hazards

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

- Drowning or suffocation caused by burial in flowing debris, not recognizing or not reacting soon enough to signs of impending mass movement
- Impact injuries caused by being hit by debris
- Stranding (a potential survival situation) due to impassable roads or routes, burial of a camp, lack of or loss of equipment
- Damage or loss of personal or project property and equipment caused by all types of slides

9.6.2 | Prevention and Preparation

Mudflows and debris flows are a hazard in many regions. Heavy rainfall may cause loose unconsolidated sediments on steep slopes to erode rapidly. Volcanic eruptions may melt ice and snow, which provides water that mixes with the erupted volcanic debris. Such an event in 1985 caused enormous mudflows in Columbia that killed 23,000 people. Deforestation and poor road building techniques on steep slopes combined with high rainfall can contribute to landslides and mudflows; they may also be triggered by an earthquake.

Preparations for projects located where landslides, debris flows or mudflows may occur:

- Carry out a risk assessment before locating a project work site or camp in slide prone country. Develop site specific SOPs and an ERP that take into account the potential risks of mass movement. Train personnel in the procedures and hold a drill if the ERP includes plans for emergency evacuation.
- Plan project site locations with extra caution where earthquakes are common. Take into account where slides or floods might be triggered by observing the patterns of storm water drainage on slopes and note where runoff water channels converge. Check slopes for signs of mass movement including tilting trees.
- Reduce the impact of exploration on the environment, especially with regard to drill pad and drill access trail construction, trenching and road building activities. Refer to Chapter 5.0 Land Disturbance in the Environmental Stewardship Toolkit.

In areas where there is a risk of mudslides:

- On extended traverses, do not camp in dry stream beds. Be aware of changing water levels at all times. Ridge tops are probably the safest place for camp sites unless lightning storms are likely to occur.
- If you hear loud noises originating in the upstream direction or see signs of a debris flow or mudflow in a stream or river channel, head away from the channel to the highest possible ground at the greatest possible speed.
- Rivers with steep banks may be subject to frequent landslides as currents undercut them. When navigating along rivers, be prepared for potential channel changes that may not be marked on maps. It may be difficult to find your location without a GPS unit.
- When projects are located near active volcanoes, any increased volcanic activity should be cause for evacuation.
- Do not examine old mine works or artisanal mine workings during times of heavy precipitation, as flooding and mudslides are increased potential risks.

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 Chapter 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.

Table 9.1: Beaufort wind scale

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.
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.

FORCE	WIND	SPEED	DESCRIPTIVE TERM	EFFECTS OBSERVED AT SEA	Effects Observed on Land
	km/h	Knots			
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 shock-like. Visibility affected.	Trees uprooted. Considerable structural damage occurs.
11		56 - 63	Violent Storm	Exceptionally high waves. Sea completely covered with long white patches of foam. Visibility affected.	Widespread damage.
12		64 - 71	Hurricane	Air filled with foam and spray. Sea entirely white with foam. Visibility seriously impaired.	Rare.

Source: Beaufort Wind Scale Table, Marine Weather Services, 2007. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2009

9.7.1 | Tornadoes

Definitions

Tornado Watch – when local conditions are favourable for the development of severe thunderstorms that can produce tornadoes
Tornado Warning – when a tornado has been spotted or is indicated by radar

Risks and Hazards

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

- Impact injuries or death caused by flying debris, large hail
- Survival situation caused by the destruction of camp or living quarters, loss of equipment and supplies
- Stranding caused by impassable roads or routes
- Damage or loss of personal or company property and equipment caused by winds, large hail

Although tornadoes may appear to be a remote risk, Canada ranks third in the world for number of recorded events with about 13 per year.

Table 9.2: Tornado risk by country

NATION	PERIOD	TOTAL TORNADOES
United States	1920-1998	44,417
United Kingdom	1950-1997	942
Canada	1950-1998	625
Argentina	1930-1979	368
France	1680-1998	294
Australia	variable	239
South Africa	1905-1996, 1998-9	195
Italy	1991-1999	158
Germany	1594-1999	136

Note that the source for the above table, reproduced in 2009, has not been archived. For current data on major tornadoes, refer to Open Government Canada.

Deaths attributed to tornadoes are another way to look at the disaster potential of tornadoes, though such numbers must be looked at with population densities, building materials, and storm-warning programs in mind.

Prevention and Preparation

Exploration company employees should know whether they are working in an area where tornadoes can be expected. Carry out a risk assessment and access local knowledge for sound advice regarding appropriate shelter, safety precautions and procedures. Exploration companies should provide employees with a reinforced concrete structure for living quarters.

When setting up a camp where tornadoes are a high risk, find the safest location for shelter in the immediate area. If threatened by a tornado, the safest place will not be in a tent or a temporary camp structure that winds can destroy. The lowest area – a ditch or creek bed, or deep in a stand of small trees is safer than sheltering in tents or vehicles. Know how to access this spot when it is dark, as the sky will be very dark and tornadoes sometimes happen at night. If such a shelter is necessary, it may be advisable to keep a small emergency kit at this location (securely anchored) that includes flashlights and spare batteries, a radio capable of receiving weather reports, a first aid kit and essential survival equipment.

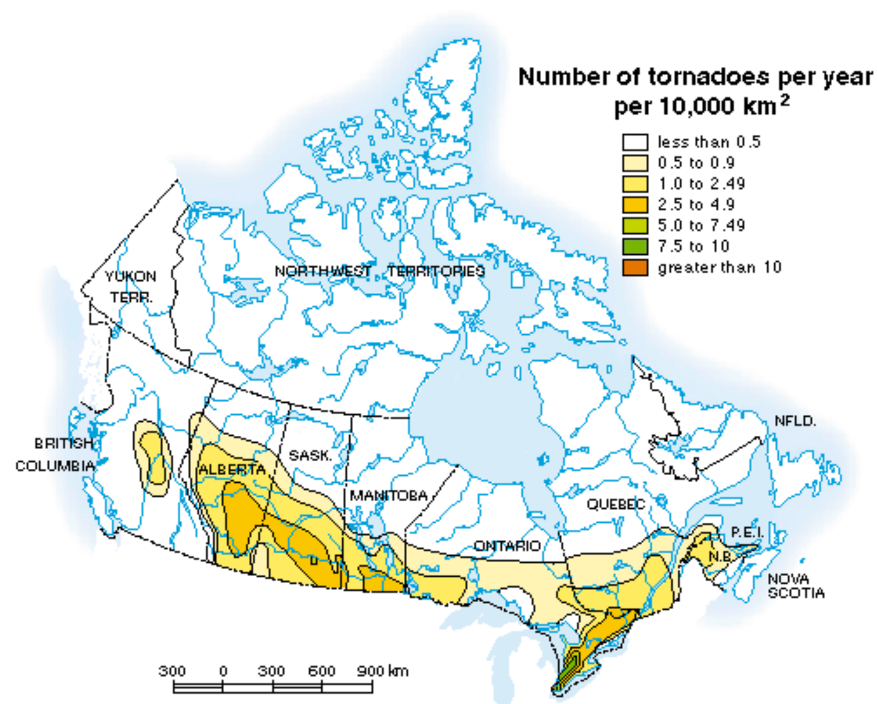


Figure 9.3: Map of the annual number of tornados

Note that the original image, produced in 1999 and reproduced in 2009, has not been archived. For similar, current data on major tornadoes, refer to Open Government Canada.

Tornado Danger Signs

Strong winds associated with severe thunderstorms occasionally develop into tornadoes. Winds in funnel-shaped clouds can reach 500 km/h (300 mph) and can do severe damage – much of it wrought by flying debris. Be alert to the possibility of tornadoes whenever there are severe thunderstorms in the area. Listen to a radio for severe weather watches and warnings and avoid unnecessary travel. Tornados can develop rapidly at any time of the day or night and there are occasions when there is no advance warning. If you see or suspect an approaching tornado, seek shelter immediately to protect yourself from flying debris.

Be familiar with features of thunderstorms and signs that indicate a potential tornado:

- Dark, yellow or greenish coloured sky
- Hail (sometimes large) often precedes tornadoes. Hail can cause injuries to people and serious damage to equipment.
- Funnel cloud: An approaching cloud of debris can mark the location of a tornado even when a funnel cloud is not visible.
- Wall clouds indicate of strong rotational updrafts, a primary indicator of potential tornado formation. Wall clouds appear as a solid dark cloud attached to the bottom of the main cumulonimbus cloud base. A rotating wall cloud is a danger sign, as tornadoes may develop within it and then descend to the ground.
- Tornadoes generally occur near the trailing edge of a thunderstorm. It is not uncommon to see clear sunlit skies behind a tornado.
- Sometimes the weather may be fine. Suddenly the wind will die down and the air will become very calm – just before severe weather and a tornado develops.
- Tornadoes usually make a continuous sound like a loud roaring plane or train as they approach. However, sometimes the noise is not audible until the tornado is very close.

If inside shelter is available:

- Shelter in a reinforced concrete building, if possible. This type of shelter is advisable for projects in high risk locations. A storm cellar or confined space within a basement is best. If this is unavailable, go to the lowest floor and the interior of the building. Cover yourself with a mattress, blankets or sturdy furniture for protection from flying debris. Stay away from all windows, doors and exterior walls.
- Do not seek shelter in vehicles, mobile homes/caravans or large buildings with wide-span roofs, as these are particularly vulnerable to damage from tornadoes (e.g., big box stores, auditoriums, gymnasiums).

If you are outdoors:

If you are in a tent camp or on foot when a tornado advances in your direction:

- On foot: Seek a low place. Seek shelter in a ravine, gully, a ditch, a cave or a culvert – but be aware of the potential for flooding. If only a field is available, seek the lowest area possible as it offers more protection from flying debris. If possible, hang on to something such as roots or a rock while covering your head for protection.
- Abandon your vehicle. Do not take shelter downwind from a vehicle and do not shelter under a tree or in a highway overpass. The overpass may act as a wind tunnel as the tornado passes.
- Lie flat, protect your head and body (blankets, helmet) and wear goggles if available.
- It is not advisable to try to outdrive a tornado in a vehicle. Tornadoes can change direction quickly and can lift a car or truck and toss it through the air. If stuck in a vehicle, stay down as low as possible below window level.
- Get off the water as fast as possible if a tornado approaches while you are in a boat. Go to shore and move inland at least 100 m. Waterspouts (tornadoes moving over water) can easily flip a boat and drown the occupants.

Additional information regarding tornadoes is available in Appendix I.IX

9.7.2 | Hurricanes, Cyclones and Typhoons

Definitions

Tropical cyclone – is the common term for a severe rotating tropical storm in either hemisphere, although there are a variety of local names (typhoon, hurricane). Tropical cyclones have very high winds that range from 110 to 300 km/h. Tornadoes may accompany them. Because these storms cover a large area, government agencies usually issue warnings.
Hurricane Watch – issued for a specific area when hurricane conditions are possible within the next 36 hours
Hurricane Warning – issued for a specific area when hurricane conditions are expected within 24 hours or less

Risks and Hazards

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

- Injuries or drowning caused by high water from a storm surge or inland flooding
- Injuries or death caused by the impact of debris, falling trees and structural collapse due to winds and/or high water

- Damage and loss of personal or project property and equipment caused by winds, inland flooding or storm surge
- Stranding (and potential survival situation) caused by a storm surge, loss of equipment, impassable roads, or if a vehicle is swept away
- Electrocution caused by contact with wet electrical equipment or downed wires
- Wildlife risks: animals, snake or insect bites (especially from snakes and fire ants) that result after they are displaced from their normal habitat by high water
- Water-borne diseases caused by bacteria, viruses or parasites in flood waters

Prevention and Preparation

- Know when tropical cyclones can be expected and listen for warnings on local radio stations. Project personnel should be able to move to safety with sufficient warning. Do not ignore official warnings. Stay informed regarding up-to-date road conditions and move to a safe area before access is cut off by flood waters.
- Always evacuate to a safe shelter when the project structures are mobile homes (caravans), tent structures, lightly built structures or when the project is located near the coast, a river or flood plain where flooding may occur.
- Inland flooding usually causes more deaths than coastal flooding from storm surges. In an inland area, preparation is necessary and evacuation may be advisable depending on the project location and the path of the storm.

If a tropical cyclone is expected and evacuation is not possible:

- Seek protection in the most solid building available on high ground. Board or tape up windows.
- Assemble lots of drinking water and store it in tightly capped containers to prevent contamination. Assemble emergency food rations, a first aid kit, radio and extra batteries for radio contact. Be prepared to survive several days without outside help.
- During the storm, remain inside in the strongest part of the building. Do not go outdoors until you hear official word that the storm has passed. The eye of the storm may give an illusion of safety. Listen for official information frequently.
- After the storm, wear heavy boots to protect your feet from glass and debris during cleanup procedures. Be aware of additional risks and hazards during cleanup work.
    - Slips, trips and falls
    - Downed electrical wires
    - Contaminated water (don't use it for cleanup or drinking)
    - Cuts and injuries caused by chainsaw accidents
    - Wildlife: snakes, scorpions, spiders, fire ants etc., seek high ground too.

Additional information: Hurricane information and forecasts for the eastern Pacific and Atlantic oceans are available from the National Hurricane Center.

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.

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.

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

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.

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.

9.9.3.1 | 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 Chapter 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.

9.9.3.2 | 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°-32°C)

- 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°-28°C)

- 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 (<28°C)

- 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.

9.9.3.3 | 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.

1. Prevent the patient from losing more body heat. Insulate the patient from the ground.
2. 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.
3. 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.
4. 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.
5. 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”.

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.

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

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 Chapter 9.9.7 Wind Chill Calculation Charts below and refer to Chapter 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.
- 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.

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.

Table 9.3: Wind chill calculation chart

Where T_{air} + Air temperature in °C and V_{10} = Observed wind speed at 10 m elevation, in km/h.

T_{air} / V_{10}	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53	-58
10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51	-57	-63
15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54	-60	-66
20	1	-5	-12	-18	-24	-30	-37	-43	-49	-56	-62	-68
25	1	-6	-12	-19	-25	-32	-38	-44	-51	-57	-64	-70
30	0	-6	-13	-20	-26	-33	-39	-46	-52	-59	-65	-72
35	0	-7	-14	-20	-27	-33	-40	-47	-53	-60	-66	-73
40	-1	-7	-14	-21	-27	-34	-41	-48	-54	-61	-68	-74
45	-1	-8	-15	-21	-28	-35	-42	-48	-55	-62	-69	-75
50	-1	-8	-15	-22	-29	-35	-42	-49	-56	-63	-69	-76
55	-2	-8	-15	-22	-29	-36	-43	-50	-57	-63	-70	-77
60	-2	-9	-16	-23	-30	-36	-43	-50	-57	-64	-71	-78
65	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79
70	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-80
75	-3	-10	-17	-24	-31	-38	-45	-52	-59	-66	-73	-80
80	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81

FROSTBITE GUIDE

Low risk of frostbite for most people

Increasing risk of frostbite for most people in 10 to 30 minutes of exposure

High risk for most people in 5 to 10 minutes of exposure

High risk for most people in 2 to 5 minutes of exposure

High risk for most people in 2 minutes of exposure or less

 A version of this guide current to 2023 can be accessed virtually.

9.10 | Heat Illnesses and Solar Injuries

Your body can develop heat illness (or heat stress) when you lose excessive amounts of water and electrolytes through sweat and/or your core body temperature rises too high. Although the combination of high temperature, high humidity, strenuous activities, dehydration (lack of fluid replacement), and lack of acclimatization all contribute to the development of heat illnesses, the most important contributing factor is dehydration. Temperatures need not be especially hot. Heat illnesses can develop if the air temperature exceeds 23°C and the humidity exceeds 50%. The higher the temperature and humidity, the more likely a heat illness will develop. If there is not enough water available within your body to produce the necessary amount of sweat to cool you, your core temperature will rise. Because evaporation of sweat is the main mechanism for cooling the human body, you must be continuously able to produce sweat in quantities that will cool you. Furthermore, sweat that pools and runs off your body does little to cool you. Sweat must evaporate from your skin for maximum cooling effect.

Field employees and their supervisors should recognize the need for acclimatization and fluid replacement to prevent heat illness, especially when employees are engaged in strenuous work. Pregnant women should be especially careful to avoid heat illness, as it may damage the fetus.

9.10.1 | Risks and Hazards

Some of the risks and hazards related to heat illnesses include:

- Death, permanent brain injury and damage to internal organs may be caused by severe heat illness (heat stroke).
- Heat illnesses may be caused by:
  - Dehydration
  - Lack of acclimatization to hot working conditions
  - Failure of co-workers to recognize the signs of heat illness in each other
  - A work schedule that lacks sufficient work breaks to cool off
  - Medications that contribute to the development of heat stress

9.10.2 | Project Planning to Prevent Heat Illnesses

Project planning should include the following measures.

- Complete risk assessments that include the potential impacts of heat related hazards on employees, including site locations and traversing routes etc. Develop strategies to mitigate the risks.
- The project supervisor should develop site specific SOPs and ERPs that address potential heat related risks and hazards.

- Training should cover the SOPs, ERPs and specific ways to recognize and handle potential emergencies caused by heat illnesses. First aid attendants should be trained to recognize and address heat exhaustion and heat stroke. Hold a practice drill if an ERP includes evacuation procedures.
- Plan work schedules to include acclimatization requirements and cooling rest breaks.
- Extensive information regarding working in hot conditions is available from WorkSafe BC.

9.10.3 | Hyperthermia

Heat illnesses are gradational in severity. There are four main forms of hyperthermia: (1) heat cramps, (2) heat syncope, (3) heat exhaustion and (4) heat stroke. Each heat illness disorder is caused to some degree by dehydration and the body's inability to get rid of excess heat. While heat illness most commonly occurs in warm climates, it may also occur where you might not expect it (i.e., the Arctic). A hot windy day or a breeze may make you feel cool, but if you don't maintain fluid levels you may become severely dehydrated. Almost all cases of hyperthermia can be prevented by drinking sufficient water to avoid dehydration.

9.10.3.1 | Prevention and Preparation

The key to preventing heat illness is preparation and recognizing the circumstances that produce heat stress.

1. Prevent dehydration. Drink plenty of water. Hydration is essential to maintain the correct body temperature and volume of blood flow to produce sweat. When performing moderately strenuous work in a hot environment, you need to drink at least 5 litres of water throughout the day. Distribute your water intake throughout the day rather than drink large quantities rapidly once or twice in the day.
   - Do not rely on thirst to indicate how much to drink. Drink plenty of water before beginning work plus about 250 ml every 20 minutes while you work. Water is best; carbonated drinks are less effective.
   - Carry enough fluids when traversing in hot conditions. A can of juice is simply not enough. Carry water purification tablets in your survival kit but do not count on finding enough water to replenish your supply.
   - Judge your own state of hydration by the frequency and volume of urine you pass; urine should be clear and copious. If the amount of urine declines and becomes dark yellow, you need to drink more water.
   - "Sports drinks" are acceptable, but it is not advisable to replace fluids exclusively with sports drinks. If you feel your electrolyte balance is affected by sweating, it is usually better to eat a salty snack and drink water rather than a sports drink. A sports drink may be useful when it is combined with drinking water, but water is usually a better choice.

- Do not drink a high caffeine "energy drink" for rehydration purposes. It is never advisable to administer drinks containing caffeine to anyone suffering from dehydration, hyperthermia or hypothermia. Caffeine increases urine output and therefore contributes to dehydration.

2. Wear appropriate clothing. Wear a broad brimmed hat in the sun. Wear light coloured, loose fitting clothing that does not leave much skin exposed. Cotton is an excellent choice of fabric but it should be fairly tightly woven for UV protection.
3. Acclimatization: It is important to become acclimatized whether you are new to a hot climate or are returning from a break, sickness or annual leave. New employees should become acclimatized before being assigned a full work load. When exposed to hot environments, your body undergoes profound changes to improve its ability to cope with heat. Changes include the following:
    - Your sweat rate increases over a period of several days. It is possible to lose 1.5 litres of sweat per hour when working strenuously under hot conditions; you need to consume a lot of water to replace such losses. You begin sweating earlier and at a lower skin temperature as your body responds more efficiently to heat.
    - The electrolyte concentration in your sweat decreases, which allows your body to retain most of the electrolytes it needs. See Nutrition in #4 below.
    - Your behaviour changes. You quickly learn to use any available shade, to rest frequently if necessary, and to replace water lost through sweat by drinking more of it.
    - Full acclimatization can take five to seven days. Exposure to hot environments should be gradually increased over the first four or five days.
4. Additional preparation and prevention:
    - On the job: Perform the heaviest work during the coolest part of the day and take frequent short breaks in cool shaded areas to allow the body to cool down. Pace yourself.
    - Nutrition: Avoid eating large meals before work. Several small meals or snacks require less energy from your body for digestion than one large meal. Eat well balanced meals. Salt: Increase your salt intake slightly. If you salt your food liberally it should be sufficient to maintain your electrolyte balance. Field work is not the time to eat salt reduced snacks. You need more salt than normal because your sweat contains salt and the more you sweat the more salt you lose. However, salt tablets are not advisable because salt does not enter the body at the same rate as fluids and too much salt at one time can increase body temperature and thirst, which can make you feel ill.
    - Verify with a doctor or pharmacist whether any medication you take may have adverse side effects when working in hot environments.

9.10.3.2 | Less Serious Forms of Hyperthermia

Prickly heat rash is an annoying but not a disabling form of heat stress. Heat cramps and heat exhaustion result from increased levels of dehydration and salt depletion as the body sweats to lower its internal temperature.

Prickly Heat and/or Heat Rash

Prickly heat (or heat rash) is a common skin condition in the tropics, as it is aggravated by high humidity. Tiny droplets of sweat become trapped under the outer layer of skin, which appear as an irritating, blister-like red rash. Frequent showering helps prevent it. Sometimes a drying lotion and mild talcum powder helps, but ointments and creams will clog up the sweat glands even more.

Heat Cramps

These painful spasms usually occur in the arm and leg muscles. They can be disabling, but they are preventable if you avoid dehydration. Regular cramps respond to rest and massage. Treat heat cramps by rehydration and replacing lost electrolytes. Pain may be relieved by gently stretching the muscle and applying ice.

Heat Syncope

Heat syncope is a fainting episode that occurs immediately after ceasing an activity. During exercise, the muscles perform a pumping action that ensures the return of blood to the heart. When exercise ceases, this pumping action stops and blood tends to pool in the lower limbs. This causes weakness or dizziness, which may be followed by a fainting episode. Heat syncope may precede symptoms of heat exhaustion. A person with heat syncope should lie down in a cooler area, elevate their legs and pelvis and drink fluids when conscious enough to safely do so. They should not carry out heavy activity for the rest of the day.

9.10.3.3 | Heat Exhaustion and Heat Stroke

The difference between heat exhaustion and heat stroke is one of degree. If untreated, heat exhaustion can rapidly develop into heat stroke. Heat stroke is a medical emergency requiring immediate medical attention.

Heat Exhaustion

Heat exhaustion occurs when the body cannot get rid of the heat it generates through metabolism and exercise. If fluids and electrolytes lost through sweating are not replaced, heat exhaustion may develop, which is more serious than heat cramps and heat syncope. Although a person suffering from heat exhaustion can continue to produce sweat, the production is not great enough to satisfactorily cool the body. Their core body temperature may be normal, but it usually ranges from 38.8° to 40°C. Anyone with heat exhaustion must be closely monitored, as their condition can rapidly escalate into heat stroke, which can be fatal.

Symptoms of Heat Exhaustion

- Pale, cool, clammy skin
- Normal mental state
- Weakness or fatigue
- Dizziness and/or fainting
- Headache, nausea and/or vomiting
- Muscle cramps
- Decreased or dark coloured urine

Treatment for Heat Exhaustion

Treatment for heat exhaustion is the same as for heat syncope, although transportation to a medical centre may be necessary if core body temperature remains high. See the heat syncope section above for treatment details.

- Although a victim of heat exhaustion may feel better almost immediately and wish to return to work, this should not be permitted until the next day. Fluids and electrolytes must be replaced and it takes about 24 hours for adequate rehydration.
- Seek medical attention if the person does not feel better after a short while, as heat exhaustion can develop quickly into heat stroke.
- If someone has been sweating excessively or has been vomiting, they may need to drink oral rehydration salts or other electrolyte replacement solutions. These come pre packaged for adding to water or they can be made from commonly available ingredients. If the only liquids available are water and a sports drink, dilute the sports drink in half with water to achieve a better electrolyte balanced than with the drink alone, which has a high sugar content. Drinks containing caffeine, especially energy drinks, should not be administered.
- Refer to Chapter 12.8.3.5 Fluid Replacement Therapy for detailed information about how to make fluid replacement therapy solutions.

Heat Stroke

Heat stroke is a life-threatening condition demanding immediate medical attention. With a rapidly rising core temperature approaching 41°C, the victim can no longer produce sweat. Skin usually becomes hot and dry (classic heat stroke), but for heat stroke caused by exertion, the skin may remain relatively cool and clammy. If the core body temperature continues to rise, the patient will die. Exertional heat stroke more commonly affects field employees and is linked with strenuous work, whereas classic heat stroke usually develops in inactive people. Heat stroke can cause permanent brain damage and injury to internal organs. Provide interim treatment immediately and transport a heat stroke victim to a medical treatment facility as soon as possible, as complications frequently develop. Monitor the patient constantly and be prepared to administer CPR.

Symptoms of Heat Stroke

- Pale, cool, damp skin or hot, dry, red skin: Either condition may be present in exertional heat stroke; only the latter is present in classic heat stroke.
- Irrational, hostile behaviour, confusion: A person with heat stroke exhibits mental changes even if they are still able to produce sweat.
- Headache, dizziness
- Nausea, vomiting
- Rapid, shallow breathing
- Irregular pulse
- Possible seizures and unconsciousness
- Collapse and coma

9.10.3.4 | Interim Treatment – Prior to Evacuation to a Medical Centre

1. Move the victim out of the sun into the coolest possible location.
2. Remove any heavy clothing, loosen tight clothing and elevate the feet.
3. Cool the victim as quickly as possible, paying particular attention to the head, armpits back of the neck and groin. Drape the victim with lukewarm wet sheets or towels to conduct heat away from the body. Use water with a temperature that is warm to the touch, but cooler than skin temperature. This temperature produces the best cooling effect by evaporation and conduction. Ice packs and water that is too cold will effectively shut down the blood supply to the skin (vasoconstriction), which can induce shivering as the body works to warm up that local area.
4. Fan the body using electric or handheld fans. Try to place the victim on a screen or hammock so they can be cooled both from above and below. The aim is to maximize evaporation from the body to cool the core body temperature – without chilling the victim. Should the patient becomes chilled, vasoconstriction will occur and less blood will circulate, which is counterproductive – increased blood circulation is the objective. Massage the victim's arms and legs to increase the circulation of cooler blood to the core organs of the body.

5. Have a conscious victim drink cool water, about 1 cup 250 ml every 15 minutes, unless nauseous or vomiting. You can add a little salt to the water but do not give full strength fruit juice, soft drinks, drinks with caffeine, or alcoholic beverages.

TRANSPORT A HEAT STROKE VICTIM TO A MEDICAL CENTRE AS SOON AS POSSIBLE.

An efficient way to cool a victim: If transporting by vehicle, douse the victim with lukewarm water or cover with wet clothing. Place the victim in a vehicle and open all the windows so that he or she is exposed to moving air. Use air conditioning, if equipped, in addition to the open windows as long as the victim does not become chilled and shiver. Drive to a medical treatment facility as soon as possible.

9.10.4 | Sunburn

The sun produces ultraviolet (UV) radiation that can cause serious burns to the skin and eyes. As both direct and reflected radiation cause burning, the best way to avoid sunburn is to avoid as much sun exposure as possible. Various products are available that contain agents to block out UV radiation.

Risks of Sun Exposure (Ultra Violet Light)

- Sunburn, skin cancers, cataracts, and corneal ulcers are all caused by exposure to excess sunlight or artificial UV radiation.

Preparation and Prevention

Factors influencing UV radiation exposure:

- Altitude: Each elevation gain of 300 m increases UV radiation exposure by 4%. Living or working at high altitude results in high UV exposure all year around.
- Latitude: The closer one works to the equator, the more intense the UV radiation.
- Time of day: UV radiation causes most damage between 10 A.M. and 3 P.M. when the sun is highest in the sky.
- Season of the year: Except near the equator, UV radiation is more intense during summer months when the sun is closer to the earth.
- Wind masks the effect of UV radiation and you may not realize that sunburn is developing.
- Filters: Sunglasses fitted with polarizing lenses will cut down glare; other lenses will also cut out UV radiation. Select sunglasses from a reputable source suitable for the working conditions. For example, when working on glaciers or snowfields, you may require different eye protection than when working on water.

- Ozone depletion of the upper atmosphere: Some areas on the earth are now less protected from UV radiation due to ozone depletion (Arctic, Antarctic, southern South America and parts of Australia).
- Environment: Depending upon your surroundings, varying amounts of UV radiation are reflected. Light coloured surfaces reflect a greater percentage of UV than darker surfaces. Some examples:
    - Vegetation reflects only 2.5%
    - Sand reflects 20%
    - Glaciers and snowfields reflect 85%
    - Water can reflect almost 100% if the sun is overhead.

Take the following precautions:

- Clothing: Wear a broad brimmed hat, long sleeved shirt, long trousers, sunglasses and sunscreen when appropriate. Shorts expose your legs to sunburn.
- Sunglasses: Wear lenses that block UV radiation.
- Sunscreen agents protect skin from ultraviolet light. There are two damaging components to ultraviolet light – ultraviolet A (UVA) and ultraviolet B (UVB). The UVA component penetrates skin more deeply and damages collagen that keeps skin firm; it also suppresses your immune system thus contributing to cancer development. The UVB component is responsible for producing most sunburns and is thought to be the primary cause of skin cancer, as it damages DNA. Look for a broad spectrum sunscreen that protects against both UVA and UVB. The sun protection factor number (SPF) measures a sunscreen's effectiveness. The higher the number, the longer the protection from burning (i.e., if the SPF is 10, the protection is 10 times longer than when using no sunscreen). This effectiveness is reduced if you are sweating or swimming. There are two types of sunscreen agents. Physical agents block or scatter UV radiation by reflection; they are usually thick creams such as zinc oxide. Chemical sunscreen agents block UV radiation by absorption. For continuous protection, you must apply sunscreen frequently to exposed skin, especially if sweating or swimming.
- Wear a broad spectrum, water-resistant, sweat-proof sunscreen with a SPF of at least 15 (use a SPF of at least 30 on your face). You need this amount of protection no matter what your race. For full effect, apply sunscreen carefully and thoroughly on exposed skin, especially to the face and the back of your hands, at least 15 minutes before going out.
- Certain medications may increase one's sensitivity to UV radiation. These include Tetracyclines – especially Doxycycline and sulphonamides including "Bactrim". Check with a doctor or pharmacist regarding potential sensitivities due to medications you take.
- When using insect repellent, apply the sunscreen first and then apply the insect repellent.

Additional information is available from the Canadian Centre for Occupational Health and Safety.

Treatment

- Loosely cover the sunburned area to prevent further sun exposure.
- Cold compresses help relieve pain; creams or lotions (calamine) may help including Aloe Vera gel, but do not apply them to blisters. Do not break blisters.

9.10.5 | Snow Blindness

Small blisters can develop on the corneas when the eyes are exposed to too much sunlight (UV radiation). Although the condition develops most frequently when working on ice or snowfields, it may also happen when working on water, at high altitude, high latitude during summer months, or using short wave ultraviolet (UV) lamps for more than half an hour at a time. The higher the altitude – the greater the risk. In high latitudes, UV protection increases in importance during late winter, spring and summer as the sun rises higher in the sky.

Risks and Hazards

Some of the risks and hazards include:

- Intense pain in the eyes is caused by burns to the corneas
- Permanent eye damage (ulcerated cornea) is caused by exposure to too much UV radiation

Preparations and Prevention

Cut down on direct and reflecting sunlight.

- Always wear large and curved sunglasses with dark lenses that are guaranteed to filter out UV radiation. Choose high quality protecting sunglasses as many brands make unwarranted claims. Carry an extra pair of glasses in case of loss or breakage. Camps should have dark tinted safety glasses available.
- In high risk areas such as snowfields, use sunglasses with side shields for more protection. Goggles may provide the best protection.
- Wear a hat with a wide brim.
- Wear protective glasses (appropriate PPE) whenever you work with short wave UV lamps and use the lamps for short periods only.
- Emergency glasses can be made by using cardboard and cutting slits to see through.

Symptoms

- Symptoms develop 8 to 12 hours after exposure and last 24 to 48 hours.
- The eyelids swell and there is intense pain, as though hot sand were in the eyes.
- Excessive tearing occurs and the eyes are very sensitive to light.

Treatment

Seek medical attention. To reduce inflammation:

- Bandage the eyes with thick sterile pads; the victim should rest in the dark.
- Apply cold compresses (not ice); ice should not be used as ice can also cause vasoconstriction of the eyeball and result in further eye injury.
- Give oral pain medicine such as aspirin or Tylenol.
- Do not rub the eyes and do not apply topical eye ointments or eye drops unless prescribed by a physician.
- If the eyes are still sensitive to light after 12 hours, re-bandage for another 12 hours. Vision is normally restored after 18 hours.

9.11 | Altitude Illness

The earth's atmosphere contains about 21% oxygen at all elevations. Because air pressure diminishes with increasing altitude, there are fewer oxygen molecules to breathe at higher elevations. If you rapidly ascend to elevations above 2,500 m, your body may have trouble adjusting to the reduced available oxygen ("thin air"). Anyone can be affected; it is not a question of fitness, age or gender, as altitude illness may suddenly develop even after previous trips when no effects were experienced. All people should check with a medical advisor before working at high altitude (and especially those with asthma or sickle cell disease and pregnant women).

Altitude illness is preventable. Acclimatization – ascending to high altitude in gradual stages – allows your body to adjust to the reduced available oxygen (see #2 in Chapter 9.11.6 below). The time required to acclimatize varies with the individual and the actual altitude attained.

Definitions

High Altitude – 1,500-3,500 m
Very High Altitude – 3,500-5,500 m
Extreme Altitude – above 5,500 m
Acclimatization – the process of the body adapting to the reduced available oxygen at high altitude

Acute Mountain Sickness (AMS) – a disorder that presents a group of symptoms in a person at high altitude before acclimatization takes place. There is no precise altitude at which the symptoms develop; it depends on the individual.
High Altitude Pulmonary Edema (HAPE) – a severe form of AMS that develops when body fluids derived from blood fill the alveoli in the lungs and replace air. Potentially, a person can drown in their own fluids.
High Altitude Cerebral Edema (HACE) – a severe form of AMS that develops when brain tissue swells from the accumulation of fluid derived from blood.
High Altitude Retinal Hemorrhage (HARH) – a form of AMS when bleeding from the retina occurs in the eyes.

The following medical terms are used to describe symptoms of AMS, HACE and HAPE. They are included to help interpret the Lake Louise Consensus on the Definition of Altitude of Altitude Illness in Chapter 9.11.2.2 Recognition and Classification of Acute Mountain Sickness (AMS).

- Ataxia – the loss of muscle coordination, clumsiness (e.g., fingers fumble with objects, a person stumbles or fall and cannot walk a straight line)
- Cyanosis – bluish or greyish discolouration of skin, lips and fingernail beds due to insufficient oxygen in the blood
- Dyspnea – difficult or laboured breathing when a person is at rest
- Edema – tissue swelling caused by fluid accumulation in extremities (hands, feet) or in the brain
- Hypoxia – deficiency of oxygen in the blood, which affects organs and the brain (i.e., the ability to think clearly)
- Tachycardia – abnormally rapid heartbeat
- Tachypnea – abnormally rapid respiratory rate (continuous)

9.11.1 | Risks and Hazards

Some of the risks and hazards related to altitude illness include:

- Death caused by HAPE or HACE
- Seizures and/or permanent brain damage caused by HACE
- Developing acute mountain sickness (AMS) caused by:
  - Lack of acclimatization as altitude is gained
  - Dehydration caused by inadequate fluid intake combined with the body's increased requirement for fluids
  - Performing hard work without sufficient hydration and/or acclimatization

- Risk of increased severity of AMS may be caused by:
  - Continuing to gain altitude when symptoms of AMS are present
  - Lack of training to recognize the signs and symptoms
  - Denial that symptoms are present
  - Lack of oxygen therapy equipment at a high altitude camp
- Misdiagnosis of AMS caused by the presence of hypothermia, dehydration, or carbon monoxide poisoning (from using a fuel-burning heat source in an enclosed space)
- Transportation risks due to remote locations and difficult access when evacuation is required
- Increased risk of developing AMS caused by some pre-existing medical conditions

9.11.2 | Acute Mountain Sickness (AMS)

Acute mountain sickness develops when the body does not acclimatize to the reduced supply of oxygen at high altitude. AMS is a progressive disorder and presents a group of gradational symptoms that may develop very rapidly or over several days. Mild AMS is uncomfortable and feels much like a hangover; moderate AMS requires careful monitoring and attention as it can quickly develop into severe AMS, which is often fatal. Acute mountain sickness is preventable by ascending to high altitude in gradual stages over several days, which allows your body to acclimatize to the reduced available oxygen in the atmosphere. The time required to acclimatize varies with each individual and the actual altitude attained.

Various risk factors contribute to AMS, which include but are not limited to:

- Lack of acclimatization – Acclimatization requires periods of rest along with progressive altitude gain. The faster the ascent to altitude, the higher the risk of developing AMS.
- Altitude – The higher the altitude, the higher the risk
- Activity level – Strenuous activity upon arrival at high altitude increases the risk.
- Predisposition – Those who have had AMS before are more likely to develop it again.
- Age – Young people are more susceptible to AMS than older people.

9.11.2.1 | Symptoms of AMS

Symptoms of acute mountain sickness may develop above 2,500 m, although occasionally some healthy people experience AMS above 1,800 m. If you feel ill when working at altitude, it is wise to assume you have AMS unless there is another obvious reason for the illness. If the symptoms are not alleviated through acclimatization, mild AMS can develop and progress to moderate and then to severe AMS, which may take the form of high altitude cerebral edema (HACE) or high altitude pulmonary edema (HAPE). One or both forms of severe AMS may develop at the same time.

Persistent symptoms should be monitored carefully and appropriate action taken – descent to a lower altitude. Do not ascend to a higher altitude again until all symptoms are gone. It is advisable to insist that a person receives medical attention when AMS is a possibility, as victims who do not wish to descend can easily disguise some symptoms. Use the Lake Louise Consensus on the Definition of Altitude of Altitude Illness in Chapter 9.11.2.2 to help determine the form(s) of altitude illness.

The symptoms of AMS are progressive – the more aggravated the symptoms, the more serious the illness. People usually, but not always, have several symptoms at the same time, and some of them are also symptoms of hypothermia and dehydration. Symptoms that indicate AMS include:

- A persistent headache develops that is not diminished by lying down; it is aggravated by exercise. A headache caused by AMS should respond to aspirin, Tylenol, or ibuprofen. As the headache may be due to dehydration, drink at least one litre of fluid and take the pain medicine.
- Insomnia: Difficulty sleeping is normal at high altitude until your body is acclimatized. Never take sleeping pills as they will decrease oxygen intake by limiting your deep breathing efforts to gain oxygen.
- Loss of appetite and mild nausea are common indicators. Nausea that progresses to vomiting is a serious sign.
- Shortness of breath: It can take a long time to recover after exertion. Dizziness is a common symptom. A person should be able to breathe at a normal rate after 15 minutes at rest.
- Fatigue or lassitude: Learn to distinguish between normal exhaustion and fatigue and lassitude. Normal exhaustion responds to a good night's sleep, while fatigue due to high altitude does not. Rest, food and increased fluid intake do not alleviate the symptoms of fatigue and lassitude. As AMS advances, fatigue may progress to lassitude so that a person does not get out of bed to eat, drink or urinate, which is a very serious sign.
- Increasing breathing difficulties are serious signs. The victim probably needs to descend to a lower altitude until the symptoms abate.
- A persistent dry cough develops that progresses to a watery cough and finally to a bloody cough; the chest may feel tight.
- A crackling sound (crackles or rales) in the lungs may be heard when you listen to the victim's chest. This symptom indicates HAPE. Rales sound like hair rubbed between your fingers when held next to your ear.
- Fluid retention, decreased urine output and dark yellow urine all indicate dehydration, which is a sign that your body is not acclimatizing well.
- A rapid pulse >110 beats per minute when at rest
- Cyanosis: A pale or bluish colour develops on the lips and fingertips from lack of oxygen in the blood.
- Loss of balance and muscle coordination: A person cannot walk a straight line for 5 m in a heel-to-toe manner without stumbling or falling. This is a sign of serious AMS as this indicates the brain is affected by swelling.

- Disorientation, poor judgment and poor coordination indicate severe AMS. Mental confusion and hallucinations indicate HACE.
- Confusion, delirium and coma are followed within a few hours by death.

9.11.2.2 | Recognition and Classification of Acute Mountain Sickness (AMS)

Because the range of symptoms for AMS may vary from mild to severe, it can be very difficult to correctly classify the condition. Criteria to determine the form of AMS should follow the Lake Louise Consensus on the Definition of Altitude Illness.

Table 9.4 The Lake Louise consensus on the definition of altitude illness

AMS	In the setting of a recent gain in altitude, the presence of headache and at least one of the following symptoms: • Gastrointestinal (anorexia, nausea or vomiting) • Fatigue or weakness • Dizziness or lightheadedness • Difficulty sleeping
HACE	Can be considered "end stage" or severe AMS. In the setting of a recent gain in altitude, either: • The presence of a change in mental status and/or ataxia in a person with AMS [inability to walk a straight line] • Or, the presence of both mental status changes and ataxia in a person without AMS
HAPE	In the setting of a recent gain in altitude, the presence of the following: Symptoms: at least two of: • Dyspnea at rest [difficult, laboured breathing] • Cough • Weakness or decreased exercise performance • Chest tightness or congestion Signs: at least two of: • Crackles or wheezing in at least one lung field • Central cyanosis [bluish coloured skin, lips, fingernails] • Tachypnea [abnormally rapid respiratory rate] • Tachycardia [abnormally rapid heartbeat]

Table reproduced with the permission of Charles S. Houston M.D. from: "The Lake Louise Consensus on the Definition and Quantification of Altitude Illness" in *Hypoxia and Mountain Medicine*, by J. R. Sutton, G. Coates, and C. S. Houston (eds). 1992.

9.11.2.3 | Treatment for AMS

- The best treatment is **descent** to a lower altitude until the symptoms are gone.
- Drink extra fluids and eat small meals high in carbohydrates.
- Acetazolamide (Diamox) can prevent AMS and it also may be used for treatment under medical direction.

9.11.3 | Severe AMS – High Altitude Cerebral Edema (HACE)

HACE is a form of severe AMS that develops when there is pressure from fluids on the brain. Early recognition of symptoms is important for recovery, as HACE can cause permanent brain damage or death. HACE usually develops at altitudes over 3,600 m, but occasionally it may develop at altitudes as low as 2,500 m. It may occur alone or in conjunction with HAPE. Victims should not go higher even for a brief time (e.g., for a day's work).

- Recognizing HACE: Symptoms usually develop 2 to 5 days after reaching high altitude, although sometimes they develop almost immediately. People who develop HACE usually also display symptoms of AMS, but not always. See the Lake Louise Consensus on the Definition of Altitude Illness in the previous section.
- Treatment for HACE: Immediate DESCENT is essential to an elevation where symptoms are resolved, which means a descent of at least 600-1,200 m. Oxygen should be administered – it should always be available at high altitude camps – but descent is absolutely necessary. Do not put off descent to wait for transportation if the weather permits walking down. Victims must never be left alone as their condition can deteriorate very rapidly, even during descent. Seek medical treatment as soon as possible.
- NOTE: Use a simple test for HACE that demonstrates the loss of muscle coordination (ataxia). Have the victim walk a straight line at least 5 m long in a heel-to-toe manner. If the victim staggers or cannot turn around and return along the line without falling, the victim must descend. He or she is probably suffering from HACE.

9.11.4 | Severe AMS – High Altitude Pulmonary Edema (HAPE)

HAPE kills more people than any other form of altitude illness. Pulmonary edema is the buildup of fluid in the lungs to the degree that they cannot function properly and victims can drown in their own body fluids. Victims should not go higher even briefly. Those who have suffered HAPE have an increased susceptibility whenever they return to high altitudes.

- Recognizing HAPE: Early recognition of HAPE is essential for successful treatment and recovery. Symptoms usually develop 2 to 4 days after reaching an altitude over 2,500 m. See the Lake Louise Consensus on the Definition of Altitude Illness in Chapter 9.11.2.2.
- Treatment for HAPE: Treatment for HAPE is DESCENT to a lower altitude where the symptoms are resolved. Oxygen should be administered – it should always be available at high altitude camps – but a descent of at least 600-1,200 m is absolutely necessary. Oxygen therapy and medication can be administered by a medical person in camp. Victims must be accompanied during descent and never left alone as their condition can deteriorate very rapidly. Seek medical treatment as soon as possible; contact a medical facility for advice if unable to descend due to weather.

9.11.5 | Other Altitude-Related Illnesses

Thrombophlebitis

There are indications that blood will clot more easily at high altitude, especially in the legs. This may be due to restrictive clothing and/or dehydration, or also as a result of sitting for extended periods of time on long airline flights or long vehicle trips. Refer to Chapter 12.8.2 Deep Vein Thrombosis (Blood Clots) for additional information.

- Risks: Pulmonary embolism may occur if a clot breaks free.
- Symptoms: Pay attention to soreness and swelling in the calf, thigh, the back of the knee, or if the pain increases when the foot is flexed.
- Treatment
    - Loosen any tight clothing, remove boots but keep the patient warm.
    - Aspirin will reduce the blood's ability to clot and relieve pain, but beware of potential nose bleeds.
    - Transport the patient to lower altitude. The patient should not walk.
- Preparation and prevention
    - Stay warm and wear clothing that is loose enough so blood circulation is not restricted (boots, socks and gaiters).
    - Drink lots of fluids to avoid dehydration.
    - Exercise legs and feet if you are confined in a tent due to adverse weather.

High Altitude Retinal Hemorrhage (HARH)

- HARH is a form of AMS when bleeding occurs from the retina. It is common above 4,300 m.
- Symptoms: Most victims are unaware of its occurrence unless there is a lot of bleeding. It may affect vision if hemorrhaging is severe and near the macula area of the retina where most vision occurs.
- Treatment: There is no treatment as vision problems usually disappear when the person returns to low altitude.

9.11.6 | Planning for High Altitude Projects

Project managers should make the following preparations when planning high altitude projects. Individual employees should take precautions, be familiar with the requirements of acclimatization (#2 below), and be trained to mitigate the risks of working at high altitude.

1. High altitude related risks and hazards should be assessed and addressed.
    - Complete risk assessments and include the potential impacts on employees working at high altitude. Risk factors include the altitude of the site, traversing routes and potential transportation crashes. Develop and carry out risk mitigation plans based on the observations and conclusions of risk assessments. Refer to Chapter 2.1.5 Risk Assessments.
    - Develop site specific safe operating procedures (SOPs) and emergency response plans (ERPs) that address high altitude hazards, altitude illness and potential accidents.
    - Training should cover the SOPs, ERPs, appropriate survival techniques and additional potential risks associated with high altitude (e.g., dehydration, hypothermia, hyperthermia and carbon monoxide poisoning). First aid attendants should be competent and trained to recognize and treat AMS, HACE and HAPE and the additional potential injuries or illnesses. Hold a practice drill if an ERP includes evacuation procedures.
    - Plan work schedules to include acclimatization requirements. Acclimatization should be a part of risk mitigation plans.
    - People who routinely work at altitude should have a blood test before returning to altitude to verify that they are healthy and don't have a virus. High altitude may have an adverse affect on viruses in your system, which may cause breathing or heart problems to develop.
2. Acclimatization – Everyone should acclimatize each time they go to altitude. During acclimatization, a person breathes more frequently and deeply in an effort to acquire the same amount of oxygen as at lower elevations. The body makes additional adjustments because it is impossible to breathe rapidly enough to obtain the same amount of oxygen as at sea level. Employees returning from even short trips to lower altitude need to re-acclimatize. During acclimatization:
    - You breathe more rapidly.
    - Your heart beats more rapidly to distribute the oxygen to your organs.
    - You urinate more frequently to rid body of fluids.

- Your blood volume decreases due to the loss of fluids, while some tissue may accumulate water (edema).
- You sleep less soundly because you breathe less frequently and then wake up in order to breathe more deeply to restore oxygen to the lungs.

Pay attention to the following points to help your body acclimatize:

- Rate of ascent: Do not rush to high altitude without sufficient rest days. The higher the work site, the more important this is to prevent developing severe AMS, HACE and/or HAPE. Once you reach an altitude of 3,000 m, do not ascend more than 1,000 m per day without a rest day.
- Rest: When going from sea level to 2,400-3,000 m, refrain from strenuous work for several days. However, light activity accelerates acclimatization. Further rest is recommended if travelling to 3,600 m.
- Work high and sleep low. When possible, sleep each night at a lower altitude than the work site, preferably below 2,500 m. It is advisable to locate project sleeping quarters as low as possible (without increasing the overall risks due to transportation etc.). If it is necessary to sleep at an altitude over 3,000 m, gradually increase the altitude at which you sleep by no more than 300 m per day.
- Fluid intake: Part of acclimatization includes fluid loss through increased urination. Therefore, drink sufficient water to pass lots of clear, light coloured urine. This requires drinking much more water than is required to quench your thirst – usually four to six litres per day. Avoid caffeine drinks and alcohol, including local fermented drinks. Dark urine indicates dehydration.
- Diet: Eat a diet high in carbohydrates; avoid a high protein diet. Eat frequent small meals.
- Avoid smoking, as it reduces the blood's supply of oxygen. Avoid sleeping pills, as they decrease your respiratory rate during sleep and contribute to hypoxia (insufficient oxygen circulating in the blood).
- Previous AMS: If you have previously had AMS, spend at least one or two nights at an elevation around 1,500 m before advancing to higher altitudes.

3. Equipment: All high altitude projects should require the following medical equipment at each camp.
    - Oxygen therapy equipment and a hyperbaric bag should be available and staff should know how to use them correctly. While oxygen should be used to relieve symptoms, it should never be regarded as a cure for moderate or severe AMS for which descent to a lower altitude is necessary.
    - High altitude projects should be equipped with intravenous (IV) equipment to administer fluid replacement products and with pulse oximeters to regularly check the oxygen saturation level of employees' blood.
4. Medications: Drugs are available that may help prevent AMS, but they have side effects and any medication should be taken only under medical supervision. When using the drugs, avoid alcohol and be sure to take more than enough for the duration of the trip. Diamox is the most widely tested drug for the prevention and treatment of altitude illness. Consult with a medical advisor regarding the possible use of Diamox and other drugs.

- Acetazolamide (Diamox) can help reduce the severity of symptoms of altitude illness and decrease the time necessary for acclimatization. It is available only by prescription in Canada, but may be purchased over the counter in some countries. Obtain medical advice before using Diamox and follow the directions regarding the dose and duration of use. While Diamox may help reduce nausea, headache and sleeplessness, the medication produces side effects that include tingling in the lips, fingers and toes, ringing in the ears, peculiar taste sensations and increased urination. As Diamox is a sulphonamide drug, people with allergies to sulpha drugs should not use it. Consider trying the drug before travelling to a remote location, as severe allergic reactions have occurred in people who have not previously exhibited allergic reactions to sulpha drugs. Whenever possible, it is better to acclimatize naturally than to depend on medication.
- Ibuprofen and Acetaminophen are usually effective for treating high altitude headaches.

5. Individual preparation and preventive measures:
    - Be familiar with and follow the acclimatization guidelines in #2 above.
    - Avoid flying directly to high altitude; it is better to drive. Postpone a trip if you have a cold or flu and have a blood test to check for viruses before departing.
    - It should be mandatory to have a medical examination (including a blood test) as part of trip preparation, especially if it is your first trip to high altitude. Discuss the potential use of medication to help prevent AMS with your medical advisor. Have a blood test when you are returning to altitude.
    - Use the “buddy system” to monitor your co-workers and watch for signs and symptoms of AMS.
    - If you develop symptoms of AMS, it is advisable to descend to prevent developing more serious symptoms. Do not go higher. Go higher only after the symptoms disappear.

Additional information on AMS is available from the Public Health Agency of Canada.

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.

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

10.2 | Responsibilities (Due Diligence) Regarding Wildlife

As presented in Chapter 1.2 Due Diligence, companies should be able to demonstrate due diligence with regard to safety at project sites. Compliance with regard to wildlife safety issues should include but not be limited to the following measures:

Exploration Companies

- Take all reasonable precautions to protect the health and safety of every employee.
- Comply with jurisdictional occupational health and safety (OHS) and wildlife legislation and regulations.
- Perform risk assessments to determine the threat from wildlife, including wildlife habitats at a project location and in traverse areas.
- Develop written safe operating procedures (SOPs) and site specific SOPs, as required, that address wildlife risks. SOPs should address the observations and conclusions of risk assessments.
- Make sure supervisors are trained, competent and provide supervision of employees who work where wildlife encounters may be a risk.
- Provide sufficient and appropriate equipment and support so employees can work and traverse safely, especially in bear country.
- Provide training to make sure employees are (1) knowledgeable about (SOPs) and emergency response plans (ERPs) that address wildlife risks and hazards, (2) knowledgeable about potential wildlife threats and how to react to encounters, and (3) competent in the use of their personal protective equipment (PPE) and deterrent equipment. Examples include:
    - In bear country, employees should know the correct response if they encounter a bear. They should be able to competently handle pepper spray and various deterrents. If handling firearms in Canada, employees must have all required licenses e.g., a Possession and Acquisition Licence (PAL).
    - Know how to prevent insect bites, especially where malaria is a risk. Know how to safely remove unpleasant creatures, such as ticks and leeches.

- In venomous snake country, employees should know what types of clothing and footwear are appropriate to reduce potential snakebite; know the correct procedures to deal with snakebite.
- Employees should know how to avoid encounters where crocodiles are a hazard.

Supervisors

- Project supervisors should develop written site specific SOPs, as necessary. Make sure employees comply with the SOPs.
- Make sure employees comply with applicable wildlife legislation and are prepared for potential wildlife related emergencies covered in the site ERPs.
- In bear country, develop site bear response plans and work with trained bear guards, as required.

Employees

- Comply with applicable wildlife legislation and follow SOPs regarding wildlife. Be familiar with the site ERPs, especially regarding bear and reptile related emergencies, which may be life-threatening.
- Take appropriate measures to prevent animal attacks and/or diseases.
- Prevent animals from becoming human habituated and food conditioned. Never feed wildlife and keep a clean camp so animals are not attracted by odours and garbage.

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, (2) 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.

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 Chapter 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 Chapter 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.
- 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.

Figure 10.1: Grizzly bear © Matt Turner

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.

- Grizzly or brown bears (Ursus arctos) inhabit pockets of the western USA, all of Alaska, much of western and northern Canada, and parts of Siberia. There are a few fragmented populations in Europe, Central and Southern Asia, and Japan. Grizzlies vary greatly in size depending on the region and the local food supply. They prefer open and semi-open country; they defend themselves fiercely, as this habitat offers little cover or protection. They are omnivorous – eating whatever is available. Grizzlies can be recognized by their large shoulder hump, long upturned muzzle and long claws (about the size of your fingers), which are excellent for digging. Fur colour is not a dependable identifying feature in North America as both grizzly and black bears range in colour from blond to black. Normally, grizzly bears avoid contact with humans, but they may seek out garbage and become a nuisance at project sites. If grizzlies perceive a threat or are surprised, they normally react by charging or attacking. Usually only young grizzlies climb trees, but adult grizzlies may climb trees and can reach up at least 4 m from the ground. Therefore, if you must climb a tree to escape a grizzly, try to get your feet 10 m off the ground. Climb until you "run out of tree".
- Black bears (Ursus americanus) are found only in North America but are widely distributed in forested areas from northern Canada and Alaska to northern Mexico. They are smaller in build than grizzlies, lack a shoulder hump, have a straight muzzle and have short, curved claws. Black bears prefer forests with open clearings and rarely venture more than several hundred metres from cover. They climb trees with ease. Black bears are omnivorous and easily become accustomed to eating any available garbage. They pose a very real threat to field camps if their innate curiosity combines with easily accessible food. On occasion, black bears are predaceous.
- 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.

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. Examples of preferred habitats include:

- Alluvial flood plains – when new growth appears in spring and when fish are plentiful
- Recently burned areas – succulent new growth and berries
- Wet meadows – skunk cabbage, sedges and horsetails
- Alpine meadows and ridges – are preferred grizzly feeding areas and travel routes
- Avalanche slopes – when new growth appears in spring
- Berry patches – preferred spring, summer and fall feeding area, especially for black bears. Bears may not be visible so watch for moving bushes.
- Rivers or streams – fish spawning grounds
- Eskers – frequented by barren land grizzlies
- Preferred travel routes – game trails, river banks, ridges, lake shorelines, and beaches

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.
    - Grizzlies den in a wide variety of locations, but often on steep slopes in alpine and subalpine areas. They dig dens in sandy and rocky materials like eskers and in places where roots systems will support the roof of a den.
    - Black bears often prefer to den toward the bottom of valleys. They may excavate dens under tree roots and brush and they use natural cavities (e.g., under a fallen tree).
    - 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.

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

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.
- 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 Chapter 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.

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.

10.3.5.1 | 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 Chapter 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.

10.3.5.2 | 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.

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 Chapter 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. BearSmart has information about electric fencing and bear safety.

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.

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.

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.

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:

1. Train employee to respond correctly to bear encounters.
2. 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).
3. Maintain warning and detection systems and deterrent equipment.
4. Monitor and report any bear activity near camp.
5. Compile and report bear problems to wildlife officers.
6. Deter and, if necessary, destroy a bear while remaining in compliance with wildlife regulations.
7. 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.

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.

10.3.8.1 | 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.

10.3.8.2 | 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.

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 Chapter 16.9 Transportation of "Dangerous Goods"). Do not ever consider hiding them in your luggage or pack.

10.3.9.1 | 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.

10.3.9.2 | 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.

Figure 10.2: Empty can of bear spray chewed by a grizzly bear. © Michelle Pond

- 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.
- The BearSmart website provides additional information about bear pepper spray.

10.3.9.3 | 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 Chapter 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 Chapter 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 c old 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.

10.3.9.4 | 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.

10.3.9.5 | Deterrents Use – Effective Range

The PDAC acknowledges and thanks Andy McMullen, BEARWISE, for granting permission to use his Deterrents Use - Effective Range chart on the following page. 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.

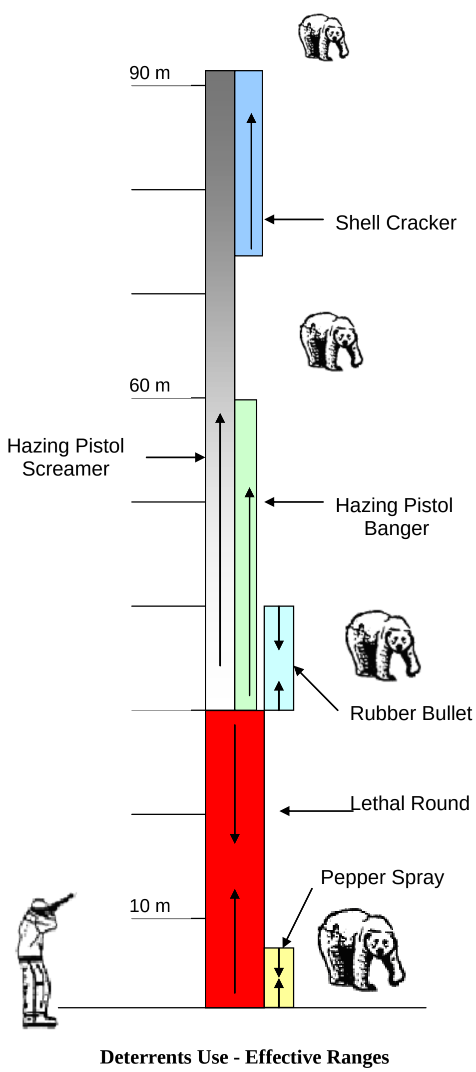


Figure 10.3: Choosing the correct deterrent during a bear encounter

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.

10.3.10.1 | 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 Chapter 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 Chapter 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.

10.3.10.2 | 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.

10.3.10.3 | 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.

10.3.10.4 | 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 BearSmart website.

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.

10.4.1 | North and South America

Cougars (mountain lions or pumas) and Jaguars

Encounters with cougars are rare, but the number of encounters is increasing as cougar habitat is encroached on. Cougar populations are increasing in western Canada and the USA.
Jaguars' preferred habitats includes forests, savannah and occasionally desert and scrub environments. They live in Central and South America, Mexico and occasionally in southernmost Arizona and New Mexico; jaguars are larger, heavier and stronger than cougars.

Prevention and Preparation

The following guidelines are based on information about cougars. The same principles should apply to jaguars.

- Inquire with locals to learn of habitat that cougars may favour. In warm regions they often rest in shady places like rock overhangs and ledges.
- It is not advisable to keep dogs, as they may lead a cougar into camp. Cougars prey on dogs much more frequently than on humans.
- Keep camps well lit at night when cougars are most active (dusk to dawn).
- Control possible sources of food to prevent food conditioning.

Traversing in Cougar Country

- Make lots of noise and carry a big walking stick to use as a weapon. Unusual or metallic sounds that sometimes work for scaring bears may work for cougars. Carry bear spray.
- Never approach a cougar. They are defensive, especially when with kittens and/or if they are feeding. Cougars cover their kill with dirt and debris; if you encounter a kill site, quickly and calmly leave the kill area and stay away.
- Never corner a cougar; always allow it a route to escape.

Cougar Encounters

- Never run away as this behaviour triggers a cougar's instinct to chase. DO NOT turn your back on it; they usually attack prey from the rear. DO NOT climb a tree as they are excellent climbers and will catch and pull you down.
- Stay calm. Try to appear as tall and imposing as possible by opening your jacket and raising your arms or holding a stick in a threatening position.
- Stop. Face the cougar and back away slowly if it is safe to do so. Speak calmly and firmly. Move to a safer location while backing up, preferably uphill so you look larger, but do not corner the cougar.
- Cougars rarely attack humans, but if an attack is imminent, try to convince it you are not prey. Be aggressive – make growling noises, shout at it, and threaten it with your walking stick.
- If a cougar attacks, try to inflict pain with a weapon as their pain threshold is rather low. Remain standing; try to get back up again if knocked down. Do not crouch down or turn your back on it. Protect our head as large cats try to attack the head and neck.
- Defensive weapons: Use a heavy stick, throw stones or branches, use pepper spray if you have it.

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.
- Coyotes generally fear people, especially where they are hunted or trapped, but if they become human habituated they will approach very near and be very difficult to scare off. If they become food conditioned, they may approach a work site or camp to search for food and water. Their range is expanding and their habitat includes forests, deserts, grasslands, and many urban and suburban areas. Packs of coyotes can kill large prey including deer and elk. Although it is extremely rare, they have killed humans. Children have been attacked and killed and an adult was recently killed in Nova Scotia.
  - Follow the same guidelines as for wolves by denying access to food and garbage and keeping a clean camp.
  - Remove sources of water if possible, which attract coyotes – especially in dry areas.
  - Coyotes are most active at dawn and dusk.

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.

Moose and Elk

Prevention and Preparation

Do not approach these large animals. Males are dangerous during rutting season and in winter when food is in short supply. Females with calves are dangerous and may defend them by charging and stomping. Like bears, they may become human habituated and food conditioned. Once this happens, moose and elk are more likely to attack a human at close range.

- Signs of agitation: Moose will lower their head and lick their lips while raising the hackles on their back.
- Back away slowly from a close encounter. If a moose charges, climb a tree or use closely spaced trees or other large objects as a shield or decoy.
- Do not keep dogs at a site where there are moose; they will attack dogs, which they perceive as wolves (enemies).
- Vehicle collisions – if a collision is imminent and unavoidable, aim for the hind quarters as the animal is less likely to rise up over the hood and crash through the windshield. Be most alert at dusk and dawn.

10.4.2 | Africa and Asia

Seek and follow local advice regarding the location and behaviour of these animals.

- Leopards, Lions and Tigers: Always maintain your distance. If you work where these animals live, use your vehicle and stay near it for safety. Never run from an encounter. Face them and back away slowly. Lions are poor climbers so you can try to get high in a tree. Except within game parks, you are more likely to encounter leopards than lions. Leopards are excellent climbers; they tend to live on escarpments and descend at night to hunt. Try not to camp near an escarpment and always sleep within a tent. Leopards are more likely to attack humans than are lions.

- Elephants: Always maintain your distance. Bull elephants are very dangerous. In rain forests, make lots of noise while traversing to announce your presence and usually they will leave the area. In savanna regions, watch out for tracks or other signs of their presence. If you encounter elephants while away from your vehicle, do not run. Face them and back away slowly. Beware of elephants that are flapping their ears and blowing – this is a sign of agitation so back away. During the dry season, do not take any fresh fruit on traverses as elephants are attracted to it and can smell it for great distances.
- Hippopotamus: Always maintain a safe distance from these animals both on land and water. Hippos graze on river banks at night and will attack and trample anything that comes between them and the safety of the river. Never camp near their grazing areas. If you are on the water in a boat or canoe, use extreme caution if you suspect there are hippos in the area. Do not talk. Remain quiet. Paddle or move with smooth, quiet motions until well clear as they may overturn a boat without provocation. A hippo with an open mouth is delivering a threat, not a yawn. Flapping ears and snorting are signs of agitation. Annually, hippos may kill more people in Africa than crocodiles kill.
- Cape Buffalo and Anoa: All Cape buffalo are very dangerous. Lone bulls are especially dangerous because they are extremely unpredictable without the security of a herd. Never approach Cape buffalo from behind as this may cause a herd to panic. They will trample, gore and toss a victim with their horns. It is safe to run from these animals, as they do not have a chasing instinct. Take cover behind a tree or anthill or try to reach a safe height in a tree. Noise-makers cannot be depended on as a deterrent. Brightly-coloured clothing may attract them.
- Hyenas and Wild Dogs: While these animals are not especially dangerous to adults, you should never corner one as they are capable of vicious attacks. Rarely, they have been reported to attack people at night sleeping outside of tents or houses.

10.5 | Dogs, Cats and Monkeys

Stray dogs, cats and monkeys present potential health threats to field employees. All animal bites are high risk wounds due to bacteria present in the animal's mouth. In most developing countries, dogs and cats are rarely vaccinated and they are major carriers of rabies and tetanus. In these countries, it is advisable to consider all bites from dogs, cats and monkeys to be potentially lethal unless you can prove without a doubt that the offending animal is free of rabies (refer to Chapter 12.8.5.12).

- Do not feed, befriend, adopt or provoke stray or wild dogs, cats or monkeys.
- Do not keep pets or encourage wild animals to hang around a project site.

- Recognize signs when a dog is likely to bite, which may include:
  - Fierce barking, snarling, growling, the tail stiff and raised high, raised hackles on the neck
  - Fearful, cowering – shy dogs can be dangerous
  - Unusually still and unresponsive dogs may be bred to disguise their aggression.
  - Outdoor dogs, chained dogs or cornered dogs are more likely to bite.
- If packs of wild dogs inhabit the area, consider equipping employees with axe handles to fend off a possible attack. Packs of feral dogs are relatively common in Africa, Mexico and in remote parts of the southwestern USA.
- In some places, food conditioned monkeys may approach and bite a person to provoke them to provide food.
- Wash any animal bite vigorously and thoroughly with soap and water. Apply antiseptic and seek medical advice. Leave bites and puncture wounds open.

10.6 | Reptiles

When projects are located where venomous snakes and crocodiles are a risk:

- Perform risk assessments that address reptile risks for project or camp locations and traverse areas. Develop SOPs that address the observations and conclusions of the risk assessments.
- Check on the location of the nearest medical treatment centre that treats venomous snakebite and post the contact information at the project/camp communication centre. This is essential information to include in the project ERP; it wastes valuable time to take a snakebite victim to the wrong medical centre.
- Develop and enforce safe operating procedures (SOPs), especially regarding the use of footwear and handling procedures for food and garbage.
- Make sure employees are trained to recognize and address traversing risks where there are venomous snakes and crocodiles and correctly respond to snakebite.

10.6.1 | Snakes

Snakes are a source of anxiety for many people even though most snakes are not venomous. Although thousands of people die annually from venomous snakebites in developing countries, particularly in rural agricultural areas, this is due to the lack of medical facilities for treatment. Very few deaths occur where there are medical facilities equipped to treat snakebite.
Most snakebites occur when people fail to use good judgement.

- In North America, most snakebites occur when people try to corner, capture or play with snakes – 40% of bites in the USA are to males who have consumed alcohol.

- Snakebites occur more frequently to people who are wearing sandals or are barefoot.
- In the field, some people are bitten when they forget to look around carefully before sitting down, or they back up into a bush with a snake under it.
- Field employees are vulnerable if they are very focused when examining outcrops or when entering portals, declines, and/or abandoned buildings at old mine sites.
- If you encounter a venomous snake at close range, do not move suddenly as snakes strike at moving objects. It is usually best to remain motionless until you locate the snake and then back away slowly, but do not back into another snake. If you encounter a snake that is not within striking distance, back away slowly. Give the snake lots of space and be on the lookout for more snakes.
- In rattlesnake country, STOP if you hear a rattler and locate the snake before moving. Check around for other snakes and then back away slowly and carefully. You should stop rather than immediately run away as there is often a mate nearby – possibly behind you. Often, rattlesnakes hunt by hiding beneath a bush, by a rock or log where they wait for prey to pass.
- Stay clear of large constrictor-type snakes, (e.g., boas, anacondas and pythons). While their diets consist mainly of rodents and small animals or fish, some species grow large enough to potentially kill a human. They often bite first to grasp their prey and then coil around and suffocate the victim. Although not the longest species of snake (they can grow to five metres), green anacondas are the world's heaviest snake. They are unpredictable, noted for an aggressive temperament, and they are capable of giving a bite that can cause serious injury. Anacondas are excellent swimmers and hunt for prey in and near water. In tropical South America, be alert when working in their preferred habitat (e.g., rainforest, savannas, and grasslands with swampy areas of slow moving waters). They are most frequently found in the Amazon and Orinoco river basins. In the event that an anaconda (or other large constrictor) constricts around a person, do not attempt to pull at the coils because the snake's strength is adapted for tightening its coils. Remove the snake by unwinding it from the tail end as the snakes' muscles are not adapted to prevent unwinding.

10.6.1.1 | Prevention and Preparation to Avoid Snakebite

Follow these guidelines for projects located where there are venomous snakes. Become educated regarding snake behaviour to avoid snakebite and excessive fear of snakes.

- Seek knowledgeable local advice regarding the habits and favoured habitats of local species of venomous snakes. Know where to expect to find them – they will be there some of the time. Snakes are cold-blooded. On a cool day, expect to find snakes in the sun resting on or near trails and rocky areas. On a hot day, they seek shade in and under bushes, logs, and rocky crevices or ledges etc.

- Complete a risk assessment to help choose the location of project living quarters. Avoid places where snakes are likely to live, such as in dry rocky locations, around swamps and watering holes, places with high rodent and frog populations, and areas with heavy vegetation or high grasses.
- Locate of the nearest medical centre that can treat snakebite and include the information in the project ERP so a victim is taken to the correct place for proper treatment. Know what field first aid procedures to administer for different types of snakebite, which vary by continent and the species of snake. (See Chapter 10.6.1.2 Treatment of Snakebite.)
- Because snakes are well camouflaged, try to train your eye to see the shapes, colour patterns, and distinctive signs of local venomous snakes. For example, American coral snakes have a colour pattern of red bands adjacent to yellow or white bands. In Mexico, Central and South America, the colour patterns are different. All sidewinder type snakes make an easily recognizable pattern of movement in sand that resembles Js or Ss.
- Snakes are more active at certain times of the year. Some snakes become very aggressive at mating times. Learn when this may occur and increase caution at these times.
- Be aware of the time of year when snakes shed their skin and be extra cautious. They cannot see well and often strike at anything nearby. Rattlesnakes may not be able to rattle again until the new skin and rattles are dry and firm.
- Do not kill snakes unnecessarily. Do not handle or disturb snakes in the wild, even if they appear dead or if they appear harmless. Many bites result from mistakenly identified venomous snakes and “dead” snakes – the South African cobra-like rinkhals snake will fake death to lure its prey. A severed snake head can administer a bite to someone who handles it; emphasize these points to both local and visiting employees.

Figure 10.4: Train your eyes to see the shapes, colours and patterns of snakes. © Dr. Kate Jackson

Tips to help prevent snakebite while working and traversing in snake country:

- Always wear loose, long trousers over boots and socks. Boots should cover your ankles – better still, your lower legs. Gaiters worn over boots are highly recommended. Proper clothing can greatly reduce the severity of snakebites by absorbing the venom or deflecting the fangs; this is especially true in Australia where the venom flows down and around the fangs to enter rather than being injected through the fangs into the victim. Never wear sandals where venomous snakes are a hazard.
- Make noise while traversing by treading heavily and you may encounter very few snakes. Snakes sense vibrations and most will retreat to avoid encounters. However, king browns and tiger snakes (Australia), cobras and some rattlesnakes will sometimes stand their ground and/or defend their nests.
- When traversing, walk at more than a metre away from rock overhangs and shady ledges, which may shelter snakes.
- Use extra caution if climbing rocks to take samples. Throw something onto a ledge before putting your face or hands up at that level.
- Never reach with your hand to pick up a rock sample or roll over a rock without looking first to check for a snake.
- In jungle or areas with heavy vegetation, watch for snakes in tree branches as well as on the ground.
- Experienced field employees say that they encounter snakes more frequently after blasting occurs in the immediate area.

- Keep tents tightly closed so no snakes can crawl inside. Check your bed before getting into it. Keep food out of all sleeping tents so it does not attract rodents. Snakes will follow rodents into a tent.
- Keep windows and doors to field vehicles closed so no snakes can crawl inside.
- Use a flashlight at night to walk around the site and between outbuildings. Unlit paths are especially dangerous after rainstorms as snakes will have emerged from holes and crevices.
- Use extra caution and wear gloves when collecting firewood, as snakes often live near wood or brush piles. Whack a wood pile with a stick before picking up wood and avoid collecting firewood at night.
- Do not hike at night. If it is necessary, always use a flashlight and a walking stick.

To avoid snakebites – avoid situations where snakes might strike you. Most snakes can only strike a distance equal to about half their body length.

- Step up onto logs and boulders rather than stepping over them and check that there are no snakes where you will step.
- Always roll over rocks or logs with a rock hammer or a long stick, not with your hand or foot. Roll them toward yourself to keep the object between you and a snake.
- Stamp on the ground and use a walking stick to sweep ahead of yourself in areas of tall grasses.
- Snakes can climb trees and fences so be very cautious if you must climb trees with dense foliage. Do not crawl under a fence in high grass.
- It is very dangerous to reach into a hole with a hand or a stick. Look carefully from a safe distance before reaching into any crack, crevice or hollow log.
- Use caution if you swim in lakes or rivers where there are venomous snakes. Snakes are often found near water and they swim well. They probably will not bite unless you try to capture them while in the water.

10.6.1.2 | Treatment of Snakebite

It is very important that the victim of a venomous snakebite receives correct medical treatment as soon as possible. In North America, the emergency rooms of hospitals can treat snakebites, but not every hospital will keep antivenin on hand. All Poison Control centres in North America should be able to give guidance over the telephone regarding where to obtain treatment. In Australia, medical help is quickly available by radio communication with Flying Doctor services. In developing countries however, it is essential to learn the location of treatment centres in the project area that can treat snakebite. Mark them on a map. Program the numbers into the satellite or mobile/cell so they are with you on traverse and post the numbers in the project office. Call ahead to notify the treatment centre of the pending arrival of a snakebite victim. Valuable time is wasted if a snakebite victim goes to the wrong treatment centre.

Only medical personnel should administer antivenin because serious side effects may develop. While some toxins may take hours to take effect, they may still cause death if left untreated and some bites are lethal in a short time. Therefore, all victims of suspected venomous snakebites must receive medical treatment as soon as possible.

General Treatment Guidelines

- Know the correct way to manage snakebite for the venomous snakes in the project area. There are two categories of snake venom. Most snakes have only one type of venom but a few have a combination of both types.
    - Hemotoxic venom affects the circulatory system and causes skin tissue damage and necrosis, destroys blood cells and causes internal hemorrhages. Snakes with this type of venom include the vipers and pit vipers (rattlesnakes, moccasins, and copperheads). Do not bandage these snakebites as this will increase tissue damage.
    - Neurotoxic venom affects the central nervous system and results in breathing difficulties and heart failure. Snakes with this type of venom include elapids – cobras, coral snakes, mambas, and kraits. Bandage these snakebites using the Australian pressure-immobilization techniques (see Chapter 10.6.1.3).
- Treatment for viper or pit viper bites (hemotoxic venom): Gently wash the bitten area with lots of water and soap to remove venom and help prevent tetanus and tissue destruction. Immobilize the limb and keep it slightly below the heart. Transport the victim to a medical centre as soon as possible. These instructions apply to all snakes (except coral snakes) in North and South America and for any viper or adder bite in Africa, Asia and Europe.
- Treatment for elapids (neurotoxic venom) and for all snakes in Australia: Wrap the bitten area using the Australian pressure-immobilization technique. Do not apply a tourniquet. In Australia, do not wash any venom off the skin of the victim because it can be used to identify the snake. If venom is wiped away, take that cloth to the medical centre where it can be used to determine the required antivenin with a venom identification kit.
- If you encounter a spitting cobra and venom gets into your eyes, flush the eyes immediately with large quantities of water or any fluids available, as the venom causes blindness. Use sputum or urine if nothing else is available. After sufficient flushing, apply antibacterial eye drops. Seek medical attention as soon as possible.
- If a victim is severely envenomated and more than a day or two from a medical centre, it may be advisable to use the Australian pressure-immobilization technique on snakebites with hemotoxic venom, (such as a large Gaboon viper). It is better to chance losing the limb than to die.
- The following "do not" instructions are very important:
    - Do not cut or suck the bite. Cutting may cause tissue damage and will not result in removing more venom.
    - Do not apply ice. It will not inactivate the venom and may cause tissue damage.
    - Do not apply electric shock. It may cause burns and cardiac problems.

  - Do not apply alcohol, as it will enlarge the blood vessels and allow more venom to be absorbed. Do not drink alcohol as it will cause a change of mental status and obscure possible signs of venom absorption.
  - Do not apply a tourniquet, as the resulting blood restriction may cause more tissue damage and may even cause a limb to be amputated.
- Only if it is safe to do so should you bring the dead snake (in a closed container) along for identification. It is never a good idea to kill snakes and risk getting bitten, especially if there are only one or two venomous species in the project area – doctors will know what antivenin to use. Do not handle a dead snake with bare hands, as reflex actions can cause the fangs to inject venom into a person for several hours after death.
- A study has shown that the venom extraction pump by Sawyer, "The Extractor", is not effective to remove venom from snakebite. It is more important to treat the bitten area appropriately and get to a medical treatment centre as soon as possible. Using "The Extractor" does not reduce the urgency for immediate medical attention to the snakebite and its use may give the victim a false sense of security.
- NOTE: There are absolutely no "traditional" medicine cures for venomous snakebite from any culture on any continent, no matter how convincing locals may seem. Do not be fooled or complacent regarding "cures" for venomous snakebite. The only treatment is evaluation by medical staff and correctly administered antivenin in a medical treatment centre.

Procedures for Snake Bites

If someone is bitted, follow these procedures:

1. Back away from the snake carefully and make sure that no further bites occur to the victim or anyone else.
2. Reassure the victim to help keep him or her calm, which is an important part of treatment. Have the victim lie down and remain in this position. Remember, many snakebites do not result in venom being injected into the victim.
3. Remove rings and jewelry and any constricting clothing that might impede the flow of blood. Snakebitten areas may swell up alarmingly.
4. Do not cut, do not suck with your mouth, and do not apply a tourniquet to the bite area. Wash the bite area gently, if appropriate. Do not wash a snakebite in Australia. Apply a bandage, if appropriate.
5. Bring transportation to the victim or transport the victim to a vehicle by stretcher, whenever possible. If absolutely necessary, the victim may be carried. The victim should not walk and should never run in order to prevent rapid circulation of the venom. Take the victim to a medical treatment centre for treatment or observation for 24 hours.
6. Keep track of vital signs during transportation. If swelling develops, mark its progress on the skin every 10 minutes and note changes in the patient's physical symptoms and mental state.

These include quality of vision, respiration rate, emotional changes, and nausea. Maintain the victim in a horizontal position.

7. Leave all dressings and any splint in place. Only a doctor at a medical treatment centre should remove them once appropriate required medications are assembled. If venom was injected, if will quickly move into the blood stream once the dressings and splint are removed.

Note: If the victim is unconscious and near death, you may apply a tourniquet between the bite area and the heart. The victim may lose the bitten limb but that is preferable to death. If the victim stops breathing, begin CPR (cardiopulmonary resuscitation).

10.6.1.3 | Australian Pressure-Immobilization Technique for Snakebite

Information regarding the Australian pressure-immobilization technique is reproduced with the permission from the:

> Australian Venom Research Unit
> Department of Pharmacology
> University of Melbourne
> VIC 3010 Australia

Try to obtain first aid instruction regarding the correct application of an elastic bandage for snakebite. An improperly applied elastic bandage may be too loose to do any good and one that is too tight may become a tourniquet and cause the loss of a limb. Do not apply a tourniquet.

Bites to the lower limb:

1. Apply a broad pressure bandage over the bite site as soon as possible. Crepe (Ace) bandages are ideal, but any flexible material may be used. Clothing, towels etc., may be torn into strips. Panty hose have been successfully use. Do not take off clothing, as any movement will assist the venom in entering the blood stream. Keep the bitten limb and the patient still.
2. The bandage should be as tight as you would apply to a sprained ankle.
3. Extend the bandage as high as possible up the limb.
4. Apply a splint to the leg. Any rigid object may be improvised as a splint, such as a spade, piece of wood or tree branch, or rolled up newspapers.
5. Bind it firmly to as much of the leg as possible. Use any rigid object for the splint (e.g., a piece of lumber, a spade).

Bites to the hand or forearm:

- Bandage as much of the arm as possible, starting at the fingers.
- Use a splint to the elbow.

- Use a sling to immobilize the arm.
- Keep the patient still. Lie the patient down to prevent walking or moving around.

Bites to the trunk:

- If possible, apply firm pressure over the bitten area. Do not restrict chest movement.
- Keep the patient still.

Bites to the head or neck:

- No first aid for bitten area.
- Keep the patient still.

10.6.2 | Crocodiles and Alligators

More than 20 species of crocodiles, alligators, caimans and gharials live in tropical and sub-tropical regions. They range in size from dwarf varieties to over five metres in length – the larger they are, the more potentially dangerous they are. The narrow nosed fish-eating species are not usually dangerous but will give a nasty bite if provoked.

All crocodiles are well camouflaged; they will see you long before you see them. Male crocodiles are most aggressive during the breeding season and females aggressively defend their nesting sites and babies. The largest and most dangerous species are the African Nile crocodile and the Indo-Pacific saltwater crocodile – they will prey on humans. The Nile crocodile ranges throughout most of the river systems in Africa from Egypt to South Africa. The range of the Indo-Pacific species includes coastal and inland waters of India and Southeast Asia (particularly Indonesia and Papua New Guinea to northern Australia). The information in this section comes from Australian sources but safe practices regarding the Indo-Pacific crocodile are also applicable to the Nile crocodile.

In Australia, both freshwater and saltwater crocodiles present an increasing occupational hazard. Their ranges are expanding and it is illegal to shoot them. Although the preferred habitats of the Indo-Pacific saltwater crocodiles (salties) are tidal rivers and mangrove swamps, they are not confined to salt water. Salties may swim several hundred kilometres upstream in freshwater river systems so their range overlaps with freshwater crocodiles, which inhabit all types of non-tidal freshwater wetlands and the tidal areas of some rivers. Although dwarf crocodiles, Australian freshwater crocodiles, gharials, caimans and American alligators are comparatively less aggressive, you should treat all these species with respect and keep your distance. In Australia, you should treat freshwater crocodiles with the same respect as saltwater crocodiles.

Prevention and Preparation

Wherever there are crocodiles, heed these warnings.

- If traversing where there are crocodiles, be especially aware of potential dangers when working near water holes and sloping river banks. Crocodiles can lunge very quickly from the water onto shore, as well as sideways and upwards out of the water to catch prey (potentially you).
- Recognize crocodile slide marks and stay away. Move away quickly if a crocodile approaches you.
- If you encounter a crocodile (or alligator), stay at least ten metres away from them and leave the area. Never agitate or provoke them; they can travel very fast on land or in the water. If you are chased on land, run in a straight line as they have little stamina. You may be able to outrun it.
- If you must cross waterways while on traverse, do so where it is narrow, shallow and rocky. Avoid water crossings that are more than knee deep, especially if water is murky.
- Obtain local advice if it is necessary to use a boat in crocodile infested waters. Indo-Pacific crocodiles will occasionally attack boats with outboard motors. Do not canoe in streams, lakes, ponds or at the mouth of rivers in crocodile habitat, especially in northern Australia. Never trail your hands or feet in the water.
- Do not choose a camp site near water holes, river banks or any source of water where crocodiles are known or might be present. Project sites should be a minimum of 800 metres from the water's edge. Dispose of garbage and food refuse carefully as it attracts crocs.
- A temporary camp site should be located at least 50 m from the water's edge and at least 2 m above the high water mark.
- Stay away from water holes, rivers and streams between dusk and dawn when crocodiles are most active.
- Do not go to the same place each day for water. Use places with shallow flowing water. Use at least three or four places in random order, as crocodiles learn very quickly when and where to expect potential food. This can be in as few as two days.
- Prepare food and wash up at least 50 m away from the water's edge and sloping banks.
- Pay attention at all times to any posted warnings regarding crocodiles or swimming safety. Do not swim in waters known to have crocodiles and alligators. Do not swim at night when crocodiles are most active. Do not swim in inland water holes unless they are posted as safe for swimming.
- Never hike at night; crocodiles often move between ponds and channels at night.
- When you shine a flashlight on the eyes of crocodiles, they reflect light and glow in the dark. Despite this fact, do not assume they are absent if you cannot see their eyes at night.
- Fish only from a boat or stand several metres back from the water's edge – never stand in croc infested waters to fly fish. Do not stand on logs, branches or rocks over the water.

- Clean fish away from the water's edge (at least 50 m) and dispose of food remains safely – away from any campsite or boat ramp.
- Animal carcasses attract crocodiles. Do not approach or moor boats near carcasses.
- In Australia, saltwater crocodiles nest during the wet season and freshwater crocodiles nest during the dry season. Therefore, you must beware of crocodiles in all seasons.
- Do not disturb or provoke young crocodiles. Juvenile crocodiles make a barking or chirping distress call that will summon their mother from a good distance and she will defend her babies aggressively.
- If attacked, fight back as hard as possible and hit it repeatedly on the nose and try to gouge their eyes with your fingers. Scream for help.

10.7 | Insects, Arthropods and Leeches

Depending on the project location and the time of year, insects may be a mere nuisance, sufficiently distracting that they impair good judgment, or they may carry life-threatening diseases. Be prepared to cope with insects and protect yourself from the diseases they may carry. People who have allergies to insect stings or bites should always carry appropriate medication or antidote such as antihistamine tablets or an EpiPen auto-injector, and they should instruct their co-workers how to administer it if necessary. For additional information refer to:

12.8.4. Protection from Insect Bites
12.8.5 Diseases (prevalent outside North America)
18.6.5 Diseases (prevalent in North America)

10.7.1 | Mosquitoes and Flies

Mosquito and fly-borne diseases are a major concern in the tropics and some temperate regions (malaria, dengue fever, encephalitis). Black flies and mosquitoes are a notorious nuisance in northern latitudes and the Arctic, especially when conditions are cool and wet.

Risks: Serious and potentially fatal diseases, annoying bites
For more detailed information regarding specific diseases carried by mosquitoes, refer to the following Chapters:

12.8.5.9 Malaria
12.8.5.3 Dengue Fever
12.8.5.6 Japanese Encephalitis
12.8.5.16 Yellow Fever
18.6.5.13 West Nile Virus

Prevention and Preparation

The information below is summarized from Chapter 12.8.4 Protection from Insect Bites. To successfully prevent insect bites, a multiple approach is necessary. When working in North America, steps 1 and 2 are sufficient.

1. Use insect repellent correctly on your skin and clothing. The most effective repellent contains from 15% to 35% DEET (N, N-diethyl meta-toluamide). Concentrations higher than this may cause reactions as it is absorbed through the skin.
2. Treat field clothing with DEET or permethrin products (insecticide) to repel or kill mosquitoes and flies (and ticks and leeches). Wear treated bug-jackets and head-nets to reduce distraction and insect bites, as necessary.

Follow steps 3 and 4 in addition to those above to help prevent malaria and other serious mosquito-borne diseases. It is important to prevent malaria, which can be spread by the bite of a single mosquito.

3. Use treated bed nets when protection from disease-bearing mosquitoes is advised (malaria, dengue fever).
4. Use knock-down insecticide sprays in your quarters and inside the bed net before going to bed.

Further measures to help diminish the impact of mosquitoes and flies include:

- Carry out measures that eliminate potential breeding places for mosquitoes. Do not permit water to accumulate in equipment, tire tracks, ruts, or other potential breeding places – especially in project locations where diseases may be spread by mosquitoes.
- Avoid wearing products that contain fragrances as they attract insects.
- In the Arctic it may help to place mosquito coils in a metal container and burn them in a tent before bed.

10.7.2 | Bees, Wasps and Ants

Risks: Reactions to stings range from minor irritations, to moderate reactions, through to severe reactions including anaphylactic shock causing death for people with allergies to the venom.

Prevention and Preparation

Bees and wasps

- Look out for bees and wasps nests while traversing and carrying out other exploration work. Bees and wasps can favour cliff faces or old mine entrances, as well as trees, underground crevices, buildings etc. Wasps live in large colonies and build paper-like nests.
- Check your work area and where you stop to eat lunch for nests of bees, wasps, and ants etc. Keep food and garbage covered as it attracts these insects.
- Honey bees only sting once and then die. They often leave their stinger embedded and it should be removed as soon as possible.
- Wasps can sting repeatedly. Yellowjackets, one of the most common wasps, sting more people than any other type of bee or wasp in North America.
- Do not swat or crush bees and wasps that fly around you as this excites them and attracts more of them.
- Avoid wearing products that contain fragrances as they attract insects.
- If you encounter a large numbers of bees or wasps, cover your face and eyes and leave the area immediately. Seek shelter in a building, a vehicle or an enclosed area. Heavy vegetation does not offer sufficient protection. If you jump into water, some bees will hover above and wait for you to emerge and continue stinging (e.g., Africanized bees).
- Africanized bees: Be especially vigilant to avoid swarms, nests or hives of Africanized honey bees. These bees are aggressive, very defensive of their territory, and may attack for little reason. Where these bees occur, stay at least 33 m from any hive or swarm of bees. While European honey bees may chase you for 50 m, Africanized honey bees may chase you for up to 800 m. If you encounter bees that “head butt”, retreat calmly and quickly, as this is a warning that you are approaching an Africanized bees nest. If stung multiple times, consult a physician as soon as possible. Remove stingers as soon as possible as the stinger sac continues to pump venom into the victim after the bee is gone. People may die from multiple bee stings even if they do not react with anaphylactic shock.
- Range: southwestern USA, Mexico, Central and eastern South America.

Ants

- Army ants (South America) and driver ants (Africa): These ants are carnivorous and build temporary nests so they migrate in large numbers. They can be an invasive problem and are a hazard in the tropics.

- Fire ants: Fire ants are found from the southern USA to South America and sting repeatedly when they attach to you. Be aware of your surroundings; watch where you walk or sit down to avoid ant hills and disturbing them. Fire ants attack rather than flee when disturbed. They crawl onto the victim, bite or pinch the skin to anchor their body, and then repeatedly sting the victim. The sting has a very painful burning sensation and develops a blister. Some people develop an allergic reaction and a few develop anaphylactic shock from the stings.
- If you are bitten: Move away from the nest area as fast as possible. As soon as you feel the pinching bite, immediately brush off any non stinging ants on your clothing or skin. Kill any remaining ants that are attached to your skin. Wash the bitten and stung area with soap and water as soon as possible to remove any venom on your skin. Disinfect the area with alcohol and do not break the blisters, as they easily become infected. Apply cool compresses or ice to the bitten and stung area to reduce swelling and itching. Apply an antibiotic if the blisters become infected. If a systemic reaction develops very soon after being stung, take Benadryl immediately and seek immediate medical attention in case the reaction progresses to anaphylactic shock.

Additional information regarding bees, wasps and ants is available in Appendix I.X

10.7.2.1 | Allergic Reactions and Anaphylactic Shock

Some people are allergic to stings from bees, wasps and fire ants. Many people are unaware that they are allergic to bees or that they can develop an allergy as an adult. A severe allergic reaction can cause death from anaphylactic shock. People with a severe reaction to such stings should always carry medication to be administered immediately upon being stung (e.g., epinephrine such as an EpiPen auto-injector, plus Benadryl). Co-workers should be instructed how to recognize signs of an allergic reaction and how to administer the medication – before an emergency. A severely allergic person should carry several EpiPens, as one injection may not be sufficient. The Twinject contains two injections but one cannot be saved for another episode – the second injection must be used or discarded.

- Symptoms of a local reaction to a sting include redness, minor swelling and itching or pain at the site but no changes in breathing or blood pressure. Treat by applying a paste of baking soda or ice water after removing the stinger or any remaining venom on the skin.
- Symptoms of a systemic reaction to a sting includes itchy red skin, hives developing on other parts of the body, a runny nose and watering eyes. Treat with oral antihistamine (Benadryl) immediately and monitor for signs of a severe reaction.
- Symptoms of a severe reaction and anaphylactic shock may appear immediately or within 30 minutes. They include the following:
    - Skin turns red within minutes
    - Swelling in the face, lips, tongue, eyes and eyelids, and neck

  - Itchy hives develop
  - Wheezing, difficulty breathing and/or tightness in the chest, which gets worse
  - Increased heart rate and respiratory rate
  - Change in consciousness and drop in blood pressure and cardiac arrest
- Anaphylactic shock is a true medical emergency and requires immediate treatment. If the patient shows signs of developing anaphylactic shock, an auto-injection of epinephrine should be prepared. Four tablets of Benadryl should be given immediately if they have not been given earlier. Unfortunately, once a victim develops swelling and muscle spasm in the airway and has difficulty breathing, the only treatment is epinephrine. The patient must be monitored because symptoms may reoccur and a second injection may be necessary. It may become necessary to administer CPR.
- Evacuate the patient to a medical facility for observation and evaluation.
- Other triggers of anaphylactic shock include: penicillin and other drugs, nuts, seafood, some food additives such as sulphites, and latex.

First Aid Tips

- Check that the stinger and venom sack do not remain embedded after a sting. Scrape them away with a knife blade, a credit card or fingernail rather than picking them out with your fingers or tweezers, which might rupture any remaining venom sack. Removing the stinger as soon as possible is more important than the method used.
- Benadryl does not take effect for 30 to 40 minutes. Consider including it in a personal first aid kit when working where stings are a risk.
- The EpiPen and Twinject are the only auto-injectors available in North America. The user should be aware of the storage requirements and expiry date. The Ana Kit has been discontinued.

10.7.3 | Ticks

Ticks are blood sucking arthropods that may transmit serious diseases. They live in grassy and wooded areas and feed on blood of various animals, including humans. Once they hitch a ride on you, ticks prefer to hide in body crevices such as the armpits, the groin and head – especially the base of the neck, behind the ears and the scalp. They latch onto people with their barbed mouth parts so you must remove them carefully. If you find one tick, there are often more. Recheck thoroughly. Remember that some ticks are very small.

Risks: Diseases carried by ticks include Lyme disease, Rocky Mountain spotted fever, and several forms of encephalitis

Prevention and Preparation

Prevent tick bites by following these precautions:

- Know when ticks are most active in a project area and know which types may be present. This information may be valuable in order to watch out for potential diseases that might develop if someone is bitten.
- Ticks are more visible on light coloured clothing. Wear a long sleeved shirt and long, tucked-in pants with footwear that covers your feet.
- Apply insect repellents containing DEET to your skin. DEET can be sprayed on clothing as well, but it is not as effective as using permethrin (an insecticide) on clothing. Apply permethrin to clothing and let dry for at least two hours. The treatment remains active for weeks even if clothing is washed a few times. Follow directions carefully and wash off any insecticide immediately with soap and water should it get onto your skin.
- Use expandable athletic cuffs and head bands soaked (and dried) in permethrin or DEET to restrict or block the movement of ticks.
- Sit on bare rocks away from vegetation when you rest or eat lunch.
- Do not drape clothing on bushes or on the ground in tick infested areas.
- Perform daily checks of your body and each piece of clothing for ticks. A short hair cut makes it easier to locate them on your head. Check frequently – at least twice a day when doing field work during tick season.
- Check for ticks on clothing before entering your living quarters or you may bring them inside where they will find you later.
- If possible, put clothes in a hot clothes dryer for half an hour to kill lingering ticks. This adds extra protection.
- Habitat: Ticks are found in grass, brush, vegetation debris and weeds near the edges of forests or woods, and near water – wherever their animal hosts live.

Removal of Ticks

Transmission of disease bearing bacteria requires approximately 24 hours of attachment, so you need to find and remove ticks quickly. Do it correctly. Two methods to remove an attached tick:

1. Use sharp pointed tweezers to grasp the tick as close as possible to the mouth parts; pull gently for one or two minutes.
2. Slide a straw over the tick so the body is inside the straw. Tie a thread in a loose knot around the straw and slide the thread down the straw to where the straw contacts the skin. Slide the knot off the straw and tighten it around the tick's jaws. This will persuade the tick to withdraw.

3. Do not use your unprotected fingers to remove a tick. Wear latex gloves if using your fingers is required. Latex gloves should be part of the project first aid supplies.
4. Do not "twist" or jerk the tick as the mouth parts may break off in the wound and increase the likelihood of infection.
5. Do not apply the hot tip of a cigarette or match to the tick's body to cause the tick to back away. Do not apply gasoline, acetone or turpentine to the tick. These actions may cause the tick to spew out infected fluids into your bloodstream.
6. Cleanse the bite area thoroughly and apply a mild antiseptic.
7. If the tick has burrowed into your skin, it should be tested for diseases. Place the live tick in a small plastic vial with a damp piece of cotton ball and send it to the appropriate testing facility, if possible. Only live ticks can be tested for Lyme disease and the humidity is important or the tick will die en route. For additional information, refer to Chapter 18.6.5.5 Lyme disease.

10.7.4 | Fleas

Most of the time, fleas are a nuisance to be addressed regarding family dogs and cats. However, fleas can carry plague, which can be transmitted when they bite humans.

Risks: Annoying bites, plague

Prevention and Preparation

- In the field, use insect repellent (DEET) or insecticide (permethrin) on clothing to discourage fleas.
- If plague is present in a project area, obtain information from local medical authorities or a travel medicine clinic regarding precautions to take and signs and symptoms to watch for, especially if there are many rodents in the area. It is a good idea to monitor the health of any colonies of prairie dogs or ground squirrels, as sudden increase in the mortality rate may indicate plague. Do not handle dead animal carcasses, as fleas may transfer onto you. In some regions it may be wise to consider prophylactic inoculation if plague is known to be present. Refer to Chapter 12.8.5.11 Plague.
- Symptoms: Flea bites appear as a small red spot within a larger spot. The spots swell and itch but usually disappear after a few days.
- Habitat: Humans, rodents, small and large animals. Adult fleas live on their host and feed on blood. Flea eggs are laid on hair and then drop off where the larvae hatch. The life cycle is easily repeated so it is necessary to eradicate the eggs and pupae as well as the adults to get rid of an infestation.
- Range: Worldwide

10.7.5 | Bed Bugs

Bed bug infestations are an increasing problem worldwide and are often found in places with a high turnover occupancy rate, including hotels (even better ones), motels, dormitories etc., and on airplanes, trains or ships. While no diseases are proven to be associated with bed bugs, their bites are annoying and can become infected and a few people are allergic to the bites. Bed bugs hide in bedding, mattresses, bed frames and headboards, upholstered chairs and couches, and cracks and crevices in flooring, walls, and draperies etc. They come out to feed in the dark and hide again when it becomes light. They will migrate into your luggage and clothing. Your best protection is to avoid them if possible. Bed bugs are difficult to eradicate.

Risks: Annoying bites, transferring infestations

Preparation and Prevention

Check your hotel room for signs of infestation and request a different room if you find evidence of bed bugs.

- Inspect the bed by removing the sheets and mattress pad. Search for signs of insects in the seams and crevices of the mattress, between the layers of bedding, and for small specks of blood or black or brown spots (feces) on these items. Check the bed frame and headboard.
- Keep all items inside your luggage. Wrap your luggage in plastic (a large garbage bag works well) and place your luggage on a rack away from the wall.
- Move the bed away from the wall and tuck in blankets and sheet so they do not touch the floor.
- If the room is infested and you cannot leave, consider sleeping with the lights on in a desperate situation.
- Avoid transferring bed bugs to your home. If you suspect your luggage may be infested, isolate your luggage when you return home. Dry clean or wash all clothing and items in hot water and place them in a hot dryer for at least 20 minutes. Wash the luggage and apply an insecticide inside and out before bringing it into the house.
- Infestations of bedbugs are very difficult to eradicate. Professional help is usually required to exterminate bed bugs, as broad spectrum insecticides are required. Bait traps do not work.

10.7.6 | Triatoma Bugs

Certain species of the genus of Triatoma bugs, also called the kissing bug, assassin bug or vinchuca, may transmit a protozoan parasite (Trypanosoma cruzi), which causes Chagas disease. Insects drop onto the victim's bed and then bite, mainly at night. The bug bites soft tissue, especially around the mouth and eyes and defecates while feeding. The bitten person then rubs the feces into the bite site and transmits the parasites into their own body. Refer to Chapter 12.8.5.1 Chagas Disease.

Risk: Chagas disease

Prevention and Preparation

If a project is located where Chagas disease is present, the following procedures are very important. Prevention is the key as treatment is generally not effective.

- Take active measures to prevent bites and to eradicate insects from your quarters. Use appropriate knockdown insecticides indoors. Use mosquito or insect repellent at bedtime.
- Search your bed and living area for insects; the beetles are large (2.5 cm) and easy to spot. They may hide under bedding and cushions on furniture.
- Fumigate all buildings whenever you occupy an uninhabited camp.
- Do not construct housing with local thatch materials in the roof or rafters.
- Habitat: Triatoma bugs inhabit palm trees, thatched roofs and the roofs and walls of mud, adobe or cane dwellings.
- Range: The species of Triatoma bugs carrying Chagas disease are found throughout some rural areas of Mexico, Central and South America.

10.7.7 | Scorpions

Scorpions are common arthropods. In most field areas where scorpions are found, you are likely to encounter many more scorpions than snakes. Most scorpion stings are not serious even though they cause sharp pain and swelling at the site of the sting. Nevertheless, a few species of scorpions have stings that can be fatal. These include the small straw-coloured species Centruroides exilicauda found in the southwestern US and Mexico (see below), Androctonus (Middle East and Africa) and Tityus (Brazil), which are found in arid and tropical regions.

Risk: Stings – painful to severe, rarely fatal

Prevention and Preparation

Scorpions are not aggressive toward humans but will sting when they are trapped or threatened. To avoid stings:

- Do not handle or provoke scorpions. All scorpions have venomous stings and some species are very venomous.
- Use a flashlight at night. Scorpions hunt for food at night and hide from light in the day.
- Never reach into dark crevices. Wear gloves when gathering firewood.
- Do not sit in areas with loose, dry vegetation.
- Use a stick or rock hammer to roll stones and logs – use the same preventions as for snakes.

- Wear shoes, not sandals. Do not go barefoot.
- Keep tents tightly closed and shake out your sleeping bag at night. Try to sleep in the centre of the tent or your room. Pull your bed away from the walls, as scorpions travel up and down walls at night.
- Always shake out your boots and clothing before putting them on in the morning. Shake out boots and clothing left in field vehicles before putting them on. Shake out items that have been left outside or draped over rocks or shrubs to dry.
- Check eating utensils before use.
- Symptoms: A sting produces an immediate pain and burning sensation and perhaps some swelling. The site is very tender for a long time. Hot compresses may ease the continuing numbness.
- Treatment: Apply ice and immobilize the affected area. Seek medical attention.
- Habitat: Mountains to deserts – plus grasslands and savannahs, rain forests, and deciduous and mountain pine forests. Scorpions may be found up to an altitude of 3,600 metres. While they prefer hot, dry climates, they may also be found in moist warm climates.
- Centruroides exilicauda (Bark scorpion): This scorpion frequently lives under leaves, bark, and in wooded groves near water. It is often found clinging upside down to loose bark, sticks and leaves and beneath rocks. Scorpions can climb, so it is possible to find them on the upper floors of buildings.
  - The sting can be fatal to very old and young people or those with a compromised immune system.
  - Size: Slender shape 1-5 cm (¾ - 2 in) in length
  - Symptoms: If stung: The venom is neurotoxic and affects the nervous system and the whole body. Signs include fever, increased heart rate, restlessness and hyperactivity, numbness and tingling in the face or extremities, blurred vision and muscle spasms.
  - Treatment: Seek immediate medical attention at a medical centre.

10.7.8 | Spiders

The bites of most spiders contain some toxin but very few species produce a bite with venom that is potentially harmful or life-threatening to humans. Seek immediate medical attention if bitten by a spider whose bite may be potentially harmful or life-threatening.
Risks: Serious illness or death may be caused by bites from a few species.

Prevention and Preparation

- Seek local knowledge regarding potentially harmful spiders. Learn to recognize the dangerous species, including their nests, and be observant in their preferred habitats.
- Always shake out clothing and check bedding if working where spiders are a hazard.

- Wear gloves and be careful when gathering wood.
- Avoid large fast-moving spiders. While many are not harmful, some can produce a nasty bite.
- Do not handle or provoke spiders.

Spiders with potentially harmful bites

Latrodectus sp. – black widow, red-back spider

- The black or brown female (15 mm) typically has a red stripe or hour-glass mark on her abdomen or back. Rarely, the mark may be white. Only the female produces enough venom to cause harm, as it includes potent toxins.
- This spider is shy and retiring. Bites usually occur when a spider becomes caught next to your skin. It will bite and run away.
- Symptoms: The toxin is neurotoxic and affects the nervous system. Initially, the bite may not hurt or show swelling. Within three hours the toxin produces muscle cramps and spasms, headache, anxiety, changes in blood pressure and intense pain throughout the body.
- Treatment: Ice packs may relieve the pain. Antivenin is available. Seek medical treatment i f you suspect a bite.
- Habitat: Rural areas, barns, garages, woodpiles, rock crevices, under logs and stones
- Range: North and South America, Australia, Europe, Africa, Siberia.

Loxosceles sp. – brown recluse

- This pale brown spider (10 mm or larger) has a dark violin-shaped pattern on its upper body.
- Symptoms: The bite causes little pain. Within five hours a painful red blister develops that is surrounded by a ring of whitish-blue discolouration. As the toxin causes the tissue surrounding the bite site to die, that area may develop gangrene.
- Treatment: Medical treatment is necessary as soon as possible. Apply cold compresses or ice.
- Habitat: Dark sheltered areas such as woodpiles, porches and eaves; in houses – dark places such as closet, under furniture
- Range: Southern United States, Mexico, recently introduced to Australia, a larger species is found in the West Indies.

Atrax sp. or Hadronyche sp. – Australian funnel-web spiders

- These black or brown spiders (2-3 cm) are aggressive and will attack when disturbed. They bite and hold onto the victim with fangs that are capable of penetrating a fingernail.
- Their venom contains many neurotoxins and bites can produce severe effects that include sweating, muscle weakness, respiratory failure and death.

- Treatment: If bitten, immediately apply a pressure immobilization bandage to the bite area as if it were a snakebite and seek urgent medical treatment (see Chapter 10.6.1.3). Only medical personnel should remove the pressure bandage, as the venom may spread rapidly when it is loosened.
- Habitat: Rock crevices, burrows, beneath houses and shrubs
- Range: Australia – coastal New South Wales, southeast Queensland and an isolated pocket near Adelaide

Phoneutria sp. – wandering spider

- Avoid these large (10 cm and more), fast-moving spiders. Their bite is dangerous and may be fatal to young children.
- Range. Eastern South America, especially common in parts of Brazil

Other Spiders

Tarantulas found in the southern USA and northern Mexico produce bites that are not potentially harmful to humans. Some tarantulas including those of the genera Hysterocrates (West Africa), Poecilotheria (India), Pterinochilus (Kenya) and Theraphosa (French Guyana) may produce a bite with severe consequences. Do not handle or provoke tarantulas.

10.7.9 | Leeches

Leeches are blood sucking, aquatic, annelid worms; they inhabit flowing and stagnant waters and damp places in tropical and temperate zones. Some leeches can produce nasty lesions.
Risks: Potential infection from lesions

Prevention and Preparation

- Insect repellent will discourage leeches.
- Wear long pants that are tucked into socks. Wear shoes that cover your feet rather than sandals.
- If you work in an area where leeches are a problem, check for them frequently throughout the day and detach them. Do not pull them off if they are firmly attached.
- Remove leeches by applying salt, vinegar, a lighted match or cigarette, kerosene or turpentine to the leech's body. They will detach and fall off. Clean the bite area and apply antiseptic.

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, Indigenous 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.

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 6.4 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.

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 6.3.1, 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:

1. **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.
2. **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.
3. **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.

4. **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.
5. **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).
6. **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.
7. **Supervision**: Workers should receive appropriate supervision in the field while performing surveys.
8. **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 Chapter 2.1.1 Working Alone vs. the "Buddy System".

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 Chapter 11.2.2). For additional information, refer to Chapter 8, Survival, and Chapters 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 Chapter 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 Chapter 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 Chapter 6.4 Traversing in Specific Terrain and Chapter 15 Snowmobiles for information regarding appropriate safety equipment and routines. Chapter 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, Chapter 12.8.4 Protection from Insect Bites, and information regarding relevant diseases in Chapters 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.

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.

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.

Chapter 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 Chapters 11.1.1 and 11.1.2 and relevant information in Chapter 6 Safe Traversing Practices.

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

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 Chapter 11.1.1.

The following guidelines apply to both IP and EM surveys:

1. 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.
2. 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.

3. 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.
4. 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.

5. Lightning safety
   Take extreme precautions whenever a lightning storm approaches. Refer to Chapter 9.2 Lightning for detailed information and references about lightning safety. Survey crews need to be aware of the weather around them while working. When a storm approaches:
   - Immzediately cease all operations. When thunder is first heard, shut off all power sources and disconnect all wires and cables from the instruments. Do not attempt to collect any wires or cables. Lightning can travel more than a kilometre along wires. Lengths of wire or large loops may have very high voltages induced by a lightning strike a long distance away; this is not only dangerous, it can also destroy equipment.
   - Move all personnel and easily portable instruments to a sheltered location, preferably a safe shelter or a field vehicle. If it is necessary to remain outdoors, do not seek shelter under a tall tree. If working on high ground, attempt to move to a lower elevation. Avoid areas of tall metallic objects (e.g., power lines, antennas, drill rigs).
   - Follow the "30-30 Rule" when thunderstorms are moving into the area. If you see lightning, count the time until you hear thunder. If the time is 30 seconds or less, you should immediately go to a safer place. After the thunderstorm has moved away, wait 30 minutes before leaving the safe location and resuming work.
6. 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 Chapter 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.

Figure 11.1: Ground magnetic survey traverse © Erika Tamboline

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.

Seismic Surveys

Employees who carry out seismic surveys should be competent and fully trained. If explosives are used, obtain appropriate permits and make sure blasters have proper certification.

- Handle and store explosives according to requirements of the authorities having jurisdiction (AHJs). Transport explosives according to dangerous goods requirements. Refer to Chapter 21.6 Explosives for additional information, located in chapter 21.
- Most shallow holes used to contain explosives are dug by hand so employees should be trained to use their tools safely and keep them in good working order.
- Wear appropriate PPE when using tools and equipment, which may include ear protection from noise as well as eye protection, good footwear and high visibility vests.
- Develop a protocol to make sure the area is clear before a blast takes place.
- If seismic surveys use truck mounted drill rigs, refer to Chapter 20 Drilling Sites for specific information regarding safe drilling guidelines.

Ground Penetrating Radar Surveys

Ground penetrating radar is useful for locating underground power lines, pipelines and cables. Follow traversing SOPs and general safety guidelines. No specific risks are involved with techniques or equipment used in these surveys.

11.3 | Geochemical Survey Safety

Geochemical surveys usually involve collecting samples at regular intervals either along streams or in a grid pattern on land. Although each sample may be small, the accumulated weight and volume can result in an employee carrying a very heavy backpack. Learn as much as possible from knowledgeable local people about specific risks and hazards so crews are prepared, especially for stream sediment surveys.

Specific Risks and Hazards Associated with Geochemical Surveys

- Back strains and injuries caused by lifting heavy samples, heavy backpacks, using improper lifting techniques
- Slips trips and falls caused by rough ground, wet and/or slippery surfaces, wearing footwear with poor traction, balance problems from carrying heavy equipment or backpacks
- Hypothermia caused by working in cold wet weather, effects of wind chill, wearing inadequate clothing, dehydration, exhaustion
- Impact injuries caused by the misuse of tools such as mattocks, shovels, mechanical augers, post hole drills
- Health risks include diseases and infections caused by contact with contaminated water or soils containing parasites, viruses, and bacteria
- Water-related risks include drowning and cold water immersion hypothermia, which may be caused by falling into water while sampling, attempting dangerous stream crossings, when working from boats, when water is a greater depth than anticipated
- Injuries or death caused by accidents when travelling by vehicles, ATVs, snowmobiles, boats or aircraft

11.3.1 | General Prevention and Preparation

All geochemical survey crews should be familiar with the relevant safety routines, guidelines and tips found in Chapters 11.1.1 and 11.1.2 and in Chapter 6 Safe Traversing Practices.

- **Back care:** Collecting silt and mineral samples is strenuous work. Use correct lifting procedures and properly constructed backpacks. Carry loads that are appropriate for your personal strength and physical size; do not overload your backpack or show off. Get help if you need it. Refer to Chapter 4, section 4.3 Lifting and Back Protection.
- **Footing:** It is easy to lose your balance when wearing a heavy pack. To prevent slips, trips and falls, watch your footing at all times, especially late in the day when you are tired. Boots should have high grip soles for work on slippery surfaces (e.g., rounded or algae covered rocks). In some wet terrain it may be advisable to wear rubber boots or use caulks (replaceable steel spikes screwed into the soles of special boots).

- **Tools:** Use mattocks, shovels, picks, etc., correctly. Use caution when traversing so you do not fall on them.
- **Wear gloves to protect your hands.** Geochemical sampling may expose your hands to soils with disease causing organisms and it is easy for cuts to become infected. Soil-borne diseases include but are not limited to: hookworm, tetanus, histoplasmosis, and numerous fungal diseases. Make sure tetanus immunizations are up-to-date.
- **Animals and insects:** 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. Digging up samples may disturb them. In bear country, be equipped with bear deterrents and pay attention to your surroundings. Sampling is quiet work so make sufficient noise to avoid startling a bear. Wear bright rather than dark clothing to avoid being mistaken for animal prey, as you appear smaller when sampling low to the ground. Refer to the relevant sections of Chapter 10 Wildlife.
- **Transportation risks:** Follow general and site specific SOPs that address the appropriate transportation risks. Refer to the guidelines sections in the relevant chapters.

Figure 11.2: Geochemical samples are often small. Wear gloves to protect your skin. © Erika Tambolinea

11.3.2 | Stream Sediment Surveys

Working near streams can be extremely dangerous. Fast flowing currents can sweep a person away if they fall in or lose their footing. Stream sediment surveys may require sample collection and/or panning the heavy minerals to form concentrates. These surveys often require the worker to collect samples while standing in water. Sampling may take place in various fluvial environments – fast flowing water, glacial outflow streams, or wide braided streams or rivers with gravel bars, slow meandering streams etc. Access may require helicopters, rafts, walking through mud or swamps, or negotiating slippery boulders and/or steep outcrops. Lichen covered rocks and logs are particularly hazardous. Water may be colder and deeper than anticipated.

Cross references: Everyone conducting stream sediment surveys should be familiar with the relevant information in the following chapters and sections of this toolkit:

- Chapter 6 Safe Traversing Practices, especially section 6.4.5 Traversing Safety Regarding Streams, Rivers and Lakes
- Chapter 9, especially section 9.9.3 Hypothermia
- Chapter 10 Wildlife
- Chapter 17 Boats, Canoes and Inflatables, especially section 17.12.3 Cold Water Immersion Hypothermia

Specific Risks and Hazards Associated with Stream Sediment Sampling

- Drowning or cold water immersion hypothermia caused by falling into water from stream banks, boats, attempting a dangerous stream crossing, not wearing a PFD
- Slips, trips and falls caused by wet, slippery or rough ground, wearing inadequate footwear
- Stranding caused by impassable streams or weather, transportation fails to return
- Health risks include diseases and infections caused by contact with contaminated water containing parasites, viruses, and bacteria
- Foot disorders caused by standing in water for long periods of time

Preventions and Precautions

There are additional risks and hazards associated with stream sediment surveys and panning sampling methods.

- **Working alone:** When following a grid line, sediment sampling can be done alone although it is much safer practice to work with a partner. Rather than each worker sampling a separate grid line alone, it is preferable to work in pairs and "leap frog" past each other by collecting the sample at every other site. This way, workers are in constant contact. If this cannot be done, employees working on parallel grid lines should be in regular and frequent radio contact if they are not actually in sight of each other. Site specific SOPs should be implemented regarding working alone.

- Hypothermia: Standing in water for long periods of time can increase the chances of developing immersion foot or hypothermia during cool weather.
  - Dress to stay warm and dry.
  - All employees who risk falling into cold water should receive training and understand the importance of: (1) wearing a personal flotation device (PFD), (2) how to work at self rescue, and (3) how to treat a hypothermia victim.
- Hyperthermia: When working in very warm climates, try to work in shade, use sunscreen and keep hydrated. Create your own shade, if necessary. Take special care of your feet to prevent fungal diseases, which are common when feet are wet for long periods of time.
- Transportation: Some surveys may require access by helicopter or boat.
  - Aircraft: Choose drop off locations carefully when using helicopter support. The water may be deeper, swifter, and/or colder than anticipated. A helicopter should never depart before the survey crew members are safely on shore when the landing site is a bar or an island. Check for the presence of bears before landing, if appropriate. Carry survival equipment in case the transportation cannot return as planned. Follow SOPs and guidelines in Chapter 16 Aircraft.
  - Boats: Use appropriate sized boats for the task when working on rivers and streams, lakes or oceans. Follow safe boating procedures and guidelines.
    - Wear a life jacket or personal flotation device (PFD) when working on water. Due to "cold shock", wearing a PFD is your most important means of defense against drowning and cold water immersion hypothermia.
    - Line (haul) boats, canoes and rafts through rapids.
    - Be especially careful to avoid sweepers (trees fallen into a river). If a raft flips against a sweeper, it is almost impossible to rescue the occupants if they are thrown into the water.
- Stream crossings: Plan surveys to avoid crossing streams, especially where flowing water is deeper than mid-calf.
  - If stream crossings are absolutely necessary, plan them carefully. Carry and use appropriate safety equipment (e.g., rope, PFD). Fast flowing water as deep as the knees can easily sweep people away if they fall in or slip. Be familiar with safe methods to cross streams and wear a PFD if there is a chance of falling in.
  - Wear a PFD or use a safety belt and line even when working near fast flowing waters or where banks are steep or slippery.
  - Stranding: It is possible to become stranded if stream waters rise suddenly. Carry sufficient

survival gear in case it is necessary to spend a night away from camp. It is better to remain out overnight than risk a dangerous stream crossing.
  - If flash floods are a hazard, seek local knowledge and heed weather forecasts regarding flood warnings. By studying topographic maps it may be possible to determine potential emergency exit routes from narrow gorges. Refer to Chapter 9, section 9.5 Floods, for additional information and appropriate precautions.
  - If sampling in agricultural areas where fences frequently cross streams, especially near roads, never climb the fence to cross the stream. It is surprisingly easy to end up tangled upside down with your head submerged with a resulting high risk of drowning.
  - Swampy meandering streams are difficult to work in. Carry a stout stick and extra socks.
  - In some places it is advisable to check with knowledgeable local sources regarding the possible presence of quicksand.
- Health risks: Depending on location, the water you must work in may carry diseases – whether they are streams, rivers, lakes, ponds, tailings ponds, or surface runoff from storms, etc.
  - Waterborne diseases include but are not limited to: giardiasis, schistosomiasis, cholera, hookworm, typhoid, leptospirosis and various forms of dysentery. Wear rubber gloves and avoid touching your face and mouth.
  - Insect-borne diseases include: West Nile virus, malaria, dengue fever and yellow fever. In addition there are diseases carried by ticks and various flies (tsetse flies, sand flies).
  - Foot disorders: Usually, feet will be wet for long periods of time. Depending on the climate, feet may be subject to immersion foot if they are continuously cold and wet or fungal diseases if they are continuously warm and wet. Wear appropriate boots and change socks frequently. Make sure your feet are dry and warm at night. Follow good foot hygiene to prevent "foot rot". Refer to Chapter 9, section 9.9.6 Immersion Foot.
  - Tailings ponds may contain toxic chemicals that can cause illnesses.
  - Refer to Chapter 12, section 12.8.5 and chapter 18, section 18.6.5 for information regarding specific diseases.
- Animal and insect risks:
  - Reptiles: Know what snakes live in the region and the relative risks from them. Most are harmless and should not be destroyed due to personal fears. Learn about their habitat, where, and when to expect them. Most snakes swim when necessary and water is the preferred habitat of some snakes (e.g., water moccasins, water cobras, anacondas). Some present more risk than others, especially if the species is aggressive or temperamental (water moccasins, anacondas). Crocodiles: Follow safe guidelines where crocodiles pose a danger to humans.
  - Insects: Increased numbers of mosquitoes are usually present near water. Some insects such as blackflies that transmit river blindness (onchocerciasis) may be found almost exclusively near water.
  - Leeches: Depending on the location, they may be a potential problem, as infections may develop where they have pierced the skin.
  - Refer to chapter 10 Wildlife for additional information.

- **Clothing and PPE:** Protect your body from cold water and infections.
  - Wear appropriate boots – rubber boots are a minimum. Depending on the water depth, it may be appropriate to wear hip waders, but be aware of the risks of wearing high waders and falling into swift flowing water. If they fill with air it may be impossible to right yourself, which increases the risk of drowning.
  - Gloves: Heavy waterproof rubber gloves are recommended. Check frequently for pinhole leaks and replace them immediately when they leak, especially if waterborne diseases are a risk.
  - Carry extra socks and/or dry inserts for boots when your feet are frequently immersed in water. Use inserts on alternate days so they dry out.
  - Waterproof clothing or rain gear: Carry good rain gear to help stay dry. Refer to section 6.3.5 Clothing in Chapter 6 for tips regarding appropriate fabrics and clothing.

Figure 11.3: Stream sampling © Erika Tamboline

11.4 | Line Cutting Safety

Cut line or picket grids are used for control for some geophysical and geochemical surveys. A cut line or picket grid is normally established from a base line with a series of cross lines spaced at specific intervals. Base lines may be surveyed in or laid out on a specific compass bearing. Cross lines are normally established perpendicular to the base line and tie lines are sometimes used to ensure greater accuracy of the grid. Lines are usually cut using axes or machetes and chainsaws. In areas with no forest, picket stakes can be used to mark a survey grid. Crews that cut lines should work as a team and not alone. As their work often requires felling large trees, it is imperative to watch out for the safety of co-workers. Workers should follow written safe operating procedures (SOPs) for falling and bucking, as required by the authorities having jurisdiction (AHJs).

The type of work involving chainsaws and cutting grid lines is often given to employees or contractors who are local to the project area – for example, Indigenous 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 assume that because they have used chainsaws in their everyday life that they do so safely. Given the high level of comfort of local people with the bush or field environment, an appreciation of their bush skills, as well as safety requirements of the workplace, need to be handled with sensitivity.

Use of geophysical equipment with built in GPS (Global Positioning System) units are reducing the requirement for cut lines, especially for surveys that use magnetometers, etc. Soil geochemistry surveys require fewer cut lines when surveyors carry handheld GPS units. Where no cut lines are used, technical survey crews should exercise greater care when travelling across the ground. The preferred approach to geophysical and geochemical surveys is one that avoids line cutting, where possible. This is largely for environmental reasons. For the same reason, it is also preferable to minimize the width of cut lines and minimize felling of larger trees. The objective should be to make the line sufficiently safe for the technical crew that will follow, but at the same time maximize the chance for the native vegetation to recover and reclaim the land.

Chapter 5 Field Equipment Safety contains information regarding the safe use of implements and equipment commonly used for field work. Please refer to section 5.6 Chainsaws in Chapter 5 for details regarding chainsaw, tree felling, bucking and limbing safety. This information is placed in section 5.6 because working with chainsaws and tree felling is also done by company employees at project and camp sites.

Specific Risks and Hazards Associated with Line Cutting

Line cutting is frequently done during winter months which can increase risks and hazards.
Risks and hazards include but are not limited to:

- Severe injuries or death due to:
    - Chainsaw accidents (often due to kickback), which may result in cuts, lacerations, or amputations
    - Being hit by falling trees or bucked sections of logs
    - Inability to correctly assess trees before cutting due to poor visibility (wind, fog, rain, snow)
- Slips, trips and falls due to:
    - Rough or unstable ground
    - Dangerous terrain such as cliffs, swamps, steep slopes
    - Ice and snow-covered ground
    - Inadequate footwear
    - Unstable body position while cutting trees or clearing brush
- Back strains and injuries due to working in awkward body positions while cutting
- Cuts, blisters, lacerations from using hand tools
- Transportation accidents due to:
    - Excessive speed while travelling by vehicles, ATVs, snowmobiles, or boats
    - Inadequate training for the mode of transportation
    - Using an inappropriate mode of transportation for the terrain or ground conditions
- Hypothermia, frostbite may develop due to exposure to cold temperatures, the effects of wind chill, dehydration, exhaustion, and/or wearing inadequate clothing, .
- Wildlife and insect risks include attacks from large animals such as bears and cougars, and bites and stings from snakes, insects, and scorpions etc.
- Water-related risks include drowning and cold water immersion hypothermia due to falling into water, attempting dangerous stream crossings, breaking through ice

Preventions and Preparations for Cutting Lines

Line cutting crews should be familiar with the relevant safety routines, guidelines and tips found in Chapters 11.1.1 and 11.1.2 and general safe field practices refer to Chapter 6 Safe Traversing Practices.

- Survey crews should follow essential pre-job tool and equipment checks before departing for work each day. Properly maintained tools help prevent accidents.
- Line cutters should not work alone. A “cutter” and a “brusher” are a team. They should travel to and from the work site together and should always be within visual and shouting distance of each other during line cutting operations.
- Training: Employees should be trained to use surveying, cutting, and clearing tools properly and maintain them in good condition. Use appropriate sheaths to store and transport axes, machetes, knifes, brush hooks and other sharp tools. This can prevent injuries when the tools are carried by hand. Refer to Chapter 5 Field Equipment Safety regarding specific tools.

- PPE: Line cutters must wear additional PPE due to specific risks and hazards associate with chainsaws and felling trees.
  - In addition to safety glasses, line cutters should wear high visibility hard hats with ear defenders (ear muffs) and a face shield, high visibility vests, gloves, steel toed boots or caulked boots. Caulks (replaceable steel spikes screwed into the soles of special boots) offer much better traction than ordinary soles when working in wet forests or other slippery conditions. Caulk boots may be made of leather or rubber.
  - Chainsaw operators should wear chainsaw pants or chaps, which are designed to slow the cutting action of the blade should the chainsaw kickback or slip and hit the operator in the leg. They should cover as much of the leg as possible but not impede movement.
- Line cutting crews need to know the purpose for cutting the lines in order to use the proper survey standards. Some surveys have different clearance width requirements. For example: electrical survey methods require thorough clearing to avoid wire and equipment hang ups, while some lines may only need minimal clearing and blazes on trees to be acceptable.
- Location: Employees working on established cut lines or picket grids should understand the layout of the grid and its orientation to keep track of their location. If the grid is accessed by a trail, whether on foot, by ATV, snowmobile or other means, all persons working on the grid should know the grid coordinates where the access trail enters the grid so they can return to the access trail at the end of the day. Mark the access trail to the grid clearly with flagging tape, cairns or other means.
- Marking coordinates: Carefully mark both the base line and the tie line coordinates. Use the appropriate method to mark the survey coordinates of each station, which may be with pickets, tags, flagging tape and/or tree blazes. Prepare a plan map showing the grid and coordinates. It is not advisable to use fire to burn lines even though it may be common practice in some localities.
- Cut off saplings, trees and stumps at ground level to avoid creating stubs or “pungies” that become a tripping or impaling hazard. Trim overhead vegetation to reduce the hazard of protruding branches, which may cause eye injuries. Stubs can cause tire damage to equipment such as ATVs. At the same time, try to leave as much as possible of the root systems of the plants, as that way the recovery will be maximised.
- Brushers and other crew members must stay at least two tree lengths away during falling operations. The cutter must check the area and not begin cutting until everyone is out of range. Keep onlookers away from the cutting site and work areas.
- Firearms: Where bears are a hazard and it is deemed necessary to carry a firearm, the persons who have permission to carry and use firearms must have all required training and certification. 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. Refer to Chapter 10, section 10.3.9.3 and chapter 18, section 18.2.2 for additional information regarding the use of firearms.

Cutting Tracks or Grids with Heavy Equipment

Using heavy equipment to cut tracks is generally not advisable due to the potentially severe environmental impact caused by the equipment. If using heavy equipment is unavoidable:

- Discuss the safety aspects of working in difficult terrain with operators before work begins (e.g., slopes, cliffs, swamps).
- Only experienced and certified operators should operate heavy equipment.
- Keep workers on foot and keep light vehicles away from heavy equipment. Use barriers when possible. Workers on foot must not turn their back on moving heavy equipment when they are working in an area with no separation.
- Refer to Chapter 21, section 21.3 Heavy Equipment for additional information regarding safe operating procedures and the use of heavy equipment.

Information about the safe use of chainsaws and safe working procedures for line cutting are available in Appendix I.XI

12.0 TRAVEL, SAFETY AND SECURITY

Introduction

The risks and hazards of travel generally depend on your destination, how informed and prepared you are before departure, your state of health, and your perceived level of importance to those who might wish to cause harm. Therefore it is important to learn as much as possible about the destination so that you can cope well, not offend local traditions, and avoid health and safety issues. For some locations it may be advisable for exploration companies to carry out a risk assessment to determine whether doing business there presents unacceptable risks to the company or its employees. When visiting a field project you may be going places where typical tourists do not travel. Use appropriate guidebooks to learn about the country and research the risks on government websites, such as those of Canada, Australia, the UK, and the USA if you want information in English. Talk to other mineral exploration people who may have worked there, though their advice may not be perfect – sometimes people working in a risky area become accustomed to the risks and downplay them. Check with a travel medical advisor who is familiar with health issues in the region. Finally, always keep a low profile to avoid the appearance of a good target and "someone of value".

An exploration company initiating a program in a country with perceived risks may benefit from professional expert advice, especially if serious security problems exist. There are security firms that specialize in assisting companies with the issue of travel outside the home country. Such companies will run training courses on safe, secure travel, audit company procedures, assist with setting up emergency response systems, provide personal security on site, and may establish "safe house" accommodations in extreme situations. Some may also assist with crisis situations such as negotiations in the event of kidnapping.

12.1 | Risks and Hazards

Lack of preparation and knowledge about potential travel-related risks can have serious consequences. Risks include:

- Impact on health caused by:
  - Disorders such as jet lag, barotrauma, blood clots in legs
  - Diseases caused by contaminated food, contaminated water, contaminated air, plus insect-borne, animal-borne, soil-borne and parasitic diseases

- Lack of acclimatization before starting work at high altitude illness, in hot climates
- Inadequate immunization, which may consequently require receiving injections with potentially unsanitary needles in developing countries
- Inadequate preparation for unfamiliar temperature and weather related risks, including hypothermia and hyperthermia

- Injuries or death caused by:
  - Transportation related crashes – aircraft, vehicles, trains, boats, motorbikes
  - Lack of training to carry out field work in unfamiliar terrain
  - Lack of an escape plan from a hotel fire
  - Kidnapping, carjacking
  - Terrorist activities
- Assault, robbery and/or loss of possessions caused by:
  - Lack of proper business contacts or a knowledgeable guide
  - Unsecure hotel room
  - Street crime, muggings, kidnapping civil unrest
- Kidnapping caused by carjacking, lack of a knowledgeable guide, terrorism
- Adverse impact on company business and reputation caused by:
  - Lack of familiarity with cultural differences, unfamiliar laws and regulations
  - Corruption

12.2 | Responsibilities (Due Diligence) and Travel Safety

Exploration companies and their employees have certain due diligence obligations regarding travel safety.

Exploration companies

- Make certain the health and safety of each employee is protected when they travel.
- Consider providing special training for employees who will enter or work in areas or countries with significant travel risks and unfamiliar terrain.
- Develop safe operating procedures (SOPs) to address the risks and hazards related to travel safety and security. These are SOPs that should be in place in addition to those for field work and normal field travel, which are covered in the following chapters:
  - 6 Safe Traversing Practices
  - Transportation: 13 Vehicles, 14 All-Terrain Vehicles, 15 Snowmobiles, 16 Aircraft and 17 Boats, Canoes and Inflatables

- Make sure that emergency response plans (ERPs) are in place that cover the destinations of travelling employees. Include a company or an agency telephone number that is easily called – collect – from any country that immediately creates contact between the employee and a suitable designated senior company person in the home country. Test the telephone number to be sure it works. Refer to Chapter 3 Emergency Response and section 19.6.2 Company Hotlines, located in Chapter 19.
- Develop a process to make sure employees have checked for up-to-date information regarding health risks at the destination, which should include diseases such as hepatitis, malaria, Chagas disease and yellow fever. Inoculations need to be up-to-date, especially for tetanus and those required for overseas work.
- Develop a process to make sure employees have received up-to-date information regarding security issues in the country of destination.
- Provide for safe means of transportation within countries where risks are high. Motor vehicle accidents are the leading cause of death and injury in developing countries. It may be necessary to provide knowledgeable drivers, safe vehicles equipped with seat belts and other safety features, or pilots for boats. Companies should enforce the use of seat belts.

Employees

- Make sure your travel documents are valid. Do not misrepresent your status in a country – do not enter a country as a tourist when you are on business – it may create security problems for you.
- Make sure your inoculations are up-to-date, especially for overseas work. Check for up-to-date information regarding health risks at the destination(s). Allow sufficient time before departure to obtain and start medication sequences (e.g., malaria).
- Be informed and check for up-to-date information regarding security issues at the destination.
- Follow company SOPs regarding travel safety and security. Be aware of the ERP provisions for emergencies and evacuations and know how to get help should you require it. Know your company or agency emergency phone number as well as the contact information and location of your country's embassy or consulate or a "friendly" embassy or consulate.
- Wear a seat belt when travelling in any vehicle, including taxis.

12.3 | International Travel Preparations

12.3.1 | Preparation Checklist

Be fully prepared before departure. The following is an information checklist to consider, especially when visiting a country for the first time. Note that the information has to be considered relative to the passport that you travel with.

- Before travelling to a new location, access government websites, for example those of Canada, Australia or the USA among others, for information regarding the country of destination. Especially check the website of the government of the country of which you are a citizen. The specific government website should help you note the entry requirements and review any travel alerts and background notes in and around the destination country relative to the passport you travel with. By reviewing information on these and additional websites, one may be able to reach a balanced decision regarding security precautions. Be aware that some countries have more experience in certain areas than others. For example, the Australian government has a presence in Laos whereas the Canadian government does not (as of 2009). For this reason it can be expected that Australian assessments of risks in Laos are likely more reliable.
- Make sure you have a valid passport that will not expire until well beyond your anticipated return date. Some countries require a passport to be valid for six months beyond the return date on the ticket. Obtain any necessary visas, documents or references. Obtain the correct type of visa, as some countries require separate visas if you visit as a tourist or on business. Leave a copy of your itinerary and travel documents with your office and family and carry a copy in addition to your passport. Carry several spare passport photos in case an additional visa is needed. For example, a plane may make an unscheduled landing en route in a third country that requires a visa. In addition, be cognizant of the implications of travel between two foreign countries and that the legal implications (e.g., visa requirements or immunization requirements) may be different than when travelling directly from your home country.
- Be familiar with any company prohibitions or restrictions on travel to certain countries for security or health reasons. Many companies have insurance to cover certain types of risks (e.g., kidnapping), which may be invalid in some locations. Check that your private life and medical insurances will remain valid at your destination. Arrange for emergency evacuation insurance, as necessary.
- Make sure your immunizations are up-to-date. Allow enough time to receive new immunizations and/or a consultation regarding anti-malarial medications, if necessary. Immunizations may be required for medical reasons or legal reasons; understand the difference. If you are travelling to more than one country, be aware of the implications of travel between specific countries, irrespective of your home country. For example, Brazil may require a yellow fever inoculation for a traveller from Peru even if it is a Canadian passing through Peru, although a Canadian travelling directly from Canada may not require this. Travel Canada lists immunizations recommended for Canadians travelling outside Canada.
- Travel medicine clinics provide immunizations and up-to-date information regarding travel health and disease issues throughout the world. Clinics are located throughout Canada and can be located through Government of Canada websites.
- Have a thorough physical examination and complete any necessary dental work if you are going to a very remote area. If it becomes necessary to receive medical or dental attention abroad, try to obtain recommendations for reliable doctors and/or dentists. The Canadian consulate can provide a list of names. A good source for overseas medical contact information is the International Association for Medical Assistance to Travellers (IAMAT).

- Bring more than sufficient prescription and over-the-counter medications for the duration of the trip plus a possible delay. Carry them in the original packaging and do not pack them all in your checked luggage. It may be advisable to carry a duplicate prescription with the identification of the doctor, dispensing pharmacy, and the dosage and drug identification numbers of the medications. Carry duplicate prescriptions for eye glasses or contact lenses. Diabetics etc., who carry syringes, should take a medical certificate to verify their requirement for medical use. Arrange for any necessary refrigeration of medication.
- Register with your government embassy or consulate abroad.
- Know the location of and carry contact information for appropriate government offices in the destination country (e.g., the embassy of your citizenship). If the destination country is a risky location, it is probably worthwhile registering with the foreign affairs office or consulate for the country of your citizenship.
- Verify that your credit card will be accepted at your destination(s). It is advisable to arrive in a country with some local currency. Take some US dollars or other recommended currency in small denominations, as they are useful in most places especially for tips. In the event of a medical emergency it is imperative to be able to access sufficient cash or have an accepted credit card. Medical fees usually must be prepaid in advance or doctors will refuse to provide service. Do not rely on international health cards.
- Have a travel agent book a hotel in a safe location with a guaranteed reservation. Try to arrive during daylight hours.
- Arrange to be met when you arrive outside immigration by a business contact or representative. Alternatively, one can use a prearranged car and driver from a reliable agency for travel from the airport to the hotel. This can often be arranged through the hotel.
- If travelling to an area where sanitation standards are questionable, plan to take extra care with personal hygiene and be very careful what you eat and drink. Take hand sanitizer in containers small enough to pass through airline security. A small portable water purifier can be useful.
- Obtain an international drivers permit if you anticipate that you must drive a vehicle. This is not always advisable and hiring a local driver is usually a better plan.
- Obtain a good travel guidebook for the area. The trip will be more interesting and fewer risks may be encountered if you are knowledgeable about the destination. Lonely Planet and Rough Guide are two examples of guidebooks that contain information appropriate for people who travel in remote or back country areas. Backpacker-type of travel is often more similar to what exploration personnel experience than what normal tourists encounter.

12.3.2 | Aircraft Travel Considerations

Commercial Air Travel

Companies should try to eliminate travel using airline companies with a questionable safety record. Bear in mind the following facts when choosing an airline:

- Most commercial jet aircraft are very safe and have similar safety performance records.
- Commercial airlines are generally safer than smaller commuter airlines, which are safer than charter airlines, which are safer than helicopters.
- It is advisable to avoid older generation jet aircraft such as DC 8s, Boeing 707s and Eastern Bloc aircraft, which are often used in developing countries. There may be problems as a result of age and/or poor maintenance.

Charter aircraft: If it is not possible to travel with a commercial airline and charter aircraft must be used, insist on a detailed safety briefing before take off and try to use only reputable charter companies. Do a visual inspection before boarding as described below. Refer to Chapter 16, section 16.3 Aircraft Charters, for tips regarding charter aircraft.

When travelling by air in developing countries:

- Try to obtain information from knowledgeable locals and compare notes with other exploration companies regarding safety records of local airlines and aircraft charter companies.
- Get into the habit of observing the aircraft, ground activities and airline personnel before boarding the aircraft. Look for oil leaks, bald tires, dirty airframes and crazed or cracked windows.
- Do not be afraid to refuse to fly if you feel the risk is too great.
- Note: A mineral exploration company should carry insurance to cover employees when in the field. Such insurance will have conditions attached. For example, it may stipulate that all aircraft charters must involve aircraft (fixed wing or helicopter) with an airworthiness certificate. Usually military aircraft will not have an airworthiness certificate and thus it is possible that travel or air accident insurance is invalid in the case of an accident in a military aircraft. Mineral exploration personnel often charter military aircraft in less developed countries because no commercial aircraft are available.

12.4 | Personal and Travel Security

In all countries, use common sense when choosing travel routes, methods of transportation and lodging. You may encounter situations over which you have little control. Be aware of the risks and be alert to potential threats, particularly when leaving your flight, taking taxis, and entering or leaving hotels. Use local knowledge whenever possible for advice on how to reduce personal risk (business contacts, hotel concierge, local office personnel, local embassy). However, be wary when people belittle risks because they may have become too accustomed to them.

- Arrange to be met by a company representative just outside immigration upon arrival, or prearrange a taxi with your hotel the first few times you visit a new country. This will avoid having to negotiate transportation. People new to a country will be unfamiliar with the local routines regarding transportation, which can place them in a vulnerable position.
- When carrying out property examinations or reconnaissance work, always be accompanied by a reliable, knowledgeable guide who is fluent in the local language, the culture, and potential risks from wildlife and/or diseases. Use approved or recommended means of transportation.

Safety and security tips

- **Driving:** In some countries, foreigners are automatically implicated in any crash when they are the driver. Therefore, it is advisable to hire a professional driver. Reliable drivers may be associated with better hotels. In some countries it is unsafe to drive at night – either in the city or in the countryside. Vehicle crashes are the number one cause of injury to travellers. Wear a seat belt and request a vehicle that is equipped with them if they are not installed.
- **Taxis:** If the streets are not safe to walk at night, use dependable licensed taxis.
  - If it is confusing to determine legitimate taxis, inquire at the airport or hotel information kiosk for ways to identify safe taxis.
  - Try to hire taxis associated with hotels (or hotel courtesy vehicles) and avoid public transportation and hailing taxis on the street. Whenever possible, select taxis equipped with seat belts.
  - Avoid poorly maintained vehicles and look over the driver carefully. Do not enter a taxi with two people in it (driver and "assistant"). If you are unsure about the taxi, step back and wait for another.
  - Pay for the taxi before you get out.
  - Carry change – taxi drivers will often claim to have no change.
- **When working alone or on an assignment**, even in an urban area, it may be advisable to have a check-in routine once a day with a person at the office who is responsible for tallying contacts each day. This can be done by email.
- **Make sure your accommodation is secure.** In countries of moderate to high risk, luxury hotels may provide better security.

- To minimize and avoid robbery:
    - Carry cash separately from credit cards. Keep your valuables in several locations (money belt, several wallets). Where pickpockets pose a high risk, it may be wise to keep a "dummy" wallet containing limited cash in a visible pocket and another wallet safe in another place. Consider keeping an expired credit card, old cash receipts and a small amount of US dollars to make the dummy wallet appear normal.
    - Be very careful when exchanging currency to prevent being cheated or robbed. If exchanging large sums of money, you may be observed and marked for robbery.
    - Remember that muggers and bandits are generally only interested in your money. If you are confronted, hand over your money on demand with one hand and keep the other hand in the air. If you have two credit cards (personal and company cards) keep them in different places. If you are held up, initially produce only one card. In some cases, exploration personnel have negotiated back their credit cards from robbers, but this can be risky.
    - Do not forget your PIN. An aggressive robber may not believe it when you tell him/her that you have forgotten it and may assault you.
    - Keep a list of contact numbers for credit card distributors so that you can neutralize the cards as soon as possible if they are stolen. Never leave credit receipts lying around your hotel room and do not throw them in the garbage.
    - When wearing a money belt, loop it around a belt loop so that if it is cut, it does not fall to the ground.
    - Leave nonessential money, valuables and documents in the hotel safe. Take with you only what you need. In some countries you must have your passport and visa with you at all times.
    - Carry a small amount of money available for tipping so it is not necessary to expose your wallet to view.
- Do not announce your travel or business plans in a public place, hotel lobby, airport etc. Luggage should not reveal your business connection.
- Try to use inconspicuous (but reliable) vehicles and park as close to your destination as possible. Often, a hired driver is the best solution.
- Protect your computer and valuable files with passwords. Do not leave your computer or external hard drives unattended in your hotel room. Lock them in a hotel safe with other valuables if possible.
- Know where your bag with valuables, documents and computer is at all times. Be especially careful in public locations such as airports, as it can be stolen very quickly.
- Always notify others of changes to your schedule and itinerary; maintain a record of local emergency contact numbers.
- When departing at airports, it is safest to check in and immediately proceed through the control gates to the restricted waiting area.
- Carefully follow airport security requirements when packing your carry-on bags. Keep informed about changing regulations.

Business people may be at some risk for kidnapping or robbery in some countries.

- It is important to maintain a low profile.
  - Dress discreetly and do not wear clothing with a business logo. Do not wear valuable jewelry; wear an inexpensive watch.
  - Do not draw attention to yourself with loud or confrontational behaviour.
  - Consider carrying your computer in a less conspicuous bag than the usual computer shoulder bag. Consider carrying an inexpensive camera.
- Be aware that you are most vulnerable to kidnapping when leaving your flight, catching taxis and entering and leaving your hotel, as well as while travelling in a vehicle.
- Avoid routine. Wherever possible, vary your travel routes and times between the hotel and office. Be wary of accidents or incidents, especially those that appear to be contrived.
- When you are walking, note possible refuges that you can use if you get into trouble. Stay close to busy thoroughfares. Avoid unlit streets or late night activities. Watch for threatening situations and refuse unsolicited offers of lifts.
- See Chapter 12.7 Kidnap and Ransom below for additional information.

Additional tips to reduce personal risk

- Do not travel to a high risk destination unless it is absolutely necessary. If you do proceed, be familiar with company crisis and contingency plans that are in place there.
- Be alert. Pay attention to what is happening ahead of and behind you when walking or riding; use the rear view and side mirrors to monitor traffic for vehicles that may be following you.
- For women: In most countries, local women never respond to strangers. You will be safest if you respond to men who approach you with cold silence and indifference. In some places even the word “no” may be interpreted as a “yes” and the beginning of a conversation.
- Show respect for local customs and cultures and be aware of any current cultural or political events that might result in civil disorder. If you encounter a disturbance, leave the area immediately and do not become involved.
- If there is any possibility of civil disorder within the country, register or confirm your registration with your embassy (or with several “friendly” embassies should yours not be available) so you will be included in any necessary evacuation.

12.5 | Hotel Safety

Although fire, theft or assault can occur in any hotel or motel around the world, a travel agent should be able to recommend a hotel in a safe area. Make a guaranteed reservation so you will not be stranded if they overbook. Use common sense and follow a few routines whenever you check in or approach your hotel room. This may prevent disaster – especially if there is a fire.

When choosing a hotel room consider the following:

- Request a room with a peep hole, a deadbolt and a chain lock.
- Avoid a ground floor room and keep windows and doors secure.
- Choose a room located on the side of the building with a street that can accommodate fire rescue equipment. Fire rescue equipment rarely reaches higher than 25 metres (6 to 8 stories).
- Inquire if there are working smoke alarms and a sprinkler system in the rooms.

To prevent theft:

- Never leave clothing or luggage unattended anywhere – especially in hotel lobbies, restaurants, and airports.
- Be careful about being distracted by someone talking to you while an accomplice takes your briefcase or other belongings.
- Request a room near an elevator if theft is a problem where you are staying. These rooms are safer because thieves usually target rooms near the end of corridors and near stairwells.
- Never leave valuables, papers, travel documents, computer or cash lying in your room; use a hotel safe. Do not think that hiding something in your room is sufficient.
- Check that all locks on hotel doors and windows work properly, including those on sliding doors that open onto a balcony. Request another room if any lock does not work properly. Check that all windows and doors are locked each time you return to the room (i.e., sliding glass and those to adjoining rooms).
- Keep all the doors and windows locked at all times, even when you leave the room briefly. Keep the door chain-locked until you visually identify visitors.
- Leave the "Do Not Disturb" sign on the hotel door at night and also when you are out in the evening to give the impression that you are in the room.
- Do not leave the sign on the door requesting that the room be made up; this advertises the fact that you are not present.
- Become familiar with regular hotel staff and stay clear of staff you are unsure of.
- If someone knocks claiming to be from hotel services, call the desk to verify this fact if you have not requested the service.

- Do not enter your hotel room if anyone is lingering nearby or follows you in the corridor. Pass by your room and find a hotel telephone to request security or return to the front desk. It is common practice for thieves to push a victim into a room as the door is being unlocked.
- Alarms: A burglar alarm can be improvised by stacking small objects such as drinking glasses and ashtrays in front of the door so the noise from them being knocked over awakens you. The standard rubber wedge door stopper will work to block the door. There are also inexpensive wireless electronic door and window alarms that sound when they are disturbed. These are readily available at many local hardware stores, security products stores, and through the internet.

12.6 | Hotel Fire Safety

During a hotel fire, people die more frequently from smoke inhalation, toxic gases or injury due to panic than from flames. If fire breaks out – DO NOT USE THE ELEVATOR – as it may take you to the floor where the fire is burning. Remain calm and DO NOT PANIC.

Plan your escape procedure from fire when you check in.

- Ask how guests are notified in the event of fire.
- Find two evacuation routes from your hotel room immediately after you enter and set down your luggage. Refer to a hotel evacuation map, which may be posted on the back of the door or in a hotel brochure. Locate the fire alarms, fire extinguishers and the fire exits on either side of the room.
- Count the doors to each fire exit so you can feel the way to the exit, even if the hall fills with smoke. Check that the exits are not blocked or locked. Note any obstacles such as furniture in the corridor or if it is necessary to turn a corner to reach the exit.
- Note whether it is possible to escape from the hotel window. There may be a roof or deck that you can safely drop onto below the window.
- Check that the window will open. If not, consider the best way to break it should the need arise.
- Test that the smoke alarm operates by pushing the button. If not, request another room if the hotel staff will not immediately repair or replace it.
- Note how to stop the air circulation fan that supplies air to the room.
- Always keep your room key, eyeglasses, identification papers and a flashlight on the bedside table so you can locate them in the dark. The flashlight should have a strong beam.
- In some places it may be advisable to carry a smoke hood (evacuation hood). The smoke hood may provide additional time and safe air to breathe to escape a hotel fire (or aircraft fire). An evacuation or smoke hood should meet certain requirements (which are not standardized) that

include protection against carbon monoxide. Some hoods require knowledge or practice to put them on correctly. To purchase an evacuation or smoke hood, search the internet for "evacuation hood" and "smoke hood" and pay attention to the safety criteria and protection time they offer.

If a fire breaks out in your room, do the following:

- Telephone the hotel operator and inform them of the fire and your location.
- Try to put out the fire only if it is small and you are sure that you can do so.

  If you cannot control the fire, leave the room and close the door securely to confine the fire. Take your key, glasses, identification papers and flashlight. Activate the alarm and notify your neighbors. Use the stairs to exit the building.

If a fire breaks out elsewhere in the hotel, do the following:

- Take your key, eyeglasses, identification, smoke hood and flashlight and go to the door. Crawl to the door if there is smoke in your room. Smoke rises; the clearest air will be near the floor.
- Before opening the door, feel the surface and doorknob to determine if it is hot. Do not open the door if it is hot.
- If the door feels cool, open it slightly to see if there is smoke in the corridor. Close the door quickly if the corridor is filled with smoke.
- If it is safe to leave your room, take the essential articles (above) especially your key and flashlight in case you must retreat to your room. Always close your hotel room door.
- If the corridor is passable, walk or crawl to the fire exit stairwell, counting the doors if necessary. Test to determine if the fire exit door is hot before opening it. If it is safe to enter, walk down the stairway holding securely onto the handrail to avoid falling. Close the fire door to the stairwell. Do not enter a stairwell that contains smoke. Try the alternate fire exit(s). Retreat to your room if you cannot find a smoke free stairwell for escape.
- Stop if you encounter smoke as you descend the fire exit stairwell. Reverse your direction and retreat to your room (or a smoke free corridor where you should bang on doors to find a smoke free room). Hang on tightly to the stair rail, as people will be attempting to go down. Smoke rises in stairwells so do not go to the roof. Chances are, these doors will be locked and you will be unable to exit onto the roof. Go to the roof only as a last alternative.
- Use your smoke hood when you encounter smoke. Wearing one may allow you to use an escape route that contains some smoke.

If you are forced to remain in your room, do the following:

- Try to notify the hotel operator that you are remaining there. Hang a sheet in the window to signify your presence.

- Fill the bathtub with water and turn on the fan to help disperse any smoke – but make sure no smoke enters. Soak towels and sheets and place them around the door, windows and vents – wherever smoke may enter. Use an ice bucket or waste paper basket to wet down the door and any walls that feel hot. Soak the mattress and place it against the hot door. Swing a wet towel around in the room to help clear the air of smoke. Remain calm.
- Open a window slightly to gain fresh air only if necessary. Before you open or break the window, make sure no rising smoke or flames can enter the room from the outside. If necessary, drape a blanket over your head to make a tent while you breathe at the opened window. This will help exclude smoky air in the room from your lungs. A wet towel held over your nose and mouth will help filter out smoke.
- If it becomes impossible to remain in your room, choose the best exit. Cover yourself with a wet blanket and use wet towels to cover your mouth and nose. Stay low to the floor to avoid smoke and toxic gases. Put on a smoke hood if you have one.
- Do not drop from your room if you are more than two floors above the ground. If it is safe to do so, try to lower yourself using a securely tied sheet etc., rather than jumping from the window sill. People are almost always badly injured or killed if they jump from more than one story.
- STAY CALM. Panic causes most hotel fire deaths.

Know how to use a fire extinguisher to help escape from a building.

Should you find yourself and others trapped by a fire that is shooting flames from a room out into a corridor with the exit beyond the flames, the following action will help you escape.

- Using a dry chemical extinguisher (B or ABC), make two discharges into the flames using a sweeping circular motion. The dry chemical compound will disrupt the flames for a short time so that people may run along the corridor past the fire to the exit on the other side.
- Repeat the circular motion discharges until everyone has escaped out the exit.

12.7 | Kidnap and Ransom

As a foreign traveler, you may be targeted for kidnapping and ransom. Those who perpetrate these crimes are either promoting a political agenda and/or seeking to gain a financial or political dividend. Travelers are advised to check if there is a history or risk of kidnappings where they intend to travel and take the necessary precautions to mitigate these risks. In the USA and sometimes Canada, the crime is often motivated by sexual predation and/or murder, whereas in most other countries the aim of kidnappers is usually limited to extortion and a ransom payment – it is simply a “business deal”.

If you are a victim of kidnapping or carjacking, the appropriate reaction depends on the country where the crime occurs.

- In most cases, you should give up your possessions quickly and try to do whatever you can to avoid being taken away from the abduction location as your chances of survival are limited.
- In general, for most other countries the best response is to remain calm and maintain your dignity. Cooperate with your captors. Do not try to mislead them, but do not provide unsolicited information. This response is appropriate for most countries.

Because abduction situations vary greatly, the following considerations should be applied based on one's best judgment at the time:

- Know the ransom policy of your government. Will they negotiate?
- The greatest risk of physical harm exists at the point of capture and during a rescue attempt or upon release.
- Remain calm and alert. Exert control on your emotions and behaviour.
- Be passively cooperative, but maintain your dignity.
- Assume an inconspicuous posture and avoid direct eye contact with captors.
- Avoid resistance, belligerence or threatening movements.
- Make reasonable, low key requests for personal comforts (bathroom break, a blanket, exercise, books to read etc.).
- If questioned, keep answers short. Volunteer nothing.
- As a captive situation draws out, try to establish some rapport with your captors.
- Avoid discussing contentious issues (politics, religion, ethnicity).
- Establish a daily regimen to maintain yourself physically and mentally.
- Eat what your captors provide and try to consume healthy balanced portions of food and drink but avoid overeating. Avoid alcohol.
- Keep a positive, hopeful attitude.
- Attempt an escape only after weighing the risks and when you are certain to succeed.

12.7.1 | Express Kidnapping

"Express kidnappings" – also referred to as ATM abductions, where the victim is forced to withdraw money from his or her bank account or credit card – are common in many urban areas. The crime is well established in some countries and is increasing in Latin America. The criminals work in teams and often patrol a major thoroughfare in several vehicles and communicate with each other via handheld radios or cell phones. When a victim is identified, they will follow him or her until the victim exits onto a side street in some quiet suburb or turns into some unattended parking lot.

When the attack is initiated, two or three vehicles will block the victim's car and team members swiftly gain access to the victim's vehicle, hijack the car and kidnap the victim all within a matter of seconds. It happens with positive and aggressive action and so quickly that the unfortunate person is in shock and the criminals are in control before he or she realizes what is happening. Invariably they rob the victim of possessions, take them to an ATM (automated teller machine) to make withdrawals using credit or debit cards, and in some cases they proceed to the victim's place of residence and steal personal belongings, such as jewellery, money and electronic equipment.

Victims should be aware that they may be held for a number of hours, often moving from one day into the next. This enables the robbers to take out the maximum daily withdrawal from the account on two consecutive days. Victims are not usually held for more than 24-48 hours and they are usually left a good distance from the kidnapping site. These events generally occur in the evening, although they do occur during daylight hours. The types of targeted vehicles vary from country to country.

- Express kidnappings are frequently conducted by ruthless individuals who are likely to resort to violence if confronted with resistance. Do not give them an excuse to become violent.
- Readily provide your personal account password. If you pretend to have forgotten it, they will typically use violence to force you to remember it.
- Remember – the primary objective of the kidnapper is to get your money. If you comply, you assist them in getting what they want, thus minimizing the potential for further violence.
- Your primary concern is survival; do not worry about your money. Remember – your life is worth much more than the money in your account.

Prevention and preparation

You can help avoid becoming a victim of express kidnapping by practicing and implementing good preventative measures.

- Do some research before a trip and seek local knowledge to find out if this crime is common. If so, learn where the risks are highest and which areas to avoid. Some information is available on the following website: https://www.osac.gov
- Avoid renting or riding in the frequently targeted types of vehicles.
- Avoid driving alone; a single occupant car is a more vulnerable target than a car with several people in it.
- Keep the vehicle doors locked and windows rolled up at all times.
- Familiarize yourself with your route to avoid referring to a map and appearing lost or vulnerable. Use well-traveled streets. Avoid short cuts and unfamiliar side streets.
- Be alert to what is happening ahead and behind as you drive. Continuously use the rear view and side mirrors to monitor traffic at least one block behind.

- Use good counter-surveillance techniques to be aware of your surroundings. Some examples include:
  - If you suspect you are being followed and this technique is possible, make three right turns and see if the vehicle is still in sight.
  - Pull over and park in a populated area so that you can try to identify the persons following you. This also disrupts their surveillance process.
- If you suspect you are being followed, radio or telephone for assistance and drive to a safe place or a populated area and seek help.

12.8 | Travel Health

It is not unusual for employees to become ill when travelling abroad. The most common ailments are related to consuming contaminated food and/or water that result in “traveller’s” diarrhea. Malaria is one of the most serious risks in places where Anopheles mosquitoes carry the disease. This section addresses disorders that may encounter outside North America, including ones for which immunization may be advisable, precautions are essential, and diseases that are an occupational risk associated with mineral exploration work.

The goal of this section is to present travel health information to educate mineral exploration employees on how to manage and mitigate the risks they will experience when travelling. Health related topics are addressed in this section and as listed below:

- Refer to 18.6.5 Diseases in chapter 18 for information regarding diseases that are routinely prevented by immunization or are typically found in North America (e.g., tetanus, polio, measles, Lyme disease, giardiasis, tuberculosis, Hantaviral diseases).
- Refer to 9.9 Cold Injuries in chapter 9 for information about hypothermia, frostbite and immersion foot.
- Refer to 9.10 Heat Illnesses in chapter 9 for information about sunburn, heat exhaustion and heat stroke.
- Refer to 9.11 Altitude Illness in chapter 9 for information about the various forms of altitude illness.

12.8.1 | Ear Barotrauma and Jet Lag

Ear barotrauma (also known as aero-otitis, barotitis, and ear squeeze or airplane ear) is caused by variations in aircraft cabin pressure and occurs most commonly during descent. It can cause acute pain, noise in the ear and temporary deafness. The risk is higher when you have a cold or other upper respiratory tract congestion, as they affect the ear’s ability to adapt to changes in air pressure.

Tips to reduce the effects of barotrauma:

- Yawning or holding your nose and blowing against closed lips can help equalize pressure between the middle ear and the cabin pressure.
- Avoid flying when you have a head cold or "flu". If it is necessary, carry a nasal spray or antihistamine tablets and use them well before you commence ascent or descent.
- Ear plugs can be purchased that assist in relieving air pressure during flight or mountain decent. These devices can be purchased online or at local pharmacies for less than $10.
- Additional information about ear barotraumas or "airplane ear" can be found via the Mayo Clinic.

Jet lag develops when your personal internal day-night pattern (circadian rhythm) does not fit with the day-night pattern at the destination. This can result in fatigue, insomnia, loss of appetite and forgetfulness etc. Generally the effects are worse the more time zones you cross and with increasing age. Jet lag may be more intense if you are tired when you start a trip, when you travel in an easterly direction, and/or when you overindulge in food or alcoholic drink en route. Consult a doctor if you are considering medication for jet lag and be aware of possible side effects.

Tips for reducing jet lag:

- Get a good night's sleep prior to departure so you are well rested.
- Try to fly during daylight hours.
- In-flight cabin air is extremely dry. Drink plenty of fluids to counter dehydration. Water is best; avoid or limit alcohol and caffeine consumption.
- Eat light meals. Eating carbohydrate-rich rather than protein-rich meals may help adjust to new time zones.
- Try to sleep during a long flight. Blindfolds, ear plugs, inflatable neck rests and pillows may help increase comfort. Remove or untie shoes.
- Melatonin helps some people. Its status as a prescription or non-prescription drug varies depending on the country. Check with a medical expert if you have any medical issues because some tablets contain other compounds (e.g., herbs that interact with prescription medications).
- While you are awake, exercise by walking or standing in the aisles about every hour. Do some muscle stretching exercises while seated and walk during stopovers.
- If available, make use of showers during stopovers on a long haul flight. A shower is refreshing and helps improve circulation.
- At your destination, take a walk in the sun at the first opportunity and try to avoid sleeping during the day.

Additional information regarding jet lag is available from the Centers for Disease Control CDC).

12.8.2 | Deep Vein Thromboses (Blood Clots)

When you sit during long fights or long uninterrupted vehicle travel, blood clots may develop in the leg (deep venous thromboses or DVTs), which can be very painful and potentially fatal. A blood clot can break up and move through your body and lodge elsewhere, such as the lungs and cause a pulmonary embolism, which is potentially fatal. Consider taking preventive actions during a long flight. For people working in mineral exploration, it is not unusual to fly for ten or more hours to another country or continent and immediately after the flight start a long drive of perhaps ten or more hours to a field project. Thus, one's legs may not get significant exercise for 20 to 30 hours. This greatly increases the risk of blood clots.

- Wear loose comfortable clothing, especially from the waist down. Avoid tight clothing, including socks.
- Exercise by stretching or walking in the aisle about every hour when awake. While seated, do stretching exercises for leg muscles and flex the feet to reduce potential swelling. Remove or untie shoes.
- Walk for at least 10 minutes rather than remain seated during a stopover.
- Consider wearing compression stockings if you have a risk of venous thromboembolism.
- Seek medical attention if any unusual swelling or pain develops in your legs after a flight or drive.
- If you are immediately undertaking a long drive after a long flight, insist that the driver stop every couple of hours and take time to stretch and walk around before resuming the trip. It is preferable to have a break, perhaps overnight, between a long flight and a long drive.

12.8.3 | Safe Food and Water in Developing Countries

When you travel or work in places where hygienic standards are questionable, be cautions about what you eat and drink. Food or drink may cause illnesses if they are contaminated with bacteria, parasites or viruses etc. Contamination may easily occur where there is a sub-standard water supply or an inadequate standard of cleanliness for food storage, preparation and handling. Diarrhea is the most common disorder caused by food or water contamination and affects many travellers. Be aware of potential sources of food and drink contamination and, if necessary, be prepared to purify your own water. The aim is to avoid bacteria such as Salmonella and those that cause cholera, typhoid and dysentery; viruses such as those that cause hepatitis and polio; and parasites such as tapeworms, hookworms and Giardia cysts.

Travellers should become well briefed on health issues including diseases, food and water safety, personal safety and travel hazards in the area where they will work. Obtain up-to-date information from a travel medicine clinic or medical advisor. Project managers in developing countries should consult with local public health officials about the safety of water, milk, meat and other food items in the area. Public health officials are generally better informed about these issues than local doctors.

12.8.3.1 | Safe Food Guidelines

Safe food guidelines regarding restaurants

- Choose local restaurants that are recommended by business contacts, hotel managers or other reliable sources. If you are in doubt about food safety, it is better to eat at a high quality hotel.
- Note the cleanliness of the cutlery, plates, glasses etc. Also check the state of the toilets as a possible indication of the cleanliness. If you see many flies inside a restaurant (or a lot of garbage outside), it may be better to eat elsewhere.
- Never eat food sold by street vendors unless there is no alternative. Then, eat it only if it has been thoroughly cooked in front of you and handled minimally by the vendor. It is advisable to bring your own clean container and utensils.
- Wash your hands thoroughly before eating and carry hand sanitizer for use when handwashing is not possible. If possible, do not eat with your hands.

Safe food guidelines for developing countries

In brief, follow the standard advice. "Boil it, cook it, peel it, or forget it!"

- Only eat meat and fish that have been completely cooked (boiled, steamed, grilled) and served hot. Beef and pork should be well done with no pink or "rare" areas. Do not eat rare or raw fish, shellfish or meat. Do not eat cold meat or cold cuts (cold preserved meats).
- Only eat vegetables that are thoroughly cooked. Do not eat raw vegetables or green salads – especially those served in restaurants, as it is impossible to clean greens thoroughly.
- Be cautious about eating peeled fruits and vegetables. Choose those that are unblemished and peel them yourself. Wash the skins, the knife, and your own hands before peeling so that you do not transfer bacteria directly to the food (bacteria are easily carried from peel to knife to food). Do not eat fruits with punctured skins, that show signs of mould, or melons that could have had water injected into them before being sold.
- Canned and boiled milk is safe. Do not eat unpasteurized dairy products because they may contain tuberculosis or brucellosis bacteria.
- Do not eat milk products, ice cream, custards or frozen desserts, as these may contain untreated water or be contaminated with bacteria. Generally, one should avoid dairy products in developing countries because they are so easily contaminated.
- Do not eat raw or soft-cooked eggs. Hard-boiled eggs served in the shell are safest. Sauces and salad dressings containing eggs such as mayonnaise are not safe.
- Do not eat foods that have been left out in the sun, re-warmed or recycled. Avoid leftovers. Buffet foods are risky as they are set out for a period of time and may not be heated or cooled sufficiently to be safe.

- If microwaving your own food, microwave it thoroughly until it is very hot. The microwave process does not uniformly heat food and therefore it does not always raise the temperature enough to destroy bacteria on the surface of food.
- Avoid food and drink served on flights that originate, travel within or stopover in developing countries. Bring your own food and bottled water if possible. Be cautious of food, water and ice on airlines returning from areas with questionable sanitation. Even though a flight may originate in a developed country, it may be resupplied in a country with lower sanitary standards.
- In developing countries where local cultures have hospitality traditions, try to avoid appearing in villages at meal times. Explain to the village leaders that you have already eaten. Emerge from your vehicle and approach the leaders while drinking water from your own container so that they will not urge you to drink their water. This may not be possible in some places.
- In Muslim countries, try not to eat with your left hand, if possible. There, the left hand is considered unclean because it is used for personal hygiene; to eat with it is considered offensive. Also, try not to touch anyone with your left hand.

12.8.3.2 | Safe Water and Drinks

When travelling (usually outside Canada, the USA, and Europe) it maybe necessary to purify your drinking water, even in cities, as it may be impossible to be absolutely certain that it is safe to drink. Some communities in Canada are subject to “boil water” alerts and even remote lakes can be contaminated so that water requires treatment to be potable. In many countries, fecal matter from human and/or animal waste products is a major source of contamination due to poor sanitation practices. Water for consumption, which includes water for brushing teeth, should be purified to kill disease causing organisms. By drinking untreated water, you may be exposed to many water-borne diseases, including hepatitis, giardiasis, dysentery, typhoid and cholera. In most countries, it is best to regard all surface water sources as unfit to drink.

All field exploration projects and camps – no matter where they are located – should test the water supply and treat it as required according to jurisdictional regulations (refer to Chapter 18.6.3 Drinking Water Safety).

Know the source of your drinking water. In some places, the water may be suspect, even in a luxury hotel.

- Water for consumption should be boiled, chemically treated and/or filtered in developing countries. Avoid untreated tap water.
- Hot tap water may be safe if it is reliably filtered and treated, but do not drink it if you are unsure.
- Commercially bottled water is safe if it is from a large dependable company. Request carbonated water to verify that the bottle was not simply refilled with local water and recapped. Break the seal yourself to make sure the seal has not been broken.

- Beverages made with boiled water such as tea and coffee, canned or bottled carbonated drinks, beer and wine are safe to drink as long as it is clear the bottle has not been opened.
- Beverages are only safe if they are served in a clean glass. Use your own container or use a straw sealed in paper or plastic. It is advisable to carry a supply of sanitary straws to some destinations.
- Ice is only safe if it is made from safe water. Avoid ice blocks and ice cubes in restaurants, as they are often made from untreated water. Freezing water or adding alcohol to water will NOT make it safe to drink.
- Always brush your teeth with water that is safe to drink. If safe water is unavailable, put the hottest possible tap water into a clean glass and let it cool (without ice) before using it.
- Do not drink water from natural waterways, dams or livestock watering points, as it may be contaminated with bacteria, viruses or chemicals, or it may have a high salt content.
- In many countries, remote wilderness lakes and streams contain enough diarrhea-causing Giardia parasites or coliform bacteria to make water treatment necessary.
- Standard water purification methods will not remove arsenic or other chemicals from water. Where arsenic or other chemicals are a problem, drink only bottled water – but know the source of this water. Seek dependable local knowledge.

12.8.3.3 | Water Treatment in Remote Areas or Developing Countries

This section addresses methods for travellers to use to purify small quantities of drinking water.

Generally, water is safe to drink when it is treated by boiling, chemical treatment, filtering or a combination of these processes. The aim is to avoid bacteria, viruses, cysts and larvae of parasites that will make you sick. A travel medicine clinic will provide information on specific water treatment methods and apparatus appropriate for your destination(s). A variety of chemical treatment tablets, filtering mechanisms, purifying cups, and sports-type water bottles containing purifying filters are available. Apply the appropriate water purification instructions when working in a remote fly camp if the water source is potentially contaminated.

Always store purified water in clearly labelled, closed containers and keep them separate from unpurified water. Rinse the containers with a weak bleach solution before refilling them.

- **Boiled water is safe to drink.** While it is time consuming and may be awkward, boiling is the best method to purify drinking water.
  - Bring water to a vigorous rolling boil and then allow it to cool without adding ice. Water does not have to boil for long (one minute is sufficient) as the heating process kills most harmful organisms.
  - At altitudes above 2000 m, it may be advisable to boil water for three minutes as an added measure of protection.
  - An electric immersion water heater may be adequate for boiling small amounts of water, but remember that the container itself must be clean.
  - Store boiled water in a sterile closed container – bring your own container if you anticipate that none will be available. Purified water can easily be contaminated again if it is not stored properly.
  - Pregnant women should drink boiled water in preference to chemically treated and/or filtered water.
- **Chemically treated water is safe to drink.** The required length and strength of treatment depends on water temperature, pH level, and the amount of sediment in the water. The contact time is important because chemicals must be in contact with the organisms to kill them. Treatment works best if water is over 21°C so start with the hottest tap water available, as it is likely to be less contaminated than cold tap water. Let the water stand for at least 30 minutes after treatment. If the water is cold when treatment begins, it should stand for a longer time before use. It may be advisable to filter water before chemically treating it, especially if it is very cold. Cloudy water must be filtered before chemical treatment, as cloudiness indicates the presence of sediment that may conceal disease-producing organisms.

- Iodine is available as drops, tablets or crystals. Carefully follow the directions for the type of iodine used.
    - Iodine tablets have an expiry date and are ineffective after the date. Iodine tablets decompose readily, have a short shelf life, and must be stored in a dark bottle as they are light sensitive. It is advisable to replace them frequently; purchase a new supply if there is any doubt about the viability of the tablets.
    - For a 2% solution of tincture of iodine, add the correct number of drops to one litre of clear water. The water should not taste of iodine.
    - Some people are allergic to iodine and some people should not be exposed to it due to health risks, age or medications so check with a travel physician before using it.
- Chlorine products can often be used by people who cannot use iodine. Halazone tablets are a chlorine purification product. Follow the directions that accompany the product.
- Bleach: For a 4-6% solution of regular chlorine laundry bleach (sodium hypochlorite), use 2 drops to one litre of water or until it smells slightly of bleach. Do not use non-chlorine bleach to disinfect water.
- Cloudy water and water that may contain Giardia cysts or Cryptosporidium must be filtered before chemical treatment. Bleach and iodine will not necessarily destroy either Giardia cysts or Cryptosporidium. Water should also be boiled or filtered with the proper type and/or size of filter to remove the cysts or sediment (see Filters: below).
- Pregnant women and women on long term assignment should consult a medical advisor about the safe duration of drinking iodine-treated water, as extended exposure to iodine may cause goitre, especially in women and children.

▪ **Filtered water should be chemically treated or boiled after it is filtered.**

- Filters: Filtering water eliminates sediment, bacteria, larvae and cysts that are larger than the filter pores. Some systems use multiple stage filters where the first stage removes sediment and the second stage removes protozoa and bacteria. Some filters incorporate a third stage with an iodine resin to eliminate viruses. For information regarding filters to use for removing Giardia and Cryptosporidium cysts, refer to the CDC.
- Filter systems must be maintained to be safe because they clog up quickly. Filters may break down over time and it can be difficult to detect cracks in them.
- Infants and children should avoid filtered water unless an iodine resin is present in the system. Nevertheless, one should maintain caution about the use of iodine filters.
- If water is very cloudy, filter it through a clean cloth to help remove sediment. Let the water stand and then decant the clear water for treatment by boiling or chemicals, or even passing through an appropriate filter system.

Additional information regarding water purification can be found in Appendix I.XII

12.8.3.4 | Safe Water for Swimming and Bathing

Some water may not be safe for swimming or bathing. Be aware of the quality of surface waters where you work. Know which parasites may be present and treat water to kill them.

- Avoid swimming in any fresh water or seawater where there is any suspicion of s ewage contamination.
- Do not swim in or dive into stagnant waters; they often contain bacteria that can enter your mouth, ears, nose and sinuses and cause illness.
- It takes very few cysts to infect a person with Giardiasis (beaver fever), a disease that may cause severe diarrhea. It is unwise to drink or swim in any water that might be contaminated with these parasites. This includes beaver ponds and cold mountain lakes, as Giardia cysts thrive in a cold alkaline environment. Giardiasis is common in remote areas of North America. In the Middle East, India and western Russia, Giardiasis is a common form of traveller's diarrhea as cysts may be present in the public water supply (see Chapters 12.8.5.14 and 18.6.5.2).
- Schistosomiasis (Bilharzia) parasites frequently occur in fresh water in tropical Africa, parts of tropical Central, South America and the Caribbean, and parts of Asia. These microscopic parasites are released from snails and the parasites may be present in water even when you cannot see the snails. It is not safe to drink, swim, wade or otherwise come in contact with fresh water that contains these parasites. They will invade through your skin if they are present (see Chapter 12.8.5.13). Water can be made safe from schistosomiasis and used for swimming and bathing by the following methods:
    - While it may not be practical, snail-free water left to stand in a securely covered container for 48-72 hours can be used for bathing. It will be free of parasites that cause schistosomiasis (but not necessarily free of Giardia or Cryptosporidium).
    - Water heated to 50°C (125°F) for more than 5 minutes is safe from schistosomiasis parasites.
    - Unpolluted seawater and chlorinated swimming pool water are safe.

12.8.3.5 | Fluid Replacement Therapy

An attack of diarrhea or vomiting can leave your body dehydrated. There are several choices when fluid replacement therapy (oral rehydration) is required. Commercially available pre-packaged mixes of balanced electrolyte-glucose solutions are easy to prepare. It is advisable to carry the packets on trips where you risk getting diarrhea.

You can also mix your own from commonly available ingredients. Sip alternately from each glass if you use the two-glass method. Drinking a succession of hot caffeine-free teas, broths and carbonated drinks will also help replace fluids and salts, but avoid milk and beverages that contain caffeine or alcohol. Be sure to use purified water when preparing fluid replacement solutions. If purified water is not available, it is better to use impure water than to avoid fluid replacement therapy altogether.

FLUID REPLACEMENT THERAPY Home Preparation Electrolyte Solution		
TWO-GLASS METHOD		SINGLE GLASS METHOD
Drink Alternately from Glass 1 and Glass 2		Potassium Chloride ¼ tsp (1 ml) (salt substitute)
GLASS 1	GLASS 2	Sodium Bicarbonate (Baking Soda) ½ tsp (2 ml)
Fruit Juice 8 oz (250 ml)	Water 8 oz (250 ml)	Table Salt ½ tsp (2 ml)
Honey or Corn Syrup ½ tsp (2 ml)	Sodium Bicarbonate (Baking Soda) ¼ tsp (1 ml)	Glucose 2 tsp (25 ml) or Sucrose 4 tsp (50 ml)
Table Salt (pinch)		Water 8 oz (250 ml)

Figure 12.1: Fluid Replacement Therapy

In an emergency, an adequate rehydration mixture can be made using:

- 2 ml (½ level teaspoon) table salt
- 30 ml (6 level teaspoons) regular table sugar (not substitute)
- 1 litre of boiled water

While this mixture contains no potassium or bicarbonate, it is better than drinking plain water or soft drinks. “Sports drinks” can also be used; it is advisable to dilute a full strength sports drink by adding 50% more water to the solution. The additional water helps dilute the high level of sugar and assists with the absorption of the electrolytes. Do not use a high caffeine “energy drink” for rehydration purposes. It is never advisable to administer drinks containing caffeine to anyone suffering from dehydration, hyperthermia or hypothermia. Caffeine, carbonated drinks and beer increase urine output and therefore they contribute to dehydration.

12.8.4 | Protection from Insect Bites

Insects carry organisms that cause many diseases and they can transfer pathogens into your body with a single bite. Some insects may cause serious diseases in some parts of the world. Fortunately, by protecting yourself from mosquito bites, you also protect yourself from ticks, sandflies, blackflies, tsetse flies and leeches. Avoid colognes, perfume or hairsprays, as the scents attract insects. Use unscented shampoo and soap.

Definitions

Insect repellents contain an active ingredient that repels insects from the body.
They do not kill insects.
Insecticides contain an active ingredient that kills insects on contact (adults, larvae or eggs).

In Canada and the USA, biting insects may be a mere nuisance or a serious distraction. Depending on the project location and/or field area, it may be important to prevent bites. Mosquitoes carry West Nile virus and western equine encephalitis. Ticks carry Lyme disease and Rocky Mountain spotted fever, and fleas occasionally carry plague. To help reduce the numbers of insect bites, wear appropriate clothing, use insect repellent on exposed skin and apply insecticide to clothing.

In Central and South America, Africa, and Asia, insects may carry significantly more serious and even fatal diseases than in North America. Additional preventive measures are required. Only by using multiple approaches can you successfully avoid insect bites. Studies show it is possible to achieve excellent protection from mosquito bites if you (1) use insect repellents with DEET on exposed skin, (2) wear permethrin-treated clothing, (3) spray living/sleeping quarters with insecticide and use permethrin treated mosquito netting at night. DEET is the abbreviation for the chemical N, N-diethyl meta-toluamide. Use pyrethroid-containing knockdown sprays that kill insects on contact. (Permethrin is a pyrethroid chemical.) Check with a travel medicine clinic to confirm your vaccinations are up-to-date and learn which diseases to protect against at the project location or travel destination. It is still necessary to take anti-malarial medication if you travel to a place where malaria is a risk.

Prevention and preparation

Barriers – physical and chemical – are the best means of protecting yourself from insect bites.

- Clothing
    - Wear long sleeves and long pants tucked into your socks. Protect yourself any time you work in areas where ticks and day-feeding insects are a problem. Make a special effort to protect yourself between dusk and dawn to avoid being bitten by night-feeding mosquitoes.

  - Clothing fabric should be tightly woven and thick enough to provide an added barrier.
  - Clothing should be sprayed with insect repellent (DEET) or treated with permethrin, a contact insecticide. See the section below: How to treat clothing and bed nets.
  - Permethrin-treated expandable athletic cuffs and headbands act as barriers, especially for ticks and blackflies. Pyrethroid-containing sprays (insecticides) are more effective than DEET against deer ticks that may cause Lyme disease.
  - Net bug jackets treated with permethrin are good barriers when worn over clothing. Although they interfere with vision, head nets are very helpful protection against swarms of mosquitoes and black flies.
  - Wear shoes and socks; do not wear sandals.
  - When using both sunscreen and insect repellent, apply the sunscreen first, preferably 30 minutes before applying insect repellent.
- Insect repellents and insecticides
  - A repellent containing DEET is most effective for use on skin. For adults, use 15% to 35% DEET on your skin as recommended by doctors. Above this concentration, toxic reactions might occur, as it is absorbed through the skin. Children should use 10% DEET or less. Pregnant women should use as little insect repellent as possible (no more than 10% DEET). Some cream style repellents contain a polymer to prevent absorption. Ask your local pharmacist to recommend specific brands and check the contents. You may spray or immerse clothing with 95% to 100% DEET.
  - Apply repellent to all exposed skin and reapply it every two to four hours, depending on the strength. Follow the application instructions and take time to apply it evenly and thoroughly onto your face, neck and limbs. Insects tend to bite where veins are near boney surfaces so pay extra attention to these areas (wrists, ankles, skull, jaw line, and shoulder blades). Do not apply it next to your eyes, on your lips or over cuts or skin irritations. Wash repellents off your skin when protection is no longer needed.
  - Reapply insect repellent more frequently if you get wet (sweating, swimming, rain) or when there are lots of insects.
  - Avoid breathing the sprays of repellents and insecticides and do not apply them near food.
  - Warning: DEET will affect the surface of plastic or synthetics, including vehicle seats and the plastic lenses of eyeglasses.
  - Do not use insecticide on your skin. Pyrethroid-containing sprays should be applied to clothing and living quarters. These sprays can also help control bed bugs.
- Bed Nets – for use in places where disease-transmitting insects are a hazard
  - Your sleeping bag or bed should be surrounded with permethrin-treated mosquito netting when you must prevent insect bites. A variety of bed nets are available. Some must be suspended and some come with collapsible poles for support.
  - Place the net over the bed before dusk and keep the net tucked under the mattress to prevent insects gaining entry. Use a knockdown spray inside the net.
  - Do not sleep in a position where you touch the net as insects may bite through the net.
  - Store the net carefully during the day and search it carefully for insects and holes each night before bed. Mend holes with tape.

- Knockdown sprays (insecticides)
    - Use aerosol insecticide sprays containing pyrethroids or permethrin because they kill insects on contact.
    - Spray the bedroom, bathroom and inside your sleeping net 30 minutes before going to bed.
    - Spray all window and door curtains to reduce the number of insects. Windows and doors should be tightly screened.

How to treat clothing and bed nets

Protection against insect bites is greatly increased when you use spray or immerse clothing and bed nets in insecticide. The effectiveness lasts through several washings or up to six weeks without washing. While 95% to 100% DEET may be used, permethrin is a better product to use because it kills insects on contact and protects longer. It is not toxic to humans, but it may cause minor skin irritations. Store the treated garments and bed nets in plastic bags out of direct sunlight when not in use.

- **To spray clothing or gear:** Permethrin sticks to fabrics but does not damage or stain them. It works best on cotton fabrics.
    - Lay the items flat and spray each side for 1-2 minutes.
    - Hold the can 30 cm away and spray back and forth.
- **To immerse bed nets**: Instructions for treating mosquito bed nets are given by the CDC.

12.8.5 | Diseases

The following diseases are arranged alphabetically for easy reference. This section contains diseases that are encountered more frequently outside North America. Diseases commonly found, or that are more prevalent, in North America are located in Chapter 18.6.5 Diseases.

12.8.5.1 | Chagas Disease (Trypanosomiasis – American)

Description

Chagas disease is transmitted by the triatoma beetle, also known as the kissing bug, assassin bug or vinchuca. This beetle is found throughout rural areas of Central and South America. They inhabit palm trees, thatched roofs and the roofs and walls of mud, adobe or cane dwellings. At night, insects drop onto a bed and bite a victim. They feed on blood and then excrete protozoan parasites in their feces onto the victim's skin, which the victim inadvertently rubs into the bite. A nodule, chancre or ulcer (chagoma) develops at the site of the bite. Chagas disease may also be transmitted through blood transfusions in countries where the disease is common and blood products are unscreened.

Prevention

Prevention is the key. Unless medical treatment is begun during the acute stage soon after exposure, it will progress to chronic progressive heart disease. Then, there is no effective treatment and the disease is generally fatal. If you work where Chagas disease is present, take active measures to prevent bites and eradicate the insects from your quarters.

- Do not construct housing with adobe, mud, straw and with local thatch materials in the roof or rafters.
- Fumigate all buildings whenever you occupy an uninhabited camp. The bugs hide in cracks and crevices as well as thatch materials.
- Use appropriate knockdown insecticides indoors.
- Sleep under a treated mosquito net. Use a knockdown spray inside the sleeping net before bed.
- Search your bed and living area for insects; the beetles are large (2.5 cm) and easy to spot.
- Avoid blood transfusions or used needles that may transmit the parasites.
- Do not consume uncooked food contaminated with feces of assassin bugs.

Symptoms

- A swollen nodule forms at the site of the bite; the skin may lose its pigmentation there. A swelling of one eyelid and then a facial lymph node develops after one to two weeks.
- Other symptoms include fever, swollen lymph glands, rash, spleen or liver enlargement.
- Symptoms may subside after a few months but the disease continues to develop in internal organs causing them to enlarge. If the heart enlarges, congestive heart failure develops.
- This disease can be confused with malaria, eye infections, mumps or sinusitis.
- A blood test is necessary for diagnosis.

Areas of concern: Mexico, Central and South America
Additional information regarding Chagas disease is provided by the CDC.

12.8.5.2 | Cholera

Description

Cholera is caused by a bacterium. It is spread through sewage-contaminated food and water. While it can be life-threatening, it is preventable and easily treated. You should seek immediate medical treatment for cholera because dehydration can develop rapidly, sometimes within a few hours. Fluid replacement therapy is important. To prevent cholera, pay careful attention to the quality of food and water you consume in developing countries.

Symptoms

- Symptoms of severe cholera include massive, watery, light coloured diarrhea that is relatively painless. It is sometimes referred to as rice water diarrhea.
- Vomiting
- Leg and muscle cramps

Prevention

Avoid contaminated food and drink.

- Do not eat raw or undercooked food – especially seafood. Foods should be fully cooked and served hot.
- Drink only boiled, bottled or treated water and other safe beverages. Do not drink beverages containing ice unless it is made with purified water.
- Wash and peel away all fruit and vegetable skins.
- Wash your hands before eating, drinking and preparing food.

Areas of concern: Africa, Indian subcontinent, Asia, Central and South America
Additional information regarding cholera is provided by Health Canada.

DRIVING RESPONSIBLE EXPLORATION

12.8.5.3 | Dengue Fever

Description

Dengue hemorrhagic fever is also known as Philippine hemorrhagic fever, Southeast Asian hemorrhagic fever, and Thai hemorrhagic fever. Other names include Breakbone fever and dandy fever.

Dengue fever is a common viral disease in tropical and subtropical regions. Dengue fever is spread by the Aedes mosquito that lives indoors and outdoors in urban areas. This mosquito usually feeds during the day and at twilight and lives in close association with humans. There has been a marked increase in the incidence of dengue fever, especially in the tropical and subtropical parts of Central and South America and the disease is spreading northward.

If you suspect that you have contracted dengue fever, seek medical attention as soon as possible. Dengue fever sometimes has a hemorrhagic component so do not use aspirin and ibuprofen (non steroidal anti-inflammatory medications). Use only Acetaminophen or paracetamol products because the fever itself can cause bleeding. This severe form of dengue fever may be fatal.

Symptoms

- Dengue fever starts 2 to 8 days after the infecting bite and lasts 5 to 7 days.
- Symptoms include sudden high fever, severe headache, fatigue, severe muscle and joint pains. Initial symptoms can resemble malaria.
- A fine itchy rash accompanies the fever. Dengue may be difficult to distinguish from malaria, flu or yellow fever until the rash appears.
- A second stage includes fever, another rash and general weakness.

Prevention

Take active measures to prevent mosquito bites.

- Use insect repellent (DEET) on skin and spray clothing with permethrin. Pay particular attention to the feet and ankles as most Aedes mosquitoes bite below the waist.
- Use mosquito nets and spray your living quarters.
- If you or a co-worker has dengue fever, make sure that mosquitoes do not bite the sick person and spread the infection to others.

Areas of concern: Central and South America, the Caribbean, Asia, tropical Africa, the Pacific Islands
Additional information regarding dengue fever is provided by the World Health Organization (WHO).

DRIVING RESPONSIBLE EXPLORATION

12.8.5.4 | Hepatitis, Viral

Description

There is a large group of viruses that cause inflammation of the liver. The symptoms range from mild and flu-like to fatal liver failure. The hepatitis viruses are transmitted in various ways and all strains of the disease are serious. Protect yourself from exposure by being immunized against hepatitis A and B.

Symptoms

- Symptoms may occur 4 to 6 weeks or more after exposure, depending on the type.
- Typical symptoms include fatigue, loss of appetite, jaundice (yellow coloured skin and eyes), dark urine, fever, abdominal pain and aching joints. Rash is often an early symptom.
- A blood test is required to confirm a diagnosis.

Hepatitis A

Hepatitis A is the most common form.

Transmission

- Hepatitis A is spread through fecally contaminated food and water, usually in locations with poor sanitary conditions. Food handlers may spread it if they do not wash their hands properly.
- Contaminated shellfish and contaminated water are frequent sources of the virus.

Prevention

- Be immunized. A vaccine is available and recommended for frequent travellers or those going to a location where hepatitis A is a risk.
- Follow safe food and water precautions, especially in developing countries where there is poor sanitation.

Areas of concern: Worldwide
Additional information regarding hepatitis A is provided by the CDC.

Hepatitis B

Hepatitis B is a more serious infection than hepatitis A. Potentially severe complications may follow infection including cirrhosis, liver cancer and chronic hepatitis. Hepatitis B can be fatal.

Transmission

This highly infectious form of hepatitis is directly transmitted by exposure to infected blood and body fluids. It is spread by the following ways:

- Person to person during sexual contact and childbirth
- Exposure to infected blood (e.g., transfusions, blood splashed into the eyes or an open wound)
- Exposure to blood-contaminated objects (e.g., needles, syringes, razors, inadequately sterilized medical equipment). This may occur during activities such as the sharing of razors, or during tattooing, acupuncture, ear/body piercing, and through the injection of drugs.
- Ingesting food or water contaminated with human excrement or urine containing the hepatitis B virus.

Prevention

- Be immunized. A vaccine is available to protect against hepatitis B.
- Avoid sharing personal items that may be contaminated with blood, including razors and toothbrushes.
- Eliminate risky behaviours: Practice safe sex. Avoid using illegal drugs.
- Prevent injuries and the need to receive unscreened blood products.

Areas of concern: Africa, Asia, South Pacific Islands and South America
Additional information regarding hepatitis B is provided by the Public Health Agency of Canada.

DRIVING RESPONSIBLE EXPLORATION

Hepatitis C

No immunization is available to prevent this form of hepatitis.

Transmission

- Hepatitis C is usually transmitted by unsafe sexual practices, contaminated needles or unscreened blood transfusions.
- Hepatitis C is not spread through contaminated food and water.

Prevention

- Do not share personal items such as toothbrushes and shaving equipment.
- Eliminate risky behaviours: Practice safe sex. Avoid using illegal drugs.
- Prevent injuries and the need to receive unscreened blood products.

Area of Concern: Worldwide

Hepatitis E

No immunization is available for this form of hepatitis.

Transmission

- Most outbreaks are believed to be spread through fecally contaminated water where poor sanitary conditions exist. Some outbreaks are unexplained.
- Hepatitis E is a serious risk for pregnant women – up to 25% of those who are infected during pregnancy will die of serious liver disease.

Prevention

- Do not drink untreated well or surface water in high risk areas.
- Drink only bottled, boiled or chemically treated water.
- If you use a filter system for water, it must have an iodine resin matrix to be effective against this virus.

Areas of concern: Indian subcontinent, Northern Africa, some parts of Asia, Eastern Europe and Central America

12.8.5.5 | Histoplasmosis

Description

Fungus spores released from high concentrations of bat droppings or bird droppings may cause serious fungal infections (mycosis) in the human body. Usually the lungs are most seriously affected, as the victim breathes in the spores. However, rich organic soils may also contain enough spores to cause infection by exposure to an open wound. Old mine workings and caves that house large populations of bats may present a health risk to exploration employees who enter them.

Symptoms

- Fatigue, cough and fever usually appear within 5 to 18 days after exposure.

Precautions

- Avoid entering old mine workings or caves that may contain bat or bird droppings. If entry is absolutely necessary, wear a respirator to minimize your exposure to airborne spores. Only use a respirator with a high efficiency particulate air (HEPA) filter capable of filtering out particles that are two microns in size (the size of the Histoplasma capsulatum spores).
- Check frequently that your respirator is working properly.
- Thoroughly wash any clothing worn after exploring old mine workings or caves.
- Areas of concern: Worldwide

Additional information regarding histoplasmosis is available from the [Canadian Centre for Occupational Health and Safety].

12.8.5.6 | Japanese Encephalitis (JE)

Description

Another name for this is Type B encephalitis.
Japanese encephalitis is a viral disease spread by night-biting Culex mosquitoes. The disease is endemic (always present) in Southeast Asia and epidemic (intermittently present) in Korea, China and far eastern Russia. It is most commonly found in rural areas, especially near pig farms as swine are a host. Wild pigs are also a potential host. It is more prevalent in the summer months (May to October) in epidemic areas and during the rainy seasons in endemic areas. Travellers to urban areas are at very low risk of contracting the disease. In rural areas, while only one in 200 infected people develop symptoms, of those cases 10% to 25% may be fatal and many survivors suffer permanent brain damage from the encephalitis.

Symptoms

- Nausea, vomiting, headache and fever
- Severe cases – lethargy, coma

Prevention

- Take precautions against mosquito bites, especially at night. Sleep under treated bed nets and use repellents or knockdown sprays on clothing.
- Vaccination against the disease is available. Discuss options with a travel medical advisor.
- Be vaccinated if you are traveling to a high risk area and you have no spleen or have a spleen that does not function (e.g., Thalassaemia, sickle cell anaemia).

Areas of concern: Asia, far eastern Russia, Papua New Guinea

12.8.5.7 | Legionnaires' Disease

Description

Other names include Legionellosis, Pontiac Fever.

Legionnaires' disease, a serious form of pneumonia, is a bacterial infection that is spread by breathing aerosol droplets of water contaminated with the Legionella bacteria. It is not spread from person to person. Legionella thrive in warm, moist places and may be present in high numbers in some types of water systems. These include evaporative condensers of large air conditioning units, cooling towers, swamp coolers, whirlpools or spas, and humidifiers or fountains that create a fine water spray and/or contain warm and stagnant water. The bacteria may flourish in industrial, commercial, or small domestic water systems. Notable epidemics have been traced to sources in poorly maintained air conditioning systems in buildings such as hotels or hospitals. Projects should carry out appropriate maintenance of their water systems.

Many cases of Legionnaires' disease are unreported, as diagnosis is impossible without special tests to distinguish it from other forms of pneumonia. Once diagnosed correctly, the disease is treated with antibiotics. Seek medical attention as soon as possible should you develop pneumonia-like symptoms.

Symptoms

- Early flu-like symptoms include fever, chills, mild cough, tiredness, aching joints and muscles.
- Pneumonia-like symptoms include high fever >40ºC, a dry cough that develops into a productive cough, shortness of breath, chills and chest pains. These symptoms may develop rapidly after the onset of the early flu-like symptoms. Seek immediate medical attention.
- Gastrointestinal symptoms including vomiting, nausea and diarrhea commonly occur.
- Legionnaires' disease has a mortality rate about 15%. Symptoms appear between 2 to 10 days after exposure – usually after 5 to 6 days.

Prevention

You cannot determine when you risk exposure to Legionnaires' disease, as you have no control over the maintenance of water systems in public places. You may become exposed even by being downwind from a contaminated water system. Note: Small windowsill type air conditioners have not been found to be a significant source of Legionella. Companies should be aware of the following information and see that projects with vulnerable water systems follow good maintenance procedures.

Eliminate conditions that promote the growth of Legionella bacteria, which include:

- Heat: Keep hot water systems set higher than 60ºC. Hot water should be above 50ºC when it comes out of a tap. Legionella bacteria grow rapidly in water between 20ºC and 50ºC.
- Sediment and scale: The presence of these promotes the growth of Legionella bacteria. In order to eliminate scale and sediment all tanks, swamp coolers, air conditioning equipment, spas, fountains, and humidifiers etc., should be drained periodically and cleaned with a chlorine compound if possible, and then rinsed to eliminate the chlorine compound.
- Common water organisms: Eliminate algae and other bacteria present in water systems because they provide nutrients and promote the growth of Legionella.
- Stagnant water: Eliminate areas of stagnant water in water systems.

Areas of concern: Worldwide
Additional information regarding Legionnaires' disease is available from the Canadian Centre for Occupational Health and Safety.

12.8.5.8 | Leptospirosis

Description

Other names include: Canicola fever, hemorrhagic jaundice, infectious jaundice, spirochetal jaundice, mud fever, swamp fever, caver's flu, swineherd's disease and Weil's disease.
This acute bacterial disease occurs more frequently in humid tropical and subtropical regions than in temperate climates. Usually, leptospirosis affects animals; however, it is an occupational hazard for field employees who are in contact with water or soil contaminated with animal urine and for mine workers because rats frequently spread the disease. One can contract leptospirosis if contaminated water or animal urine comes in direct contact with an open wound or the mucous membranes of the eyes, nose or mouth. Potential for exposure may increase after heavy rains and as a result of increased surface runoff, such as after floods. The disease is also transmitted by eating infected meat.

Symptoms

- Symptoms usually appear between 3 to 14 days after exposure.
- Symptoms start with the sudden onset of a severe headache, fever, chills, muscular pain and vomiting.
- Symptoms may be mistaken for those for influenza, hepatitis, dengue or hemorrhagic fevers, and even meningitis.
- The first phase is flu-like followed by a brief interim without fever and then symptoms reappear that include jaundice, rash, meningitis, and bleeding or kidney failure.
- If untreated, victims may develop organ failure, meningitis and/or respiratory problems. While uncommon, death may occur.
- Weil's disease (the most serious form) is identified by jaundice and bleeding in the skin and subcutaneous tissues.

Prevention

- Avoid swimming, bathing, or immersion in stagnant pools or sluggish streams, especially if you know that dogs or rats are in the area. Try to determine if water may be contaminated.
- Beware of the dangers of urine contamination if you befriend stray animals.
- Cover cuts and open wounds with waterproof dressings if they will come in contact with dirty water.
- Wear gloves and prevent exposure to soils that might be contaminated.
- Carefully wash (or avoid) fresh vegetables grown where soil might be contaminated with animal urine.

Areas of concern: Worldwide
Additional information regarding leptospirosis is available from the [Leptospirosis Information Center].

12.8.5.9 | Malaria

Description

Malaria is a life-threatening disease and just one mosquito bite can infect you. Each year, between 300 and 500 million people develop malaria and between 1.5 and 3 million people die from the disease. Malaria is carried by the night-biting female Anopheles mosquito, which may infect humans with one of four species of parasites of the genus Plasmodium. Once injected into the bloodstream, the parasites invade the liver where they multiply and then destroy red blood cells. Although three forms of malaria are relatively benign, one form, P. falciparum, is a very dangerous and often fatal form of the disease.

The information presented in this section is limited and it is essential to seek up-to-date information from a physician at a travel medicine clinic. It is also advisable to access additional information from the references at the end of this section.

Risk of exposure to malaria

You risk exposure to malaria in any tropical region where infected mosquitoes are present. People living in North America and other non malarious regions are more susceptible to malaria because they have no immunities to the disease. The risk of contracting malaria depends on:

- The degree of local risk at the destination, which depends on:
  - Length of stay
  - Time of year (rainy vs. dry season)
  - Style of living (urban vs. rural)
- Your behaviour – whether you adhere to preventive behaviours
  - Avoid exposure to mosquitoes when they are active
  - Wear appropriate clothing that covers your body
  - Use insect repellents and insecticides appropriately
- The efficacy of the prophylactic medication
- Whether you take the prophylactic medication as directed – the medication does not kill all the parasites; technically, the medication is a suppressant.

Local risks include:

- Areas of highest risk generally include low-lying rural areas; the risk of exposure greatly increases during the rainy season.

- In Africa, especially sub-Saharan Africa, higher proportions of mosquitoes carry malaria. The disease is transmitted all year in both urban and rural areas.
- In Southeast Asia and South America, malaria is more prevalent in rural areas than in urban areas. The risk of exposure greatly increases during the rainy season.
- In some countries such as Papua New Guinea, malaria is prevalent both in low-lying areas and at high altitudes. The risk of exposure occurs all year.

Prevention and preparation for malaria – individual actions

To prevent malaria, it is necessary to focus on the four risk factors listed above. Understand that individual behaviour is a critical part of prevention. Take active measures to avoid mosquito bites and take the correct prophylactic medication as directed. Even so, using both physical and chemical barriers combined with an anti-malarial drug may not be 100% effective. Be informed.

- Prior to travel, check with a travel medicine clinic for up-to-date information about the risks at the destination and which prophylactic medication is appropriate. P. falciparum has rapidly developed drug resistances, which makes it very important to receive current information regarding prophylactic medication. Various anti-malarial drugs are available and you should discuss options with a physician at a travel medicine clinic. Check with a knowledgeable doctor where a clinic is unavailable.
  - Take a full supply of prophylactic drugs with you including enough to cover treatment in an emergency. Take the medication as directed. Complete the full course of medication even if the trip is very short.
  - Avoid buying anti-malarial medications in developing countries. Drug nomenclature is confusing and therefore you may not receive the correct medication in some countries. Many anti-malarial drugs marketed in developing countries are dangerous due to contamination and counterfeiting. The marketing of counterfeit anti-malarial drugs, especially in Southeast Asia and Africa, is a very serious, widespread and increasing problem. It is usually impossible to distinguish between real and fake drugs.
  - Controversial advice exists regarding prophylactic medication to prevent malaria versus rigorous preventative measures to avoid mosquito bites. Health care providers in some developing countries discourage the use of anti-malarial drugs. Do not discontinue your anti-malarial medication because of this reason.
- Prevent mosquito bites from dusk to dawn, as malaria is spread by night-biting mosquitoes. Use physical and chemical barriers.
  - Wear light coloured clothing with long sleeves, long pants, and shoes and socks that cover your feet – especially in the evening. Clothing should fit loosely but be made of tightly woven fabric to provide a barrier against mosquitoes. Protection increases when clothing is treated with permethrin products or sprayed with DEET.

- Use insect repellent on exposed skin. Doctors recommend those that contain 35% DEET (N, N-diethyl meta-toluamide).
- Use permethrin-treated mosquito netting over your bed and tuck it under the mattress.
- Thoroughly spray the bedroom, bathroom and inside the sleeping net before dusk with a knockdown insecticide containing permethrin. Make certain that all windows and doors are tightly screened.
- Tip: Do not shower or bathe at dawn or dusk to reduce exposure to mosquitoes.
- See Chapter 12.8.4 Protection from Insect Bites for information regarding the proper use of bed nets and correct spraying procedures.

- No folk remedies work!

Prevention and preparation for malaria – corporate actions

Companies have a responsibility to protect the health and safety of employees. This includes developing practices that prevent employees from acquiring malaria and supporting employees should they become infected with the disease.

- Provide access to up-to-date information about malaria. In developed countries, this means employees should be able to access travel medicine clinics. Require employees to follow pre-trip health and safety routines (see Chapter 12.3.1 Preparation Checklist).
- For exploration personnel based in countries that have malaria, especially developing countries, companies need to confirm that adequate medical care is present and available, and that personnel have access to reliable drug supplies.

Camps and projects located in malarious areas can decrease risks by eradicating mosquito breeding places as much as possible. The following are some measures that companies have found to be effective in reducing the incidence of malaria:

- Locate camps in dry open areas as far as possible from mosquito breeding areas.
- Camp structures for work and accommodation should be protected with tightly fitting insect screens on doors, windows and other openings. Screens must have a mesh size that excludes all mosquitoes and be checked continuously for holes. Repair holes and gaps immediately. There should be no cracks or holes in walls or roofs where mosquitoes can gain entry.
- Remove objects that hold or may contain water (e.g., cans, containers, tires). Fill in excavations, wheel ruts, tire tracks etc., and keep ditches drained. It takes very little water for mosquitoes to breed; therefore constant vigilance is necessary.
- Rigorously enforce a policy that requires sleeping under a treated bed net. Follow through with consequences when employees do not adhere to this policy, which may include dismissal.
- Eradication programs should target the specific species of Anopheles mosquitoes present in the project or camp area. Some species prefer to breed very near human habitations while others preferentially select the shorelines of streams, lakes or ditches.

  - Arrange for indoor residual spraying of sleeping quarters and office areas using insecticide, which can also be used for treating clothing and bed nets.
  - Fogging with insecticide: Carry out fogging surrounding quarters and office areas including under buildings, on walls and on roofs – wherever mosquitoes may rest when they are not active. Carry out fogging with insecticide on the camp margins up to 100 m from camp structures. Fogging is best carried out early or late in the day when air is cooler and wind velocity is low.
  - Cut back vegetation and/or jungle forest to eliminate resting and breeding places for mosquitoes. The local species of Anopheles mosquitoes present will help determine the appropriate distance for clearance.

Symptoms of malaria

While malaria can be treated effectively in its early stages, a delay in seeking treatment can have serious or even fatal consequences if you are infected with P. falciparum. Be vigilant for symptoms of malaria and seek medical help as soon as possible if you become ill, especially with fever. Assume the fever is a symptom of malaria until proven otherwise. Symptoms are non-specific and it is easy to misdiagnose.

You must seek urgent medical attention if you have these symptoms:

- Sudden high fever accompanied by sweating and chills. The fever may be continuous or paroxysmal (episodic).
- Headache, diarrhea, fatigue and muscle aches
- Loss of appetite, nausea, vomiting
- Severe illness with unrelenting headache, mental confusion, fever and prostration calls for immediate evacuation to a treatment facility. With P. falciparum malaria, cerebral infection accompanied by seizures and coma is not uncommon and can be fatal. Progression may be very rapid from the onset of symptoms to death from severe complications – only 36-48 hours in some cases.
- Symptoms of malaria can begin as soon as one week after exposure. They may, however, take many weeks or even months to become evident. On rare occasions, the disease takes years to develop.

Diagnosis of malaria

Malaria can be difficult to diagnose as the symptoms are non specific. Some potentially serious diseases mimic malaria. When identified early and treated with appropriate drugs, almost all malaria can be completely cured. However, if diagnosis is not prompt, it can be much more difficult to treat successfully.

Should you become ill after you return from a malarious area – even if up to 3 months later – be sure to mention your destination(s) to your doctor and request testing for malaria, which requires thick and thin blood smears. If you become ill in the place where you have acquired malaria, the doctors will be familiar with the symptoms and diagnostic procedures.

- The incubation period is usually 1 month. Depending on the form, it can be as short as 5 days or as long as 2 years.
- Malaria can be confused with meningitis, typhoid fever, dengue fever, hepatitis and gastroenteritis.
- A blood test (smear) is required for diagnosis. Stop all prophylaxis medication. Try to obtain a smear within 24 hours of the onset of symptoms. Have a technician or doctor make thick and thin blood smears and repeat testing twice if the first smears are negative (after 12 and 24 hours). If you are returning to Canada or a home country where malaria is not present, bring one set of blood smears home with you and give them to an infectious disease specialist in your home country along with the following information:
    - Your status (state of health) and location
    - Diagnosis – type of malaria as derived from the smear
    - What you are taking for treatment
    - What you were taking for prophylaxis
- P. vivax and P. ovale can live for years in the liver and not be affected by most anti-malarial drugs. Extra treatment is required if you contract either of these forms of malaria.
- Always consider the possibility of malaria if you experience fever and flu-like symptoms for at least 3 months after leaving a malarious area. Seek medical attention immediately.
- There are no folk diagnostic tools or remedies that work.

Areas of concern: Refer to the CDC table and WHO interactive map for information regarding the risk of malaria in a selected city or country.
Additional information regarding malaria is available in Appendix I.XII

12.8.5.10 | Meningococcal Meningitis

Description

This acute bacterial infection causes an inflammation of the linings of the brain and spinal cord. If untreated, it is usually fatal. It spreads directly between people by coughing, sneezing and contact with nasal secretions. It usually affects children and young adults. The incubation period is only 2 or 3 days to 1 week. Urgent medical treatment is required as 10% of victims die – even with immediate and optimal medical treatment.

Symptoms

- Seek urgent medical treatment, as symptoms progress swiftly.
- Sudden high fever, chills, stiff neck, aversion to light, nausea and vomiting
- Mental confusion and drowsiness within 24-48 hours
- Convulsions, coma and death

Prevention

- Consult a travel medicine physician regarding possible immunization. Vaccines are available, but it is necessary to use the correct type. Consider the risks: destination, time of year, length of stay, nature of your work, your age and health.

Areas of concern: Sub-Saharan Africa (known as the African Meningitis Belt), Indian subcontinent, Arabian Peninsula, parts of South America and Southeast Asia

Additional information regarding meningococcal meningitis is available from the Government of Canada.

12.8.5.11 | Plague

Description

Bubonic plague is transmitted to humans through bites of infected fleas, usually via rodents or rabbits. The pneumonic form of plague may be transmitted directly from an infected person by coughing. If there is any suspicion that someone has contracted plague, immediate full medical treatment is essential because plague can be fatal.

Symptoms

- The onset is 1 to 5 days after exposure.
- High fever, chills, severe headache, prostration and shock develop.
- Black or purple spots (hemorrhages) form under the skin.
- Lymph node swellings develop (buboes) that will drain pus.

Prevention

- Avoid exposure to fleas.
- Use insect repellent on your skin and permethrin-treated clothing.
- Spray your quarters with knockdown sprays containing permethrin.
- Rodent-proof the project living quarters. Handle all dead rodents with gloves and use a spade when carrying them for disposal.
- Do not keep pets that can potentially carry fleas at a project or camp.

Areas of concern: Africa and Asia, western North America, rural areas of South America
Additional information regarding plague is available from the CDC.

12.8.5.12 | Rabies

Description

Another name for rabies is hydrophobia.

Rabies occurs throughout most of the world. It is a particularly serious problem in many developing countries because there are few vaccination and control programs for dogs. There, one should regard any bite received from mammals as potentially lethal (e.g., dogs, cats, bats, monkeys, jackals, mongooses etc.). In North America, rabies is carried by a variety of wild animals: bats, raccoons, skunks, foxes, coyotes and wolves etc. Rabies is a deadly disease so you should not risk receiving bites from feral and wild animals anywhere in the world.

Transmission

In addition to transmission by bites, rabies may be transmitted by the lick of an infected animal on an open wound or eating incompletely cooked meat of an infected animal.

If you are bitten:

- Wash the wound immediately with lots of soap and water or alcohol. You can even use spirits, if necessary.
- Next: Wash with povidone-iodine to reduce the numbers of bacteria.
- If possible, have someone isolate the attacking animal (catch and kill, if necessary). It should be tested for rabies.
- Arrange for immunotherapy as soon as possible, if it cannot be proven without a doubt that the attacking animal was free of rabies. Do not wait for symptoms of rabies to appear; it will be too late and the victim will die from the disease.

Prevention

- Avoid stray animals, especially dogs.
- Never befriend wild mammals, especially monkeys. This is particularly important advice for children who are attracted to animals.
- Eat only well cooked meat.
- People should consider pre-exposure injections of rabies vaccine before they move for a prolonged period to an area with a high incidence of rabies. If bitten, these injections simplify (but do not replace) the need for additional treatment. Discuss this option with a travel medicine advisor.

Areas of concern: Central and South America, India, most of Africa, all of Asia and Southeast Asia
Additional information regarding rabies is available from the Canadian Centre for Occupational Health and Safety.

12.8.5.13 | Schistosomiasis

Description

Another name for this is Bilharzia.

In many tropical and subtropical regions, the freshwater streams, lakes, ponds and ditches are contaminated with worm-like parasites that cause schistosomiasis. Do not drink, bathe, swim or wade in these waters. If you inadvertently become exposed, dry yourself off vigorously with a towel and apply rubbing alcohol to the affected parts of your body as soon as possible. This may help prevent an infection.

Symptoms

- A prickly rash or “swimmer’s itch” develops when the parasites enter the skin.
- Additional symptoms may develop four to six weeks later, which include high fever, rash, abdominal pain and swelling, fatigue, weight loss, muscle aches, cough, and perhaps bloody diarrhea.
- In chronic schistosomiasis involving the urinary tract, painless haematuria (blood in urine) occurs.

Prevention

- Avoid contact with contaminated water.
- Chlorinated water and sea water are safe for swimming.
- Bath water is safe if you heat it above 50°C or 122°F for more than 5 minutes, or if it stands in a secure container for more than 48 hours.
- Drinking water must be boiled for at least one minute or filtered, as iodine treatment alone is not effective enough to kill the parasites.

Areas of concerns: Most African countries, Southeast Asia, tropical South America, Egypt, Puerto Rico and some Caribbean Islands including Antigua, Guadeloupe, Martinique, Montserrat and Saint Lucia. The prevalence is changing so review information, as necessary.
Additional information regarding schistosomiasis is available through the CDC.

12.8.5.14 | Travellers' Diarrhea

Description

Travellers' diarrhea is a common and uncomfortable problem. It is caused by eating food or drinking water that has been contaminated with microorganisms. Almost always, the illness only lasts for a couple of days. It may be caused by a variety of bacteria, viruses or parasites. The information in this section should help minimize the risks of developing traveller's diarrhea and provides advice should you develop this problem.

Symptoms

Diarrhea usually starts suddenly with stomach cramps, frequent loose watery stools, feeling tired or weak, and sometimes vomiting. Most cases resolve within 2 to 3 days without treatment. There are, however, two important points to adhere to: (1) maintain or increase your fluid intake and (2) restrict your food intake immediately. Avoid fatty foods, milk or dairy products, rich or spicy foods and seasoned meat while you have diarrhea. Dry biscuits and bread can be eaten. Avoid alcohol; it will dehydrate you and could irritate your bowel.

For relief, take two tablets of Pepto-Bismol every 30 minutes for up to 8 hours. If diarrhea is severe, it may be necessary to drink some oral rehydration salts. These come pre-packaged to which you add water, or you can make your own from commonly available ingredients (see Chapter 12.8.3.5 Fluid Replacement Therapy).

Medications

Imodium, Lomotil or Codeine Phosphate should not be taken to treat traveller's diarrhea. These medications stop the peristalsis within the bowel which results in an increased growth of the bacteria and the toxic levels within the bowels. This in turn can result in ulceration and perforation of the bowel and lead to death.

Antibiotics may be used to treat diarrhea that persists after 2 or 3 days. Ciprofloxacin, Levofloxacin, or Norfloxacin are the preferred antibiotics for initial treatment. Zithromax (Azithromycin, Z-pack) may also be used to treat travelers diarrhea in developing countries. This antibiotic treats additional bacterial infections that Cipro does not. Obtain medical advice if diarrhea persists longer than 5 days.

Seek urgent medical attention in the following circumstances:

- If blood or mucous appears in your stool
- If you develop a high fever
- If stomach/abdominal pain is severe and persists beyond 8 hours
- If diarrhea continues beyond 5 days

Prevention

The following simple precautions greatly reduce the risk of contracting travellers' diarrhea:

- Always wash hands thoroughly after using the toilet and before eating.
- Never drink tap water unless it is first boiled or purified. (Keep iodine solution in your medical kit for this purpose.)
- Use bottled water or other pre-packaged drinks (e.g., bottles or cans of soft drinks, hot drinks such as tea and coffee).
- Refuse ice in drinks, as it may have been made with contaminated water.
- Avoid salads and uncooked fresh vegetables.
- Always peel fruit (or wash it thoroughly in purified water).
- Choose restaurants where the staff, surroundings and food appear clean.
- Choose restaurants where plenty of people are eating, as news of a source of illness usually results in less patronage.
- Ask for lukewarm food to be replaced with fresh, hot food (including rice).
- Never eat raw seafood.
- Avoid unpasteurized milk and dairy products.

Additional information regarding travellers' diarrhea is available from the CDC.

12.8.5.15 | Typhoid

Description

Typhoid fever is a serious, sometimes life-threatening disease caused by Salmonella typhi bacteria. It is spread by consuming food and/or water that have been contaminated by feces or urine from patients or carriers. Food handlers often spread typhoid. All employees should be vaccinated before they travel to risky areas. As the vaccine is only 50-55% effective, you still need to be careful of what you eat and drink.

Symptoms

- Symptoms usually develop between 1 to 3 weeks after exposure.
- Fever, severe headache, loss of appetite and occasionally, rash.

Prevention

- Be immunized and be careful what you eat and drink.
- Do not eat raw salads and leafy vegetables. In some countries, farmers frequently use night soil (human excrement) for fertilizer.
- Peel your own fruits and eat well cooked foods that are served hot.
- Avoid shellfish, especially when they are raw or undercooked. They may have been gathered from sewage-contaminated beds.
- Avoid creamy foods like mayonnaise, whipping cream and custards that contain milk products and eggs. These products are easily contaminated.
- Drink only boiled, bottled, treated water or other safe beverages.

Areas of concern: Africa, Central and South America, most of Asia

12.8.5.16 | Yellow Fever

Description

Yellow fever is an acute viral infection transmitted by the bite of infected mosquitoes, mainly by the Aedes aegypti and Haemagogus species, which are day biting mosquitoes. Yellow fever is characterized by a short incubation period of less than 6 days, high fever and hemorrhagic features causing internal bleeding, jaundice and organ failure. The fatality rate may be up to 30% in unvaccinated people. Vaccination is recommended for all visitors to yellow fever endemic zones in Africa and South America.

Many countries require travellers to show proof of vaccination when in transit within the yellow fever endemic zones or from infected areas or infected countries. If you are unable to show proof, there is the risk being quarantined or vaccinated by local authorities who may use contaminated needles and/or syringes – always carry your vaccination card.

Prevention

- Be immunized.
- Inoculations must be administered in an approved vaccination centre. A single dose protects for 10 years. When vaccinated the first time, your certificate for border crossings becomes valid 10 days after your injection. For revaccination, the certificate is valid immediately if you were vaccinated within the past 10 years.

Observe universal precautions to prevent mosquito bites:

- Stay in air conditioned and/or well-screened quarters.
- Wear long sleeved shirts, long pants and shoes with sock (not sandals).
- Use insect repellents containing DEET on skin.
- Use permethrin sprays on clothing.
- In rural areas use mosquito nets and knockdown sprays.

Areas of concern: The WHO website lists countries with a risk of yellow fever transmission and countries requiring a yellow fever vaccination to enter or when in transit between countries where yellow fever occurs.

13.0 VEHICLES

Introduction

Drivers of vehicles are a major cause of work-related accidents and safety incidents in the mineral exploration industry. Usually they are due to driver error or negligence. Therefore, by improving driver skills, attitudes, defensive driving techniques, and by reducing driver fatigue, an exploration company can expect to reduce vehicle collisions and incidents. Carrying appropriate equipment and good maintenance practices also contribute to improved vehicle safety. Company employees who travel in countries where roads and driving conditions are particularly hazardous should avoid driving and instead use local staff drivers or professional drivers associated with their hotel.

When they differ, the instructions in the manufacturer's operator manual that accompany a vehicle or piece of equipment (e.g., winch or jack) take precedence over instructions in the Prospectors & Developers Association of Canada (PDAC) Health and Safety Guidelines.

13.1 | Risks and Hazards

Risks include death, personal injury and damage to company property.

- Crashes may be caused by:
  - Driving too fast for road conditions
  - Lack of driver's training, poor driving skills
  - Fatigue, falling asleep while driving
  - Collisions with animals
  - Engine failure/breakdown or tire blowout
- Stranding may be caused by:
  - Running out of fuel
  - Engine breakdown
  - Flat tire – no spare(s)
- Damage to company property may be caused by:
  - Crashes

- Not following safe operating procedures, lack of training
- Poor maintenance
- Vehicle fires

13.2 | Responsibilities (Due Diligence) Regarding Vehicles

As presented in Chapter 1.2 Due Diligence, companies should be able to demonstrate due diligence in regard to their employees' use of vehicles both driving to and from a field work site as well as while working in the field. Requirements to demonstrate this aspect of due diligence include but are not limited to the following measures.

Exploration Companies

- Develop written safe operating procedures (SOPs), site specific SOPs (as needed) and an emergency response plan (ERP) for the use of vehicles.
- Provide competent, trained supervisors; provide training and education for employees regarding SOPs, ERPs, regulations and work place hazards, terrain hazards related to driving
- Carry out inspections and maintenance of vehicles
- Monitor the use of vehicles and implement consequences when regulations and SOPs are not followed.
- Documentation: Keep records of all training, accidents, incidents and corrective actions, mitigation of hazards, inspections, maintenance, infractions etc., that apply to vehicles and their use.
- Provide required personal protective equipment (PPE).
- Carry adequate insurance.

Project Supervisors

- Implement company SOPs and those in the manufacturer's operator manuals of vehicles and accompanying equipment.
- Place warning decals on vehicles and associated equipment in the local language, when possible.
- Advise, instruct, and monitor employees and contractors regarding jurisdictional regulations, health and safety regulations, company SOPs, and potential hazards of using vehicles.

Operators

- Follow company SOPs and training regarding company vehicles.
- Be familiar with the warning decals on vehicles and associated equipment.

- Use PPE and safety equipment as directed.
- Report hazards, dangers, and defective vehicles and equipment to a supervisor.
- Be familiar with project ERP procedures regarding vehicles.

13.3 | Safe Driving Guidelines for All Vehicles

1. Obey the rules of the road of the country, province, territory or state. Vehicles must carry vehicle registration and insurance documents.
2. Comply with the manufacturer's operating procedures located in the vehicle operator manual. Most manufacturers supply comprehensive operation and maintenance procedures.
3. Only properly licensed and trained employees should drive company vehicles. It is advisable for drivers to obtain an international driver's licence when it is necessary to drive in some countries.
4. Wear a seat belt at all times. Vehicles must be fitted with seat belts for each seat. The only exception to this rule – do not wear a seat belt when driving on frozen lakes or ice bridges.
5. Use vehicles that are appropriate for the job and conditions of the field area. Vehicles should be mechanically sound and carry sufficient equipment. Essential equipment should not be shared between vehicles.
6. Develop an emergency response plan (ERP). Include procedures that address breakdowns and overdue vehicles etc. In the event of a breakdown, it is usually best to stay with the vehicle. If it is necessary to go for help, leave a visible explanatory note with the vehicle in addition to any communication you may have with the camp or project. This may avert a full scale search.
7. Each project should establish a communication schedule with predetermined check-in times. Employees should adhere to the check-in schedule and inform their base camp of changes in plans.
8. Inform the person in charge of the planned route and the estimated time of arrival or 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 a vehicle does not arrive or return as planned, or if it does not check in on schedule.
9. Respect the legal speed limit. Most crashes result from driving too fast for existing road conditions. Reduce speed if road conditions are unknown, if they deteriorate, or if visibility is reduced – no matter what the legal speed limit.
10. Obtain permission to cross private land. Leave gates as they are found.
11. Drive to protect the environment. Use existing roads and tracks. Minimize off-road driving especially in wet conditions, on stream banks and in fragile environments.
12. Avoid having passengers ride in the back of open vehicles unless they are properly restrained. Tray back trucks should be fitted with benches, seat belts and side bars if passengers are carried.
13. Do not drive a vehicle if you have consumed alcohol or if you have taken medication or drugs

that might affect your ability to drive.

14. Do not drive when you are drowsy. Stop and take a break or nap, or have an alert passenger drive.
15. Where vehicles operate in the vicinity of heavy equipment or where visibility is routinely limited, vehicles should be equipped with a flashing light on top of the cab, and/or a whip with a flag and light at the tip, and/or with reflective tape.
16. Companies should consider establishing guidelines regarding the use of company owned or leased vehicles for recreational purposes.

13.4 | Equipment Lists for Vehicles

The required and recommended equipment carried in vehicles should depend on (1) the time of year, (2) the terrain, (3) the degree of isolation, and (4) the distance to the field area or work site. Although the lists may seem extensive, note that a survival situation can develop near civilization depending on the weather. It is better to be safe than sorry. Use the lists to help determine which equipment is appropriate.

In addition, all vehicles should be equipped with stickers or laminated cards located in the glove box with the following information:

1. Contact telephone numbers for the camp, local office, manager, garage, police, etc.
2. Operating instructions for the vehicle radio or satellite phone, if present
3. A copy of the emergency response plan

Equipment for Field Vehicles

Items in bold should be considered essential.

- **First aid kit**
- **Communication: radio, mobile /cell phone, or satellite phone**
- **Maps, compass, GPS** (Global Positioning System) unit and **extra batteries**, as required
- **Vehicle operator manual** (store in glove box)
- **1 or 2 spare wheels with fully inflated tires, as required**
- **Jacks: axle jack for tire changes, plus Hi-Lift jack for field vehicles**
- **Lug wrench** (cross-type is best)
- **Tool kit**
- **Heavy duty jumper cables**
- **Tire pump and tire gauge**
- **Extra fluids: e.g., oil, coolant, transmission, brake, and windshield washer fluids**

- **Appropriate spare parts: e.g., fan or serpentine belt, hoses, filters, fuses, spark plugs**
- **Flares or reflective hazard signs for roadside safety**
- **Spare keys** (hidden on vehicle)
- **Drinking water** (quantity depending on region)
- **Fire extinguisher, Class ABC** (or locally certified) – mounted near driver and readily accessible
- **Shovel** (snow shovel in winter, spade in summer)
- Large flashlight and extra batteries
- Extra matches (waterproof)
- Survival kit suitable for region
- Axe or small saw
- 10 metres rope or straps to tie down cargo
- Duct tape
- Recovery strap or Kinetic Energy Recovery Rope (KERR) – tow chains or cables are more dangerous
- Maintenance log book (store in glove box)

Additional Equipment

Consider the following for specific work conditions or locations:

- Extra fuel in certified containers, as required
- Tire repair kit
- Spare bulbs for headlights and tail lights
- Hand operated winch (Note: Hi-Lift jacks can also be used for winching)
- Extra fire lighting equipment
- Extra drinking water
- First aid kit that includes latex or vinyl gloves and a face shield where AIDS is endemic
- Roll of paper towels
- Extra battery – mounted under the hood on opposite side of the exhaust manifold or a portable power system, depending on region

Additional Recommended Equipment in Cold Climates

- Windshield ice scraper and brush (winter)
- Tire chains for snow

- Extra mitts and wool hats
- Sleeping bags and/or blankets (1 per person)
- Space blankets (3 minimum to create shelter in vehicle)
- Gas line antifreeze
- Traction aids or sand bags
- Emergency candles, sterno cans
- Extra food (high calorie foods)
- Small stove and fuel

Additional recommended equipment in hot climates

- Large plastic bag for collecting water
- Transpiration bags
- White and clear plastic (for shelter, catching water)
- Space blankets (1 per person)
- Extra drinking water (minimum of 10 litres per day per person)
- Extra water for radiator
- Extra coolant
- Food (carbohydrates are recommended)
- Machete (tropics)

Addition equipment recommended for some tires and wheels, depending on country

- Tire repair kit and tire gauge
- Tire levers
- Wheel brace
- Rubber mallet

Use good judgement and carry appropriate equipment for the field area. Take into consideration how remote the work site is, how quickly help will be available, the climate, and if you are travelling alone.

Drivers are responsible for returning a vehicle with all equipment. Missing or damaged equipment should be replaced or repaired. Radios and their antennas should be maintained in good working order and returned intact with the vehicle.

Keep tires, including the spares, at the correct pressure, which should be as recommended in the vehicle operator's manual, not what is stated as the maximum allowable pressure on the tire. This information may also be found mounted on the door frame or in the glove box. No vehicle should be fitted with a combination of radial and cross-ply tires, as this can adversely affect the handling of a vehicle. This can severely damage the axle assembly or transfer case on four-wheel drive vehicles (4x4s). Note: "All Season Radials" are a poor substitute for winter snow tires.

13.5 | Vehicle Maintenance and Inspections

To make sure of their reliability and safety, company vehicles should undergo regular maintenance and inspections. Drivers should conduct a daily safety check on their vehicle to determine any need for repairs before departing on a trip. If a vehicle is obtained from a motor pool, be especially careful to inspect it. No vehicle should be driven if it is not in roadworthy condition as a mechanical breakdown may put your safety and/or life in jeopardy.

13.5.1 | Vehicle Maintenance

Log Book

Each vehicle should contain a log book to record mileage (km) and routine servicing or repairs to the vehicle. Drivers should keep the log book up-to-date. Use the log book to note any mechanical problems as soon as they are identified, including tires, steering, lights, windshield wipers, communication equipment, the exhaust system etc. Report problems to a supervisor so that repairs can be completed as soon as possible. Do not use defective equipment.

General Maintenance

- Follow the schedule for maintenance and inspections prescribed in the manufacturer's operator manual. Increase the frequency for heavily used vehicles.
- Contain all lubricants and fluids when maintenance is carried out.
- Maintain records of inspections and maintenance performed on company vehicles.

13.5.2 | Regular Vehicle Inspections

Carry out a thorough safety check on all field vehicles at the beginning of the field season.

Daily Check

Before a vehicle is driven for the first time each day, the driver should walk around it before entering and note:

- Do the tires look properly inflated? If in doubt check with a tire gauge. Are the tires free of cuts?
- Are the windshield wipers properly attached and in good condition? Clean the windshield as required.
- Check the exterior lights. Are the lenses undamaged and clear of dirt or snow?
- Check the oil, coolant, and windshield washer levels. The vehicle should be level.
- Check the vehicle for oil leaks, grass or brush caught in or under the vehicle.
- Check that the brake lights and turn signal lights all function.

Start the engine and check the following:

- Adjust the mirrors and the head rest. Clean the interior windshield glass if needed.
- Listen for unusual sounds as the engine starts. Check gauges (oil, temperature, voltage) to be sure the vehicle functions correctly.
- Check the fuel level.
- Test the brakes. Check the brake pedal travel.
- Check the steering wheel play, gear linkage and the accelerator.
- Check the warning lights. Warning lights should go out when the engine is running. Never take a vehicle into the field if a warning light indicates a problem. Have a mechanic or trained people correct the problem.
- A pre-operation check form should be filled out by the driver and filed with the supervisor. In Canada, the records should be kept for three years to comply with Workers Compensation Board legislation.

Periodic Inspection

Make this inspection in addition to the daily check. The frequency will vary with vehicle use. With normal usage, a weekly inspection may be enough. With heavy usage, this inspection routine may be necessary each day. Pay particular attention to brake lines, fuel lines and tires.

- Check the battery acid level if the vehicle has a non-sealed battery. Battery acid should be about 5 mm higher than the plates. If necessary, add distilled water. Never smoke or use an open flame for light while checking battery acid levels because a battery produces hydrogen gas that may explode. Use a flashlight if a light is required. At the beginning of the cold season, make certain the vehicle battery is in good condition. Have the battery load tested (by a mechanic, if necessary) as it is possible for a battery to indicate it is well charged yet still be unable to turn over a motor.

- Check battery connections. Make sure they are tight and corrosion free. Keep the terminals clean and lightly coated with petroleum jelly, which will reduce corrosion.
- Check the radiator coolant level when the engine is cold. If it is low, top up the coolant with the appropriate mixture of water, antifreeze or corrosion inhibitor.
- Check the brake fluid level. Top up with the same type of fluid. Before adding fluid, clean around the cap so no contaminants enter the reservoir.
- Check the fluid level in the hydraulic clutch reservoir (manual transmission) or the power steering fluid level (automatic transmission).
- Check the automatic transmission fluid level according to the manufacturer's instructions.
- Check all hoses and lines. Check all radiator hoses, fuel lines, brake lines and those associated with power steering for cracks or leaks. Connections should be tight and hoses free of kinks or swellings and with no wear marks that indicate rubbing or friction points.
- Check wires and electrical connections. Make sure they are firmly connected and do not rub against anything.
- Check the tire pressure, including the spares. Check for any tire damage. Only full size tires may be used as spares on field vehicles. Set the tire pressure according to the specifications in the manufacturer's operator manual. Tire valve caps should be present, as they keep out moisture and dirt, which might distort the valve and allow air to leak from tires. The following website contains excellent information about tires: http://www.nhtsa.dot.gov/cars/rules/TireSafety/ridesonit/brochure.html
- Check all necessary equipment. Make sure that the required tools, first aid and emergency kits are present and complete.

13.5.3 | Contractor's Vehicles

If you are required to drive a contractor's vehicle, do not assume that it is in good working condition. Carry out a thorough roadworthiness test. Make certain that the brakes, steering, lights and other controls work properly. Perform the daily and periodic inspections on the vehicle to protect your own safety.

13.5.4 | Rental or Leased Vehicles

- For a rental or leased vehicle, the driver's name and valid driver's license number is required to appear on the rental or lease agreement. Keep the agreement in the vehicle at all times. Carry your driver's license and insurance papers while operating the vehicle. Only persons listed on a rental agreement may drive a rental vehicle unless there are extenuating circumstances e.g., for the safety of individuals in the vehicle.

- Perform inspection procedures on rental or leased vehicles that are used for field work. Even when a vehicle is rented for a short time, check that the vehicle has an appropriate jack and full size spare tire if the vehicle will be taken on rough roads. Assemble the necessary equipment in leased vehicles before driving them to the field.
- Try to avoid driving in countries where the roads and driving are particularly hazardous. In some places, foreigners may be automatically implicated in any collision if they were driving. Therefore it is advisable to have local citizens do the driving. Where the company office employs professional staff drivers, arrange to use these drivers. Where no staff drivers exist, try to obtain a driver associated with a hotel with which you are familiar.
- In certain countries, employees renting vehicles while on company business should consider what insurance is included in the rental car rate and take out any additional insurance that is required to comply with local insurance laws. See that there is insurance to cover any damage to the hired vehicle and also damage to other property including third party vehicles. This is important to avoid delays or problems with local officials in the event of a collision.

13.6 | Training

Exploration companies should see that their employees have the knowledge and skills to handle both 2-wheel and 4-wheel drive field vehicles if it is part of their job. Companies may consider a driving probation period for new employees. Team an inexperienced driver with an experienced driver rather than two inexperienced drivers together.

As a minimum, training should provide instruction in the safe operation, loading and handling of vehicles to meet the local conditions where they will be driven. Employees need to know the performance limits of the vehicle and its equipment and should demonstrate to a qualified supervisor that they are competent to drive company vehicles. To prevent crashes, employees should develop safe driving skills and attitudes and learn defensive driving techniques. Practice skills such as changing tires, using jacks and winches before they are needed in an emergency. Defensive driving courses are offered through the Canada Safety Council.

13.6.1 | Loading Guidelines

Learn how to load the vehicle correctly. If you are towing a trailer, load it according to the directions in Chapter 13.7.5 Towing.

- Do not exceed the GVWR (Gross Vehicle Weight Rating). Refer to the vehicle's operator manual or the certification regulation plate mounted on the vehicle.
- Securely anchor all internal and external loads. Secure all items. Loose items may become airborne if you suddenly stop. Consider installing a cargo barrier between the passenger and cargo sections.
- Balance all loads both inside and outside the vehicle. Place heavier items forward near the cab (pickup trucks) and place lighter items toward the rear to avoid undue stress on the rear springs. The heaviest items should be loaded in front of the rear axle. Check frequently for spills and leakage when transporting liquids.
- Only light loads are permitted on roof racks. Make sure these are thoroughly secured and do not obscure the driver's vision.
- Transport propane tanks, fuel drums and gas bottles on the back of flatbed or pickup trucks. Always transport these items securely tied in an upright position. Do not transport them inside a hardtop vehicle.
- Avoid transporting passengers in the back of pickup or flatbed trucks.
- Follow Transport Canada regulations for the transportation of dangerous goods.

13.6.2 | Vehicle Controls and Equipment

It is very important to refer to the operator's manual for any vehicle or related equipment (e.g., winch, jack, tow bar) when you use it the first time. Some equipment may require operating procedures that are not covered by (or vary from) this guide. The directions in this section should not supersede instructions given in a manufacturer's operator manual.

- Make sure you are familiar with the controls of the vehicle before driving it (headlights, windshield wipers, turn signal etc). Check the operator's manual.
- Do not drive while using a handheld mobile/cell phone or radio. Use a handheld telephone only while stopped. Pull over to the side of the road in a safe place.
- Know the capacity of the fuel tank and carry extra fuel, oil and water when driving in remote areas. Use the fuel in an auxiliary tank first (if fitted) followed by fuel from the main tank. Then, the gauge will indicate the final reserve. Switch fuel tanks before it is empty. Try never to run dry as contaminants (dirt, water) may be sucked into the carburetor or injectors.
- Do not engage the overdrive feature when driving off-road, in town traffic, on wet roads or on gravel, snow and ice.
- Know when it is appropriate to use the "cruise control" feature. Cruise control should not be used on twisty two-lane roadways, on snow-covered roads, in icy conditions, or in heavy traffic.

13.6.3 | How to Change a Tire

Check the vehicle operator's manual for specific instructions about how to change a tire. Whenever possible, use an axle or frame jack (not a Hi-Lift jack) to change a tire. Because vehicles on jacks are very unstable, never allow passengers to remain inside or enter a vehicle once it is raised on a jack. If a Hi-Lift jack (bumper jack, Jack-All, kangaroo jack) is used, pay strict attention to safety (see Chapter 13.6.4 below). The following are general instructions.

1. Change a tire only on a safe, level and firm surface – well off the road. If necessary, drive on a flat tire to find a safe location to change it.
2. Put on the four-way hazard flashers or set out warning flares, if needed.
3. Place the transmission in P (Park) for automatic transmissions or in gear for standard transmissions. Set the hand brake firmly before turning off the engine. Never start the engine of a jacked-up vehicle as the action may cause it to drop off the jack.
4. Remove all necessary tools, equipment and the spare tire from the vehicle prior to jacking. Do not enter the vehicle or the trunk once it is jacked-up as the motion might cause the vehicle to fall off the jack.
5. Chock ahead and behind the three remaining wheels with large rocks or pieces of wood. It is especially important to chock ahead and behind the wheel diagonally opposite the flat and both front wheels if the flat is on a rear tire. Place extra support under the vehicle, if possible. An extra spare tire works well.
6. Check the vehicle manual to locate the proper jacking points and for any suspension features that require deactivation before jacking (such as air suspensions). Use the jacking point nearest the tire being changed.
7. Follow the instructions for the type of jack available. Adjust the jack until it is firmly in place and the base is stable. Never place a jack on an icy, slippery or sloping surface. Consider carrying a small steel plate or a heavy piece of wood for a base if you make frequent tire changes or if a Hi-Lift jack is the only type available. In muddy conditions, a strong wooden base may be essential for the jack to perform properly.
8. Loosen the wheel nuts slightly with the lug wrench before jacking, but leave them on so the wheel does not fall off. If they are very tight or rusted, you may have to step on the lug wrench to move them.
9. Jack the vehicle up the minimum height necessary to change the tire. Usually 5 cm (2 in) clearance under the flat is sufficient.
10. Remove the wheel nuts and then remove the wheel. Remember to remove the topmost wheel nuts last and replace them first so the tire does not fall onto you. Replace the flat with the spare. Do this gently so you don't cause the vehicle to fall off the jack. Install the wheel nuts with the bevelled end inwards to tighten onto the rim.
11. Hand-tighten all the wheel nuts snugly before lowering the jack.
12. Lower the vehicle until the tire just touches the ground. Avoid rocking the vehicle.
13. With the lug wrench, tighten the wheel nuts fully. Use a criss-cross sequence (top-bottom-left-right) to obtain even tension.

14. Lower the vehicle and remove the jack. Tighten the wheel nuts again with the lug wrench. Place the flat in the spare wheel position. Replace all your equipment so it is available the next time it is required.
15. Check the wheel nuts again after travelling about 40 km (25 miles).

unless it is also supported on blocks.

Figure 13.1 : Follow safe procedures when changing a flat tire. © Courtney Mitchell

13.6.4 | How to Use a Hi-Lift Jack (Jack-All, Kangaroo Jack)

The Hi-Lift jack is a useful tool for off-road work, but also a potentially dangerous tool. It is advisable to use an axle jack for routine tire changes, depending on the weight of the vehicle. To increase safety when using a Hi-Lift jack, follow instructions that come with the jack and accessories, including those for lubrication and storage. If unavailable, instructions are available at the Hi-Lift website. A DVD (Digital Video Disc) is also available from the company that includes instructions for using a Hi-Lift jack and accessories. If none of these are unavailable, follow these guidelines:

- Vehicles may easily slip off a Hi-Lift jack. Never stand or work in an area where the vehicle might roll or slide if it slips off the jack.
- Hi-Lift jacks are difficult to use on vehicles that do not have steel step bumpers. Whenever possible, attach a Hi-Lift jack to the bumper, as the vehicle is less likely to slip off the jack. Note: Do not use a Hi-Lift jack on vehicles with a plastic bumper (it will break) or a rounded bumper, as the jack will not correctly fit onto this style of bumper. Hi-Lift supplies a "bumper lift" that can be attached to fit curved steel bumpers. Hi-Lift also supplies a "lift mate" accessory that can be attached to a wheel to lift it.
- Inspect the jack before use to see that it is complete and in good repair. It should be lubricated and free of dust and dirt to work correctly. Follow the instructions that accompany the jack.
- Place chocks before and after the tires to prevent the vehicle from rolling. Set the hand brake.
- Always use a firm base under a Hi-Lift jack (steel plate, wooden block, flat rock).
- If using a High-Lift jack for winching, follow the instructions with utmost care.
- Using a Hi-Lift jack as a chain tightener is very dangerous. If you use it for this purpose, follow the instructions with utmost care and keep your head well out of range of the handle.

WARNING: To raise or lower the vehicle, the reversing latch of the Hi-Lift jack must be in the appropriate UP or DOWN position. NEVER move the position of the reversing latch unless the jack handle is in the upright (vertical) position against the steel bar. If the jack handle is horizontal when the latch position is changed, the handle may quickly move up and down out of control. It may hit the operator and cause serious injury or even death.

Follow this sequence when raising a vehicle with a Hi-Lift jack:

1. Make sure the jack handle is in the upright position against the steel bar.
2. Lock the reversing latch in the UP position.
3. Make sure the lifting mechanism or "nose" fits firmly under the bumper or jacking point before starting to raise the vehicle.
4. Pump the handle up and down with both hands to raise the vehicle. Never use an extension on the handle. The vehicle will rise with each down stroke. Keep your head and body out of range of the jack handle.
5. Stop if there is any indication of instability with the jack or the vehicle.

6. Place the handle in the upright position as soon as the vehicle is raised high enough. Never leave the jack with the handle in a horizontal position.
7. Chock the vehicle before you proceed with changing a tire. Place supports under the vehicle before carrying out any work underneath it.

Follow this procedure when lowering a vehicle with a Hi-Lift jack:

1. Make sure the jack handle is in the upright position against the steel bar.
2. Lock the reversing latch in the DOWN position.
3. Carefully pump the handle up and down with both hands to lower the vehicle. The vehicle will lower with each up stroke. Keep your head and body out of the path of the handle in case the vehicle or the jack slips.

WARNING: Do not push a vehicle off a High-Lift jack. Pushing a vehicle off a Hi-Lift jack is extremely dangerous; the vehicle may not go where you intend it to go.

13.6.5 | Starting a Vehicle with Booster Cables (Jump Start)

This procedure can be dangerous as batteries contain hydrogen gas and sulphuric acid that, if ignited, could explode and cause severe burns. Cold temperature increases the danger. Never smoke or allow open flames around batteries. Both the boosting battery and the dead battery must be the same voltage. A set of booster cables contains one cable with RED (positive) clamps and one cable with BLACK (negative) clamps. Work carefully to avoid electric shock.

When connecting the booster cables to a battery terminal, be sure the clamps do not touch each other. If possible, work in an open area – not in a garage – and wear goggles or safety glasses.

- Remove rings and wristwatch from your hands and wrist to prevent unplanned contact with the battery terminals and booster cable leads.
- Place the vehicles close together but not touching each other.

These instructions apply to vehicles with batteries that are grounded (earthed) at the negative terminal. Follow this battery-cable connection sequence exactly. Failure to do so could result in personal injury or damage to batteries and the electrical systems of both vehicles.

1. Clamp one RED (positive) clamp onto the positive terminal of the good battery.
2. Clamp the other RED (positive) clamp onto the positive terminal of the “dead” battery.
3. Clamp one BLACK (negative) clamp onto the negative terminal of the good battery.
4. Clamp the remaining BLACK (negative) clamp to the engine block of the “dead” vehicle. This grounds the electrical circuit to help prevent short circuiting.
5. Start the engine of the vehicle with the good battery and rev the engine slightly.
6. Start the engine of the “dead” vehicle and let both vehicles idle for a few minutes.
7. Turn off the ignition of the vehicle with the good battery.
8. Remove the cables in exactly the reverse order – 4, 3, 2, 1.

13.6.6 | Winches

There are various types of winches; some are power operated and are normally mounted on the front of a vehicle. Other winches are hand operated. Choose the winch that is appropriate for the vehicle, which depends on how and where it will be used. Learn how to operate the winch on the vehicle by reading the operator's manual. Practice in a safe place – before you need it in an emergency. Most winches also have instruction decals attached directly on them. Do not remove any instruction or warning decals.

A ratchet type or "come-along" hand operated winch is very useful to pull a vehicle out of mud or a ditch. A come-along winch only has about 3 metres of cable so an additional strong recovery strap or cable is required. Do not use small hand winches with nylon cables for winching vehicles as the nylon stretches and will backlash very badly if the hook slips.

Additional recommendations for using a winch

- Assemble the necessary winch accessories required for safe operation. These include heavy leather gloves, hook strap (to keep fingers away from the fairlead opening), choker chain, tree saver straps, block and tackle, clevis or D shackles, and a correctly mounted tow hook. Maintain the equipment in good condition and inspect the cable periodically. Recovery straps or ropes are safer than chains or cables, but require a second vehicle for pulling. Inspect the winch and cable before use. Do not use kinked, frayed or damaged wire rope/cable. Replace it.
- Plan the pull. It may take two steps to extract a vehicle or remove an obstacle. Plan for safety.
- Never overload a winch. Refer to the winch operator's manual for the winch lifting or pulling capacity and do not exceed it. Most winches have the rated capacity stamped on them. Know the cable capacity and make sure the winch and cable are capable of doing the job. Remember that the terrain and slope affect the pulling capacity of the winch.
- When using a winch to pull out a vehicle, attach the hook to the frame or a frame-mounted tow hook on that vehicle. Never attach it to the bumper or to any moving part of the vehicle (e.g., axle, shocks, springs and steering mechanisms). Do not connect a recovery strap with a winch hook to extend the length of a pull.
- Wear leather gloves to avoid cuts from frayed cables.
- Steel winch cables may snap or tear free during winching operations. No one should ever stand within range of a cable that might whip backwards. Try to visualize the possible paths of a snapping cable so that all spectators stand at least as far away as the snapping cable can fly. Stand clear before the cable is tightened. Use a remote control whenever possible.
- Raise the hood of any vehicle involved in winching to protect the windshield from a snapping cable. Drape a blanket, tarp, or even a jacket over the cable to help dampen any whipping action. Do not allow the drape to be wound into the winch.
- Never step over a winch cable that is under tension. Walk around.

- Keep the winching action straight – as close to 180° as possible – to maintain the capacity of the winch. Pull at a different angle only long enough to straighten the load. Use a slow, steady motion.
- Remember to leave enough cable on the winch spool (at least 5 turns). Perform the winching operation twice rather than risk detaching the cable from the winch spool. Make sure the cable will wind on properly and not develop kinks or knots. Rewind the cable onto the spool smoothly after the job is done.
- If the winch relies on power from the vehicle battery, do not deplete the battery to the point that the engine will not start once the job is finished.
- Turn the switch off if the winch motor stalls; check if the motor is hot – do not let it overheat.
- Always use genuine rather than non-standard "over-strength" shear pins. Carry extra shear pins and know how to replace them in the winch.
- Do not use your winch to tow another vehicle. A sudden shock load may exceed the capacity of the winch. Use a tow strap or chain.

Note: If you use a Tirfor winch, also known as a Griphoist winch, it is absolutely mandatory to use the genuine Tirfor cable with this type of winch, as regular cable is made of softer steel and can slip out of the Tirfor jaws.

13.6.7 | Fuelling Procedures

- Use the correct fuel.
- Fuel at a designated fuel site whenever possible.
- Fuel only in an open well-ventilated area with the engine stopped.
- Do not smoke. Do not allow open flames or sparks in a fuelling area.
- Do not top up and 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 (Canadian Standards Association) approved. When filling portable containers, always place them on the ground outside a pickup bed, enclosed vehicle or a trailer so the containers are properly 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.
- If a truck has a vinyl bed liner always place CSA approved gas cans and equipment with small motors (chainsaws, generators) on the ground to fuel them. Vinyl bed liners prevent the grounding (earthing) of the can or equipment. Static electricity builds up when the fuel flows through the hose into the can. A spark may cause vapours to ignite and explode when the nozzle is withdrawn. Do not fuel ATVs or snowmobiles being transported in a truck with a vinyl bed liner – fuel them when they are on the ground.

13.7 | Handling and Driving Skills

13.7.1 | Braking

Good braking skills are fundamental to safe driving. The following practices will increase safety and help avoid accidents. Anti-lock brakes (ABS) systems are common in vehicles. [Transport Canada's website] provides an explanation of their purpose and function.

- If the vehicle has ABS (anti-lock brake system) brakes, use a steady, firm foot action when applying the brakes. Do not pump the brakes, especially in an emergency. The chattering or groaning noise you hear when firmly applying ABS brake is an automatic pulsing action, which indicates they are working correctly. While ABS brakes improve the vehicle control when braking on slippery surfaces, having ABS brakes will not shorten the distance required to stop the vehicle. It always takes longer to stop on slippery surfaces than on dry surfaces. The incorrect use of ABS brakes may contribute to the cause of a crash.
- Try to avoid heavy braking on a curve, which may cause a vehicle to skid and possibly roll over.
- Reduce speed and downshift to a lower gear when descending long or steep hills. Most vehicles with automatic transmission can be manually downshifted to reduce speed appropriately. Let the engine, rather than the brakes, do the work.
- If your vehicle stalls and you have power-assisted brakes, depress the brake pedal only once to stop. Do not pump your brakes as this will use up the vacuum reserve in the brake system.
- Do not brake suddenly if you have a flat tire while driving. Steer a straight course and reduce speed gradually. Choose a safe place to pull completely off the road and change the tire.
- Brake smoothly while driving straight ahead to avoid jackknifing when towing a trailer.

A vehicle's braking ability may be impaired if the brakes are wet. While most vehicles have disc brakes that are not always affected by water, drivers should be aware of the possible consequences of wet brakes. It may increase the distance required to stop or cause the vehicle may pull to one side. Test the brakes after crossing streams or driving through deep puddles. Test the brakes periodically when you drive on slushy or muddy roads (see Chapter 13.8.3 Weather-Related Driving Tips).

To test the brakes, check that no traffic is nearby and do the following:

- Depress the brake pedal lightly to determine if the brakes respond normally. If they do not, they are probably wet.
- If the brakes are wet, continue to drive carefully for a short distance while applying light pressure on the brake pedal. This will heat the brakes and evaporate any moisture.
- If the brakes do not function properly after these measures, it is not safe to continue driving.

13.7.2 | Parking

The following parking guidelines are designed to eliminate injuries and property damage caused by uncontrolled movement of unattended or improperly parked vehicles.

Parking light vehicles and four-wheel drive vehicles

- To reduce the risk of collisions, back into parking spaces or choose a parking space where you can exit by driving forward.
- Place the gearshift in P (Park) for vehicles with automatic transmissions. For manual transmissions, leave it in gear.
- Turn the engine off and engage the parking brake before leaving the vehicle.

When you park on a hill, turn the wheels so that if the brakes fail, the vehicle will coast off the road and away from traffic. Set the parking brake whenever you park a vehicle on a hill. Set the gearshift in P (Park) for automatic transmissions; set it in first or reverse gear for manual transmissions. Chock the wheels, if necessary.

- When you park heading downhill, turn the front wheels in the direction of the curb and allow the vehicle to move forward until the front of the wheel rests against the curb.
- When you park heading uphill, turn the front wheels in the direction of the street and allow the vehicle to reverse slightly until the back of the wheel rests against the curb.
- If you park on a hill with no curb, turn the front wheels toward where the curb would be.

When you park at a work site or remote location:

- Park in an identifiable and cleared area. Check for overhead dangers from falling trees or branches, rocks or snow. Avoid parking over dry flammable material.
- Park facing the exit direction so you are ready to drive away. A surprising amount of vehicle damage occurs at the end of a day's hard work. Also, it is easier to make a rapid exit in case of emergency.
- When parking pickups near a helicopter landing site, make sure that all lightweight materials in the bed of the pickup are weighted down and rubbish is removed to prevent the downdraft from sending them into the air. Designated parking areas for vehicles should be at least 50 metres from the landing site and away from the flight path.

13.7.3 | Reversing

- Before reversing, check that there are no obstacles, pedestrians, or traffic in the intended path of movement. If there is any doubt, get out and check by walking around the vehicle before backing up.
- It is advisable to equip field vehicles with an audible back-up alarm.
- Mines Acts and regulations require an audible back-up alarm on vehicles at a mine site. Check that your vehicles meet the jurisdictional requirements.

13.7.4 | Crossing Streams

Be cautious when driving across streams. Do not attempt a crossing unless it is absolutely necessary. Check both upstream and downstream for some distance to determine if there is a better place to cross. Remember, if in doubt – Do not cross.

- Get out of the vehicle and walk across to check the following: the entry and exit points, water depth, firmness of the stream bed, the presence of flowing current, and for hidden hazards. Check that there are no washouts (washaways) or potholes.
- If the water is too deep for a safe crossing (more than 0.5 metres or 20 inches), determine if the water level is rising, falling or stationary. Place a stick at the stream edge and observe the ebb and flow at that point. You can then estimate if a safe crossing will be possible within a reasonable length of time.
- Once you enter the water, try not to depress the clutch, as this may allow water into the transmission and affect the operation of the clutch.
- Drive slowly when you cross, as there may be hidden hazards. If necessary, use low range gears and drive with enough power to prevent water entering the exhaust pipe.
    - It is essential to prevent water from entering the engine air intake, as major damage can result if even a small amount of water is sucked into the engine. Vehicles can stall if you drive too fast and the fan sprays water over the ignition system. Placing a sheet of plastic in front of the radiator will help prevent water from flowing through the radiator grill and being sprayed by the fan. This will also reduce the possibility of mud clogging up the radiator grill. Remember to remove the plastic afterwards or the engine will overheat. Do not remove the fan belt.
    - After entering the water, accelerate to create a reasonably small bow wave in front of the vehicle and then maintain this wave with a steady speed. If there is a fast-flowing current, cross at an angle against the flow from downstream to upstream to help maintain a bow wave.
- If the vehicle stalls, do not try to restart the engine if the tail pipe is under water, as this will suck water into the engine.
- Check if the brakes work properly afterwards (see Chapter 13.7.1 Braking).

- Do not drive through flash floods or on flooded roads as the water may hide washouts. Avoid driving in dry stream beds, as they may undergo torrential flash flooding (refer to Chapter 9.5 Floods).

13.7.5 | Towing

Driver error, excessive speed, improper load management and improper equipment maintenance are the four main causes of vehicle-trailer accidents. If purchasing a vehicle that will be used to tow trailers (including boats, snowmobiles or ATVs), investigate if there is a "tow package" option for the vehicle, as it may increase the towing capacity and safety of the vehicle. The vehicle needs to have adequate power to safely haul the loaded trailer. Vehicles handle differently while towing a load so drivers should receive training in towing procedures and review a copy of appropriate operator's manuals.

Select the correct trailer and towing equipment for the job:

- Choose the correct trailer so the load is legal and it handles correctly. The Gross Combined Mass (GCM) of the trailer determines whether the trailer requires a braking system.
- The total weight of the trailer and cargo load should not exceed the vehicle's weight restrictions. Overloading can cause tire failure, broken springs or shackles, or structural failure of both the trailer and towing vehicle. Overloaded trailers may overturn more easily. Refer to the vehicle's operator manual or the vehicle certification regulation plate for the specified weight limit.
- One method to determine the appropriate capacity of a trailer for the job: Compute the weight of the load and add 33% to compensate for bad roads, extra equipment etc. The "load" equals the boat, ATV, snowmobile, fuel and/or field equipment etc., that will be transported.
- A trailer used for field work may require an extra heavy duty suspension system.
- Use a hitch that suits the size and weight of the vehicle and trailer. The vehicle's operator manual will indicate the specifications. Make sure the ball hitch and socket are the same size by checking the size stamp on both parts. Consider installing a stabilizer bar if you will drive on very rough roads.
- If towing a boat, the trailer and boat should be compatible so the boat is correctly supported.

Trailer Inspection

Before loading any trailer, check for:

- Structural damage
- Condition of the trailer hitch
- Worn or damaged springs, shackles, signal lights, brakes and tires

- Leaking bearings or missing bearing covers (jack up the trailer, grasp the wheel and rock it to see if there is play and listen for a rumbling noise, which indicates worn bearings)
- Spare tire (fully inflated)
- Check that the signal lights are correctly placed and functioning. [Transport Canada's website] indicates the required location of lights for trailers.

Prepare and load the trailer correctly before departure.

- Use tires on a trailer with the highest load rating that will fit on the trailer, as this helps prevent blowouts. Check the tire pressure when the tires are cold.
- All trailers should be equipped with safety chains in case the hitch breaks. Make sure to attach the safety chains properly; safety chains should cross under the tongue and be secured to the vehicle. They should be long enough to permit proper turning, but no longer.
- Distribute the load in the trailer so that it is slightly heavier toward the front yet without excessive weight on the tongue. Check the trailer and vehicle operators' manuals regarding the correct tongue weight. Normally it is between 10% and 15% of the loaded trailer weight. The vehicle and trailer should be level when hitched – either with the trailer loaded or unloaded. There should be no appearance of "nose-up" or "nose-down". Proper load distribution helps reduce fishtailing and sway.
- Load the heaviest objects of the cargo as low as possible to maintain a low centre of gravity. Loads should be balanced across the trailer width. Secure the cargo thoroughly so that no shifting will occur. It is illegal to tow a trailer when the load is not properly secured.
- Any load that extends more than 1 metre behind the trailer should have a clearly visible white, red, orange or yellow fluorescent flag attached.
- Load snowmobiles with skis forward to avoid snowmobile windshield damage. Remove windshields if possible.
- The driver needs clear, unobstructed visibility when towing a trailer. Vehicles that tow loads should have rear view mirrors designed for extra visibility.
- Practice turning, stopping and backing up before actually towing the trailer on a trip. Practice in an area with no traffic and get the feel of it.
- Make sure the load has not shifted after arriving at the destination. Chock the wheels before uncoupling the trailer or unloading heavy items to make sure it does not roll.

Inspect the loaded trailer and vehicle before starting each trip.

- Complete an inspection of the vehicle, including all fluid levels, tire pressure and the brakes. Complete a full inspection of the trailer hitch, safety chains, wheels, tires, lights, load distribution and load security. Check that trailer-vehicle connections are secure and all lights function properly. Check the tire pressure on both the vehicle and trailer. Test the vehicle brakes (and trailer brakes if present).

- After driving a short distance, stop and check the lights and connections again. Do a thorough vehicle and trailer check at appropriate intervals.

Towing Skills and Tips

Perform all starting, stopping and steering actions smoothly to avoid possible skids and jackknifes. This is especially important when driving on wet or slippery surfaces.

- Leave extra distance between your vehicle and the vehicle ahead. A good rule is to allow the vehicle ahead to pass a fixed point at least 5 seconds before you pass that same point ("5 second rule").
- Excessive speed is one of the major causes of towing accidents. Do not exceed the posted or recommended towing speed limit, and reduce your speed if the driving conditions deteriorate. If the vehicle-trailer combination fishtails and sways while underway, you are travelling too fast. Swaying increases with speed. Slow down when driving in poor weather, when road conditions are slippery or rough, and in heavy traffic.
- Passing other vehicles: Towing greatly affects the ability of a vehicle to accelerate, pull into traffic, change lanes, pass, and perform other manoeuvres. Allow plenty of room to accommodate the vehicle and trailer. Change lanes smoothly, overtake, and return to your lane without crowding other vehicles. Remember that a vehicle towing a trailer will accelerate less quickly.
- Stopping distance: Vehicles towing loads require extra distance to stop. Avoid sudden stops, which may cause the trailer to jackknife or the load to shift.
- Braking: Apply brakes gently and smoothly.
  - Brake gently before entering a turn. When turning, the extra weight of the trailer will continue pushing the vehicle ahead, especially on gravel or slippery roads. It is easy to lose control and jackknife. Also, entering a corner too fast may cause the trailer to pull the vehicle off the road causing a rollover.
  - Use a wider turning radius when turning a sharp corner (e.g., at intersections). The trailer wheels on the inside of the curve will track closer to the curb than those of the vehicle.
  - Do not use the brakes for extended periods as they may overheat; then you may experience brake failure. Downshift when descending long or steep hills and let the engine do the braking.
- Off-road towing requires extra caution. Very uneven ground may cause severe pitching at the hitch. It is easy to jackknife when towing a load down steep slippery slopes because braking and handling are more difficult. Slow down and use a lower gear.
- Cross-winds will cause trailers to sway. Swaying may also happen when large vehicles pass you. Prepare for cross-winds by holding the steering wheel firmly. Be ready to reduce speed by

releasing your foot gradually from the accelerator. Do not brake suddenly and continue to steer straight ahead. Slow down.

- In hot weather or in mountainous areas, watch the temperature gauge for signs of overheating. Carry extra radiator coolant (see below: If the Engine Overheats in Chapter 13.8.3).
- Downshift when climbing hills to maintain speed.
- Do not engage cruise control while towing a trailer.

Backing a Trailer

- Use extra caution when backing a vehicle-trailer combination. Get out of the vehicle and check for hazards before backing. If possible, have someone guide you to help avoid obstacles. Practice backing before getting underway.
- Technique tip: Hold the BOTTOM of the steering wheel with one hand and move your hand in the direction you wish the trailer to turn. Turn the wheel a little at a time. Go slowly.

To back a trailer to left

To back a trailer to right

Figure 13.2: Backing a trailer

Parking a Vehicle and Trailer

Always try to park on level ground rather than on a slope. Try to find a place to park where you can manoeuvre the trailer easily and position it for an easy departure. Chock the wheels of both the vehicle and the trailer.

If it is absolutely necessary to park on a slope, a helper should place chocks against the downhill side of the wheels of both the trailer and vehicle and then:

- For automatic transmissions: Apply the parking brake, then shift into PARK, and finally take your foot off the brake pedal. It is possible to damage the transmission if you place the vehicle in PARK before the other actions.
- For manual transmissions: Apply the parking brake and then turn off the motor in either first or in reverse gear.

When you drive away after parking on a slope:

1. For automatic transmission: Start the engine with your foot on the brake pedal. Shift into gear.
2. Release the parking brake and foot brake. Slowly move away from the wheel chocks. Have a helper pick up the chocks.

13.8 | Defensive Driving Skills and Attitudes

Defensive driving is defined as "driving to prevent collisions in spite of the actions of others and the conditions around you". According to statistics, drivers can prevent 85% of vehicle collisions. The aim of defensive driver training is to develop driver attitudes and skills that will result in fewer vehicle accidents. Defensive drivers are able to recognize impending road hazards and emergencies. They know the best ways to handle them and react in time to prevent accidents. Employees should drive defensively at all times.

13.8.1 | General Defensive Driving Techniques

Eighty-five percent all collisions are preventable using defensive driving techniques.

- Adjust your speed to the driving conditions. Drive steadily and smoothly maintaining sufficient distance between your vehicle and the one ahead to allow you to stop should the other vehicle suddenly stop.
- Reduce speed when encountering adverse road conditions. These include heavy traffic, bad weather, poor light or visibility, and hazardous road surfaces (e.g., water, sand, oil, ice, snow, wet leaves, potholes, mud, ruts).
- Anticipate possible problems by scanning well ahead and behind the vehicle. If you identify a hazard, take preventative action. Don't have a "wait and see" attitude.
- Respect the "3 second rule" for safe following distance. Under normal conditions, allow the vehicle ahead of you to pass a fixed point 3 seconds before you pass that same point. This computes to one vehicle length for every 15 kph (10 mph). Increase this following distance when experiencing adverse conditions or when towing a trailer (use a "5 second rule").
- Be ready to yield the right-of-way to another vehicle to avoid a collision. An aggressive driving attitude often causes accidents.
- Drive with the daytime running lights or headlights on at all times where this is legal. Other drivers can see your vehicle more easily.
- Do not assume other vehicles will turn in accordance with their turn signals. Wait until they have commenced the turn before passing or pulling out in front of them.
- Do not run yellow lights. When leaving a stop light, wait a couple of seconds and look both ways after the light changes to allow "red light runners" through the intersection.
- Maintain an even temper. Do not drive when you are emotionally upset. Don't let another driver's bad driving cause you to lose your temper and do something stupid or have an accident. Road rage can be a serious problem.
- Know how to control skids.
- Be attentive. Keep your eyes moving so you don't develop a fixed stare.

- Wildlife: Be aware of the potential for collisions with wildlife or free range livestock, especially at dusk and dawn, although deer and moose may be encountered any time. Animals are attracted to road salt in the spring and are very active during rutting season. They may freeze in the headlights or bolt into the road at the last moment. Aim for the rear end of a large animal if a collision is imminent, as big animals rarely reverse their direction. Due to their dark colour, bison are very difficult to see at night. They favour roads for warmth and salt while they forage along the shoulders.
- Watch for trains at level crossings. Never race a train to an unguarded crossing or drive around lowered crossing gates. When a train has passed, wait a moment and look for another train when there are multiple tracks.
- Disengage the overdrive feature when descending steep hills to slow your speed. Downshift to a lower gear, if necessary. Let the engine rather than the brakes do the work.
- Proceed with extreme caution near the site of a crash. Other drivers looking at it may not be paying attention to their driving.

In addition to defensive driving techniques, the following strategies help reduce accidents:

- Avoid fatigue. Driver fatigue is a very serious but under-rated problem. Limit driving to no more than 9 hours a day, if possible. Take a break about every 2 hours. As you tire, eye movements slow down. You lose peripheral vision and do not process information as quickly. Therefore, you will not notice potential driving problems as quickly as when alert. Once you become aware of fatigue, it has already reached an acute stage. If you feel tired, stop and take a nap or ask someone else to drive.
- Plan routes and time of travel with road safety in mind – consider the road quality. If necessary, take into account any potential threat to personal safety (e.g., armed hold-ups, animals).
- Know how to reach your destination so it is not necessary to travel in convoy with another company vehicle or refer to a map while driving.
- Park the vehicle in a safe place when you stop by the side of the road. Park well off the road on a straight stretch away from curves, hills and intersections.
- Minimize night driving whenever possible. Avoid driving at night, in areas of known increased risk (wildlife, pedestrians, violence), and after a day's work or a long flight. If unavoidable, have two drivers in the vehicle or hire a driver.
- Don't push the weather. Snow – wait until roads are ploughed; fog – wait until it clears or travel at a speed that does not exceed your visibility with low beams on; rain – reduce speed; freezing rain – avoid travelling if at all possible; high winds – slow down or stop if the wind strength is causing damage.

13.8.2 | Techniques for Unpaved Roads

Employees who are required to drive on poor quality unpaved roads should receive specific training to address the relevant hazards (e.g., terrain, climate and weather, remoteness). Although a 2-wheel drive truck may be adequate for some conditions, a 4-wheel drive vehicle is preferable if work involves considerable unpaved road or off-road travel. Know your driving capabilities and the limitations of your vehicle. In some situations, it may be safer to use an ATV or to walk. Driver attitude is an integral part of vehicle safety. Don't push your luck. It is better to walk than get stuck many kilometres from help.

Use the following techniques and information regarding variable quality unpaved roads:

- Drive according to the present road conditions – don't rely on "how it was the last time". Conditions on unpaved roads change rapidly due to weather (e.g., wind, rain, storms, floods, snowstorms and whiteouts).
- Gravel roads: Slow down and let the dust settle ahead of the vehicle for maximum visibility. This also reduces damage to the vehicle windshield from road gravel. Beware of soft shoulders on gravel roads.
- Driving in dust:
  - Drive with the headlights on and stay well back from other vehicles. Never attempt to pass a vehicle in a cloud of dust.
  - Slow down when being overtaken by another vehicle to avoid being blinded by dust. Reduce speed so that you can stop within the limits of your visibility.
  - Be prepared to avoid livestock or vehicles that may "suddenly appear".
- When driving on "washboard" gravel roads, the steering and braking abilities of the vehicle are diminished because the tires are only in contact with the crests of the washboard ripples. Slow down, as the vehicle may skid if you brake suddenly or take a corner too fast.
- Always assume you will encounter oncoming traffic – especially when cornering on narrow roads. Honk your horn when you cannot see around a corner or over the crest of a hill. Slow down and keep to your half of the road so there is a better chance to avoid a collision.
- Be careful when approaching old bridges and culverts in remote areas; they may be in poor condition or even be missing, especially on inactive logging roads. They are an even greater potential hazard at times of freshet and flood.

13.8.3 | Weather-Related Safe Driving Techniques

Any time you drive, you may encounter unexpected circumstances. Always adjust your driving methods to meet local road and weather conditions. When necessary, prepare the vehicle to operate in harsh climates to help reduce risks.

Wet/Windy Weather Driving Tips

- Paved roads are most slippery at the start of a rainfall due to accumulated oil and grease. Light rains will not wash away road grease and oil. Only heavy rain lasting half an hour or more will do so.
- Slow down and be alert to potential problems on the road ahead. Do not follow another vehicle too closely and increase the spacing between vehicles as conditions worsen.
- Slow down when driving through heavy rain, standing water or slush. A wedge of water can build up and interfere with the tire-road contact of the vehicle at speeds as low as 50 km/h (30 mph). This "hydroplaning" results in a loss of steering and braking control; the effect is like driving on ice.
- If brakes become wet, dry them as described in Chapter 13.7.1 Braking.
- Disengage overdrive and cruise control when roads are wet and/or slippery.

Warm or Hot Weather Driving Tips

- Use engine oil with a viscosity recommended by the vehicle's operator manual for hot weather.
- Watch the temperature gauge in hot weather as the engine may overheat, especially if you are going uphill frequently. After a long hot drive, idle the engine for one minute before turning off the ignition.

If the Engine Overheats:

- Turn off the air conditioning and pull off the road in a safe place.
- Open the windows and turn on both the heater and fan to the maximum setting to help extract heat from the engine.
- If there are no signs of steam from the engine, lift the hood of the vehicle to help ventilate the engine compartment. Let the engine idle at a slightly higher than normal speed.
- Carefully check for leaks in the system and check for broken fan or pump belts. Turn off the engine immediately if you discover any broken belts, a broken fan, or leaking coolant.
- Never remove the radiator cap when the engine and radiator are hot.
- Never use cold water to cool a hot engine, as this may crack the engine block.
- Once the temperature returns to normal, check the belts and hoses for damage or looseness and leaks. After verifying they are in good condition, check the coolant levels and refill if necessary.

Cold Weather Preparation and Driving Tips

- The following measures make cold weather driving safer.
  - Make sure there is antifreeze (ethylene-glycol) at the correct concentration for the expected minimum temperature.
  - Check the condition of the battery and cables frequently so that ignition does not become a problem (see Chapter 13.5.2 Regular Vehicle Inspections).
  - Use appropriate antifreeze solution in the windshield washer fluid and carry extra windshield washer fluid.
  - Use engine oil with a viscosity for cold weather as specified by the vehicle's operator manual.
  - In very cold weather use a lighter weight lubricating oil in the drive train (differentials, standard transmission) if recommended in the vehicle's operator manual.
  - Add fuel line antifreeze to the fuel tank.
  - Install and use a block heater and a battery warming blanket in vehicles that operate in very cold conditions.
- Completely clear the vehicle's hood, roof, windshield, side windows and all lights of snow and ice. Remove vapor, frost or ice from the inside of the vehicle's windows so you can see clearly. Use the defrost feature to diminish the condensation.
- Keep the fuel tank at least half full in case you become stranded.
- When driving in fog or blowing snow, set your headlights on low beam for less reflection and better visibility. Always be able to come to a full stop within the distance you can see.
- On snow-packed or icy roads, accelerate and brake gently to avoid skids.
- Do not use your parking brake in very cold weather as it may freeze while engaged.
- Do not let ice and snow accumulate under fenders, as the accumulation can cause steering difficulties.
- Remember that bridges and overpasses ice-up before ice forms on the rest of the road. Know where to expect black ice, which may look like shiny asphalt.
- Make sure vehicles are properly equipped with snow tires. Use tire chains in winter mountain conditions, as necessary.

Driving on Ice Roads

- Never drive on ice roads or bridges unless the ice thickness has been measured and verified to be safe for the weight of the vehicle. Refer to Chapter 21. Advanced Exploration Sites, Trenches and Access Routes.
- A period of warm temperatures can cause the ice thickness can diminish rapidly even if the temperature does not rise above freezing. It is imperative to measure the ice on a continuous basis to determine the load bearing capacity of the ice.
- Never wear seat belts while travelling on ice roads or bridges.
- Obey the speed limit. The allowable speed limit varies with the ice thickness and depth of water under the ice. Vehicles are required to travel at low speed, especially when approaching land so

the deflection/pressure wave does not rupture the ice.

- It may be advisable to partially roll down the vehicle windows and keep ice rescue picks and a Res-Q-Me type window breaker immediately available. If a dangerous situation develops, drivers and passengers should wear the ice rescue picks.
- It is particularly important to establish strict check-in times with the project or camp and inform them of any changes to the schedule when travelling on winter ice roads.
- Do not park a vehicle on ice unless it has been established that the ice is thick enough. Ice must be thicker to support a stationary load than a moving load of equal weight.

Tips for Other Road Conditions

- Beware of slippery or muddy conditions, particularly during the rainy season. Strips of steel landing mats can provide traction if the vehicle gets bogged down. Carry a piece of heavy plywood to use as the base for a jack in case you need to jack up the wheels and place logs or rocks underneath them.
- Be cautious when driving through wet places on unpaved road areas. For flooded areas or large puddles, get out of the vehicle and walk through them. Check the firmness of the road bed, the water depth and look for ruts. Remember, never drive through floods.
- If working in desert areas, be prepared for sand. Carry a shovel and a strong steel bar for anchoring the winch in case there are no trees. You can also bury a spare tire or a wide fluted boat anchor to anchor the winch.
- Avoid driving or parking in dry stream beds if there is any possibility of flash flooding.
- Logging trucks and ore trucks have the right of way on private roads. Familiarize yourself with specific procedures and obey local rules. Expect them to take the inside of curves, even though it may be the wrong side of the road. Sound the horn and listen carefully. Whenever possible, use radio contact to track the location of these vehicles.
- Regularly clear away dry grass and vegetation from sump and exhaust guards. Do this daily or more often, as needed, depending on the locality.
- Avoid parking in tall dry grass to avoid the possibility of starting a grass fire from hot engine parts. Equip all field vehicles with spark arresters if there is a risk of a bush or grass fire

Figure 13.3: Test the quality of the road bed by walking across before driving through water. © Bill Mitchell

13.9 | Four-Wheel Drive Vehicle Operation Guidelines

Four-wheel drive vehicles (4x4s) handle very differently from other vehicles. They can be significantly less safe than regular vehicles due to their design characteristics (high ground clearance and high centre of gravity). The high centre of gravity affects the stability of 4x4s and vehicle rollover is potentially a serious problem.

Learn to handle the controls and use the correct techniques for on-road and off-road driving. Most accidents or incidents that develop with 4x4s are due to (1) driver error, (2) misreading the road conditions or terrain or (3) not knowing the limitations of the vehicle.

13.9.1 | General Driving Techniques

Review the section on the engagement and disengagement of 4-wheel drive in the manufacturer's operator manual for the specific vehicle. Some vehicles have automatic locking hubs while others require manual engagement of the hub locks. Some vehicles have all-wheel drive features. Failure to follow the instructions can be dangerous and cause expensive damage to the vehicle transmission.

- 4-wheel drive vehicles should not be driven on pavement at high speed with 4-wheel drive engaged. This may cause serious wear to the front transmission, tires and suspension. Unnecessary use of 4-wheel drive increases fuel consumption and driver fatigue. Check the vehicle's operator manual regarding the proper use of the 4-wheel drive system.

- Four-wheel drive vehicles offer increased surface traction but no increased breaking ability. 4x4 braking ability is the same as for other automobiles. In fact, braking distance may increase due to the extra vehicle weight.
- Avoid sharp turns and abrupt manoeuvres. These actions make 4x4s particularly vulnerable to loss of control and rollover.
- Slow down for better control when it is windy. Cross-winds adversely affect the stability of 4x4s, especially those with a cab on the back.
- Anticipate steering wheel kickback when driving over rough terrain. Keep your fingers and thumbs firmly placed on the outside of the steering wheel and your hands in the “ten-and-two” position. If the vehicle has an air bag in the centre of the steering wheel, it is safer to keep your hands in a “nine-and-three” position.

13.9.2 | Off-Road Driving Guidelines

Good off-road driving entails smooth, even manoeuvres – not sensational performances. The best off-road drivers are not afraid to stop and try again with a slightly different strategy. Maintain a light touch on the gas pedal to achieve steady, smooth power.

- Know the limitations of the vehicle. The ease of some manoeuvres will depend on the length of the wheelbase and the vehicle’s clearance.
- Know your own skill level and ability to handle the vehicle. Some terrain may be too difficult for the driver even though theoretically, the vehicle can do the job. Do not get the vehicle into a difficult situation requiring extraction because you are afraid to stop and try again.
- Know the vehicle’s clearance limitations. Be aware of:
  - Ground clearance is the height of obstacles that can be cleared. The axle height is lower than the highest clearance.
  - Know the approach angle to avoid scraping the winch or front bumper.
  - Know the departure angle to avoid scraping the towing hitch or rear bumper.
  - Know the ramp angle to avoid hanging up the undercarriage or axle on ridges.
- Learn the appropriate techniques for the terrain where you must drive. Mud and sand require different methods than driving on firm or rocky surfaces.
- Inspect difficult terrain on foot to determine the height of rocks, depth of ruts or standing water, streams, unstable ground etc., and for other hazards that might strand or disable the vehicle.
- Use a passenger to act as a spotter or marshaller for the vehicle when you encounter difficult obstacles. The driver should follow directions and keep his or her eyes on the spotter who can see the hazards more clearly than the driver. To avoid confusion, only the spotter should relay instructions to the driver. If bystanders think they see a better solution they should inform the spotter, not the driver.

Slopes

- The ability to judge which gear to use for various conditions comes with training and experience.
- When driving off-road, drive straight up and down slopes. Do not spin the wheels on a hill as this may cause the vehicle to slip sideways and roll over.
    - Driving up a slope: Choose the right gear before you start and try not to change gears. It may be necessary to use low range and a low gear so you do not stall. It is better to crawl slowly up a slope than have to change gears part way up.
    - Driving down a slope: When coming down a steep or slippery slope, use low range and the lowest gear possible so that the engine does the braking.
- If you fail to make the crest of a hill, never try to turn around on the slope as you may roll over. Back down the slope and let the engine compression do as much braking as possible.
- Approach the top of a hill with caution. While you need enough momentum to reach the crest, you need to be able to stop safely at the top to determine the next move. If a hill is very steep, walk to the top to identify any hazards before driving up.
- Try not drive horizontally or at an angle across slopes, as the vehicle may tip and over turn. It is especially important not to traverse slippery slopes. Avoid ruts, bumps or rocks that increase the downhill tilt of the vehicle, which will increase the potential of tipping over.

Obstacles

- Drive across ditches at an angle so only one wheel at a time drops into the depression. Do not drive at excessive speeds or try to jump ditches with a vehicle.
- Steer toward a road's high spots. Let one wheel ride over large rocks to maintain maximum clearance. Try to straddle ruts.
- Mud, sand, and soft ground:
    - Drive slowly and steadily to avoid spinning the tires.
    - If the decision is made to deflate tires to drive on sand, do it correctly. Follow the directions in the operator's manual. Deflated tire pressure adversely affects the steering and handling of a vehicle. Reduce speed to avoid overheating the tires and avoid tire damage. Do not drive over rocks with deflated tires. Deflate the tires for only as long as necessary and then re-inflate them. Carry a good low pressure tire gauge and a compressor to re-inflate the tires. If no instructions are available, deflate by no more than 10 psi (pounds per square inch) for hard sand and 15 psi for soft sand.
    - If you become mired in mud, dig it out at the sides and in front of the wheels to release the suction. In some cases, it may be necessary to jack up the vehicle and place logs or rocks under the tires.
    - Wash off mud and sand at the end of the day to maintain the vehicle.
- Avoid spinning the wheels as this causes a loss of traction for the vehicle. Spinning the wheels will cause them to dig deeper into the ground (sand, mud, snow) and may make the vehicle slide

sideways. When the wheels begin to spin, reverse out and try again choosing another route or using a bit more speed.

- Protect the environment: 4-wheel drive vehicles can cause significant environmental damage, depending on the local climate and vegetation.
    - In deserts, do not drive off established tracks, as severe erosion may result from the removal of "desert varnish" that holds the surface together.
    - Avoid becoming stuck in mud or sand, as spinning the wheels causes erosion.
    - Wherever possible, use existing roads or tracks, especially in fragile environments.

14.0
ALL-TERRAIN VEHICLES (ATVS AND QUADS)

Introduction

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 and search the appropriate type of terrain (arid, wetland, alpine) for information regarding how to mitigate the environmental impact of exploration activities.

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!

14.2 | Responsibilities (Due Diligence) Regarding ATVs

As presented in Chapter 1.2 Due Diligence, companies should be able to demonstrate due diligence with regard to employees' use of ATVs. Requirements to demonstrate this aspect of due diligence include but are not limited to the following measures.

Exploration Companies

- Develop written safe operating procedures (SOPs), site specific SOPs (as needed) and emergency response plans (ERPs) for the use of ATVs
- Make sure supervisors are trained so they are competent; provide training and education for employees regarding SOPs, ERPs and work site hazards etc.
- Carry out inspections and maintenance of ATVs
- Monitor the use of ATVs and implement consequences when SOPs are not followed.
- Documentation: Keep records of all training, accidents, incidents and corrective actions,

mitigation of hazards, inspections, maintenance and infractions that apply to ATVs.
- Provide required personal protective equipment (PPE).
- Carry adequate insurance.

Project Supervisors

- Implement company SOPs and those in the ATV manufacturer's operator manuals.
- Place warning decals on ATVs and associated equipment in the local language, if possible.
- Advise, instruct and monitor employees and contractors regarding company SOPs, health and safety regulations, and the potential hazards of using ATVs.

Operators

- Follow company SOPs and training regarding company ATVs.
- Be familiar with and follow directions on the warning decals on ATVs and associated equipment.
- Use PPE and safety equipment as directed.
- Report hazards, dangers and defective equipment to a supervisor.
- Be familiar with project ERP procedures regarding ATVs.

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).

- 1. 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.
- 2. 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.
- 3. 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.
- 4. 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.

- 5. 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.
- 6. 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.
- 7. Develop an emergency response plan (ERP). Include procedures that address breakdowns, an overdue ATV, an injured rider and other potential incidents.
- 8. 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.
- 9. 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.
- 10. 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.
- 11. 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.
- 12. 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.

- 13. 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.
- 14. 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 Chapter 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.
- 15. Obtain permission to cross private land. Leave gates as they are found.
- 16. 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.
- 17. ATVs should not be used for chasing or harassing wildlife. Provincial and territorial legislation prohibits these actions.
- 18. 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.
- 19. Companies should consider establishing guidelines regarding the use of company owned or leased ATVs for recreational purposes.
- 20. 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).
- 21. Be aware of the hazards along your regular path (fences, wires). Mark them with flagging tape if they are not be obvious.
- 22. 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.
- 23. ATV riders should not wear headsets and listen to Ipods or other audio entertainment devices.

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 Chapter 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)

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.

Figure 14.1: Check the tire pressure before setting out each day.
© Courtney Mitchell

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.

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.

Training should provide riders with the following:

- 1. 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.
- 2. 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
- 3. 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.

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.

  - 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.
- 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.

14.8 | Basic Safe Riding Skills

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.

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.

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.

14.8.4 | Towing Trailers

Passengers should not ride on an ATV that is towing a trailer even if the machine is designed for two people, as the stability is affected by the loaded trailer. Passengers should never ride in a trailer being towed by an ATV.

- When towing a trailer, follow the manufacturer's Gross Vehicular Weight Rating (GVWR). Check the operator manual regarding the maximum allowable tongue weight and the maximum allowable load limit.
- Make sure the ATV hitch is compatible with the trailer hitch. Use a trailer with a low centre of gravity and a wide wheel base.
- The ATV and the trailer must be level; it may be necessary to install a special extension to achieve this.
- Use tow chains for added security.
- Place loads slightly forward of the centre and equal distances from the sides of the trailer.
- Load and secure the cargo to prevent movement while underway; any movement would be hazardous to riders. Loads that shift can cause injuries.
- Use caution when disconnecting a trailer as the load may shift.
- When towing a trailer (or carrying heavy loads such as core boxes):
  - Slow down. The heavier the load, the slower the speed should be. It is harder to control the ATV with body movements when towing loads.
  - Use an ATV with 4-wheel drive capability, if possible.
  - Towing greatly increases the risk of roll over. Avoid sharp turns, hills and rough terrain. Carry

less than the maximum load if it is necessary to haul on slopes or uneven ground.
    - Allow more distance to brake and stop. Do not skid or slide.
    - Block the wheels when parked.
- Pull loads using only the hitch or a tow bar. Do not drag loads using chains or ropes attached to rear racks because the ATV may flip backwards on a slope or with any sudden acceleration. Chains or ropes may become entangled with rear wheels or brake cables.
- If an ATV must tow another ATV, use a rigid straight bar whenever possible. If necessary, a tow rope or strap may be used. Secure the ATV being towed at the lowest point on the frame but avoid the steering components. If possible, a rider should ride on the disabled ATV to control the steering and brakes, but this must be done with utmost caution. Tow the disabled ATV as close as possible to the lead ATV to prevent the ATV under tow from hitting the lead ATV with any force if a sudden stop is necessary.

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.

Figure 14.2: The correct way to unload an ATV from the bed of a pickup truck.
© Bill Hinde. Used with permission of the Farm and Ranch Safety and Health Association.

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.

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.

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.

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.

14.9.4 | Tips for Climbing Hills

Refer to the operator manual for specific instructions. Some ATVs can climb a steeper hill than they can safely descend! Analyze the slope carefully. Generally, when approaching a hill you should keep your weight uphill.

- Keep both feet firmly on footrests.
- Shift the ATV into a low gear and increase speed before ascending a hill.
- For small hills, shift your body weight forward by sliding forward on the seat; for steep hills, stand on the footrests and lean well over the front wheels in order to shift as much weight forward as possible. Always keep as much of your weight UPHILL as possible.
- If the hill is steep and you need to downshift on the slope to prevent stalling, release the throttle and shift quickly and smoothly while always keeping your body weight as far forward as possible. Do not allow the front wheels to lift, which might cause the ATV to flip backwards.
- If you lack power to continue uphill yet have enough forward momentum and enough space to turn around safely, do a U turn before you lose speed and then proceed downhill.
- If you are riding uphill and you lose all forward momentum, apply the parking brake before you roll backwards and dismount to the uphill side (or to one side if pointing straight uphill). You need to know the capabilities of the ATV you are riding and follow procedures in the operator manual. (Not all ATVs can do the same manoeuvres to get out of this situation.)
- Never attempt to ride downhill backwards. If you apply the rear brake the ATV could flip over backwards on top of you.
- Do not attempt to climb steep hills while carrying a passenger. They should walk up.
- Consider: If the hill is steep, transfer some cargo to the front racks to add weight to the uphill side of the ATV.
- Practice on small hills and gentle slopes before attempting higher, steeper hills.

Figure 14.3: Keep weight uphill when ascending a slope. © Kim Bilquist

14.9.5 | Tips for Descending Hills

Refer to the operator manual for specific instructions. Some ATVs can climb a steeper hill than they can safely descend! Generally, when descending a hill you should:

- Analyze the slope and check the terrain carefully. Choose the best route that goes as directly as possible downhill yet avoids obstacles.
- Avoid riding downhill at an oblique angle.
- Keep both feet firmly on the footrests. Never use your feet to slow down the ATV.
- Shift your body weight to the rear by sliding back on the seat. KEEP YOUR WEIGHT UPHILL.
- Use low gear – do not use neutral. Descend with the throttle closed and let the engine slow the ATV down. Apply the brakes gradually to reduce speed, as necessary.
- Consider: If the hill is steep, transfer some cargo to the rear racks to add weight to the uphill side of the ATV.
- Practice on small, gentle slopes before attempting to ride down long or steep slopes.

Figure 14.4: Keep weight uphill when descending a slope. © Kim Bilquist

14.9.6 | Tips for Traversing Slopes

Refer to the operator manual for specific instructions. Avoid traversing slopes whenever other safe routes are available; the ATV is less stable and therefore more like to roll over than when going straight up or down a slope. When you traverse a slope, it is very important to: keep your weight uphill:

- Avoid traversing slopes with slippery, excessively rough or loose terrain.
- Keep both feet firmly on the footrests.
- Lean toward the uphill side of the ATV. You may put weight on the downhill footrest to increase traction, but it is most important to lean your upper body into the hill.
- Travel on the inside of a trail that traverses a hill as the outer edge of the trail may be loose or unstable.
- Steer slightly uphill to keep the vehicle moving in a straight line, if necessary.
- Avoid obstacles, ruts and holes as much as possible. They may increase the tilt of the ATV in the downhill direction, and thus increase the likelihood or a rollover.
- If the ATV begins to tip, turn the front wheels downhill if the terrain permits this; if the terrain does not permit turning downhill, dismount on the uphill side immediately.

Figure 14.5: Keep weight uphill when traversing a slope, and when turning downhill. © Kim Bilquist

14.9.7 | ATV Retrieval Tips

ATVs are heavy machines and are labour intensive to extract. To avoid injuring your back, learn safe retrieval methods and use care when recovering an overturned or bogged-down ATV.

- ATVs may be very difficult to extract from mud or muck. Dig the mud away from the wheels to break the suction before trying to move the machine.
- Install a winch or carry a hand-operated ratchet winch or "come-along" if you work in swampy areas or in terrain where it is difficult to retrieve an ATV. A come-along is very useful for pulling an ATV out of mud or a ditch. As a come-along winch only has about 3 metres of cable, an additional tow strap or recovery strap may be required. Follow the directions in the winch manual, which should always be kept in the ATV tool box. For general information on winch safety, refer to Chapter 13.6.6 Winches.
- Whenever possible, extract an ATV using a winch cable or tow strap. Secure the strap or cable at the lowest point possible on the ATV, which may be difficult if the vehicle is mired deeply in muck. Do not hook two winch cables together, as one of the towing hooks may fail and then whip backwards and cause serious injury.

14.9.8 | Riding in Various Terrains

Refer to the Environmental Stewardship Toolkit and search for various terrains for information about how to reduce the impact of ATVs on the environment.

- Follow existing paths and trails whenever possible and avoid making new ones.
- Remember that all surface runoff including flash floods increases erosion caused by ATV damage to the terrain – no matter what the climatic conditions.
- Don't spin tires to get out of mud – you will only dig in deeper.

The following are important types of terrain that are adversely affected by ATV use.

Arid Terrain: In desert regions, fragile ecosystems are easily damaged. Limit the use of ATVs to avoid widespread damage to desert pavement and dune systems. Repeated passes will break up the surface, which allows severe erosion by both wind and water to develop. Even desert varnish on bedrock is destroyed by ATVs crossing over it. Do not create multiple trails.

Alpine terrain: In mountainous regions, alpine areas are above tree line and often have steep slopes. They are easily scarred by ATV use. Avoid cutting across switchbacks on trails, which will widen a trail and encourage erosion. Avoid crossing meadows and steep hillsides. Do not drive across vegetation, which in some areas may be the only source of food for domestic and/or wild grazing animals.

Tropical terrain: Poor tropical soils such as laterites are easily eroded by ATV use. This is especially true during the wet season. It is important to minimize ATV use at this time of year.

Wet terrain: Whenever possible, avoid crossing swamps, marshes and streams, and ride back from lake shores when possible.

Forest regions: Avoid severe damage to surface terrain and decrease erosion to the vegetation and soil by placing crosswise "corduroy" logs on paths that are used continuously.

Figure 14.6: A breakdown or running out of fuel may strand you in a remote area.
© Matt Turner

14.9.9 | Riding in Water

Keep stream crossings to a minimum, as ATVs can cause severe environmental degradation to them. Consider constructing a bridge if a stream must be crossed more than a few times or more frequently than about twice a month. Refer to the Environmental Stewardship Toolkit and search for bridges and crossings, types of crossings, creek crossings, open bottom structures and closed bottom structures. These references will help determine the most suitable structure for the type of stream to be crossed. If traffic is restricted to ATVs, a bridge may be relatively simple, although it needs to be safe and secure.

- Obtain permission to cross a stream from the landowner or government agency, if required. Some jurisdictions require a permit from governmental fisheries authorities, otherwise stream crossings by ATVs or vehicles are illegal.
- When crossing a stream, choose a place to ford where both banks have a gradual slope. Do not ford where it will damage the banks, the stream bed or the location of fish spawning grounds.
- Check the stream depth, stream bed conditions and the current before entering the water. Walk through the stream to do this, if necessary.
- Most ATVs can safely operate in a river or creek up to 30 cm (1 ft) deep. Water should not come up higher than the footrests. Use caution, as ATVs overturn easily in deep water. Avoid riding in fast flowing water, as the large tires may float causing you to lose control of the machine.
- Proceed at a slow steady speed to avoid submerged obstacles and slippery rocks. If you enter water at high speed the ATV may slow down so suddenly that you are thrown off. Keep both feet firmly on the footrests and be prepared to shift your weight to prevent overturning.

- Test the brakes several times after crossing a stream. To dry the brakes, apply light pressure until they feel normal again.
- Wash the ATV using fresh water to prevent corrosion after it is ridden through salt water.

14.9.10 | Riding in Sand (Deserts or Beaches)

From an environmental standpoint, it is best to avoid riding in sand dunes, especially where the dunes provide a barrier next to arable land or a coastline. Vegetation on dunes is easily destroyed by various means including the use of vehicles.

- Know the dune system. Different types of dunes present different dangers due to their configurations.
- Do not ride on vegetation, as it helps stabilize dunes. Ride only on barren sand dunes. Blowouts may develop when vegetation is damaged, which allows sand to migrate from where it was trapped. This may initiate the migration of an entire dune system.
- When riding in dunes, ATVs should be equipped with a bright-coloured antenna flag mounted on whip rods at least 1.2 m to 2.4 m long and clamped onto the back of the ATV. A light at the tip is essential if it is necessary to ride at night.
- Carry a GPS unit when finding your location may be a problem, as dune sands shift continuously.
- Adapt your riding strategy to the immediate conditions and do not rely on your memory of conditions from previous rides.
- Be prepared to make a U turn whenever you approach a crest in case there is a steep drop off on the other side.
- Beware of the visual distortions created by heat haze. Hazards may exist where there appear to be none.
- Wet, deep or fine sand may cause a loss of traction and cause the ATV to slide, tip or get bogged down.
- In some areas, assume wet sand is unstable and could be quicksand. Do not cross unless you know it is a safe area.

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.

Figure 14.7: Utility vehicles are usually safer to use than ATVs. © Courtney Mitchell

15.0 SNOWMOBILES

Introduction

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

Definition

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

15.1 | Risks and Hazards

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

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

Specific risks and hazards associated with snowmobile use include:

- Injuries:
    - Back strains caused by lifting a snowmobile stuck in slush or righting an overturned one
    - Impact injuries caused by excessive speed, not wearing a helmet, collisions with objects or other snowmobiles
    - Slips, trips and falls on slippery surfaces
- Cold injuries (hypothermia, frostbite, cold water immersion hypothermia) caused by wearing inadequate clothing, excessive speed that increases the effect of wind chill, extracting a snowmobile stuck in overflow or slush
- Thin ice caused by unrecognized variable ice thickness due to underwater currents and/or

temperature variations, pressure ridges, undetected cracks (snow covered)

- Breaking through ice caused by lack of local knowledge regarding hazards and/or location of thin ice, inaccurate measurement of ice thickness, inaccurate measurement of the total load
- Stranding – potential survival situation caused by mechanical breakdown, running out of gas or oil, whiteouts, avalanches blocking the route
- Getting lost – potential survival situation caused by loss of battery power of GPS and/or communication equipment, whiteout conditions, wrong type of equipment for the area
- Avalanche-related death or injury caused by using snowmobiles in avalanche prone terrain, lack of expert advice, lack of avalanche safety equipment and/or training, not following SOPs and ERPs, poor planning

15.2 | Responsibilities (Due Diligence) Regarding Snowmobiles

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

Exploration Companies

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

Project Supervisor/Camp Manager

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

Operators

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

15.3 | Safe Operating Guidelines for Snowmobiles

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

1. Comply with the manufacturer's safe operating procedures in the operator manual. Most manufacturers supply comprehensive operation and maintenance procedures. Some manufacturers also supply safety videos for their machines.
2. Obey the laws of the country, province, territory, state and municipality that apply to snowmobiles. Snowmobiles should carry valid registration and insurance documents. Companies may choose to specify that riders carry a valid driver's license, depending on liability and insurance issues.
3. Riders and passengers should wear appropriate personal protective equipment (PPE). This includes a Canadian Standards Association (CSA), Department of Transport (DOT) or Snell approved helmet, face visor and/or goggles, good quality boots (preferably with felt liners), warm gloves or mitts, and appropriate winter protective clothing. If working on ice, riders and passengers should wear a floater snowmobile suit or a personal flotation device (PFD) if there is even a remote chance of breaking through ice. (See Chapter 15.10 Working on Ice.)
4. Snowmobiles should carry required and appropriate safety equipment as recommended in Chapter 15.4. Essential equipment includes:
   - The machine should be equipped with a first aid kit, tools and spare parts, communication and safety equipment appropriate for the trip.
   - Each rider and passenger should carry an essential survival kit on their person (knife, fire starter kit, whistle, and compass etc.) and ice rescue picks when working on ice.

- Carry appropriate navigation and communication equipment (radio, satellite phone or cell phone), a GPS (Global Positioning System) unit with extra batteries and be trained to use them.

5. Develop an emergency response plan (ERP). Develop procedures that address breakdowns, overdue snowmobiles, whiteouts, stranding, getting lost, breaking through ice, and other site specific risks such as avalanches. Riders should carry a written copy of emergency procedures.
6. Each project or camp should establish communication schedules with routine check-in times that reflect the working conditions. Employees should adhere to their check-in schedule and inform the person in charge of changes in plans.
7. Employees should inform the person in charge of the tracking system of their daily planned route with estimated time of arrival or return. The information should be recorded on a map. The person in charge should be familiar with the ERPs and know what to do if a rider does not arrive or return as planned, or if they do not check in on schedule.
8. New riders should be trained to operate and maintain snowmobiles. They should be given a copy of the manufacturer's operator manual. All riders should be able to perform typical field emergency repairs.
9. Travel using the "buddy system" whenever possible, especially on long traverses, but do not team two inexperienced operators together. Travel with separate machines for safety. If it is necessary to work alone, follow the guidelines in Chapter 2.1.1. Working Alone Versus the "Buddy System". It is advisable to carry a satellite phone, which is the most dependable means of communications, especially in remote areas.
10. Maintain a safe speed and keep the snowmobile under control.
11. Obtain permission to cross private land. Leave gates as they are found.
12. Do not ride a snowmobile if you have consumed alcohol or taken medication or drugs that might affect your ability to ride. Consumption of alcohol and exposure to cold temperatures increase the chance of developing hypothermia and frostbite. Alcohol is a major contributing factor in many snowmobile accidents.
13. Snowmobiles should not be used for chasing or harassing wildlife; provincial and territorial legislation prohibits these actions.
14. Use caution when riding along the edge of paved roads or railroad right of ways. Check local regulations, as it may be illegal to do so.
15. Companies should consider establishing guidelines regarding the use of company owned or leased snowmobiles for recreational purposes.
16. Ride to protect the environment; do not ride over shrubs, young trees or fragile environments without sufficient snow depth. Use dedicated paths for snowmobiles whenever possible.

15.4 | Equipment Lists for Snowmobiles

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

Carry more equipment if you are travelling:

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

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

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

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

Equipment that may be required, as necessary

- Snowshoes
- Communication equipment (radio, satellite phone, cell phone, as appropriate) and extra batteries
- Location equipment (compass and maps, GPS and extra batteries)
- Spare ignition key
- Spare drive belt, spark plugs, headlight bulbs

- Tools, including manufacturer's tool kit
- Axe
- First aid kit
- Small shovel, probe pole, beacon (essential in avalanche terrain)
- Safety throw-rope to aid recovery if partner falls through ice (depending on season)
- Extra fuel and oil
- Food
- Operator manual
- Waterproof matches, lighter, fire making equipment
- Knife
- Gas line antifreeze (isopropyl based), as required by manufacturer
- Survival kit
- Flashlight and extra batteries
- Large space blanket (1 per person)
- Duct tape and wire
- Candle, sterno cans
- Flares
- Work gloves
- Large metal cup
- Log book

Additional equipment for long traverses and/or very cold conditions
(Refer to Chapter 8. Survival for additional recommendations)

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

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

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

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

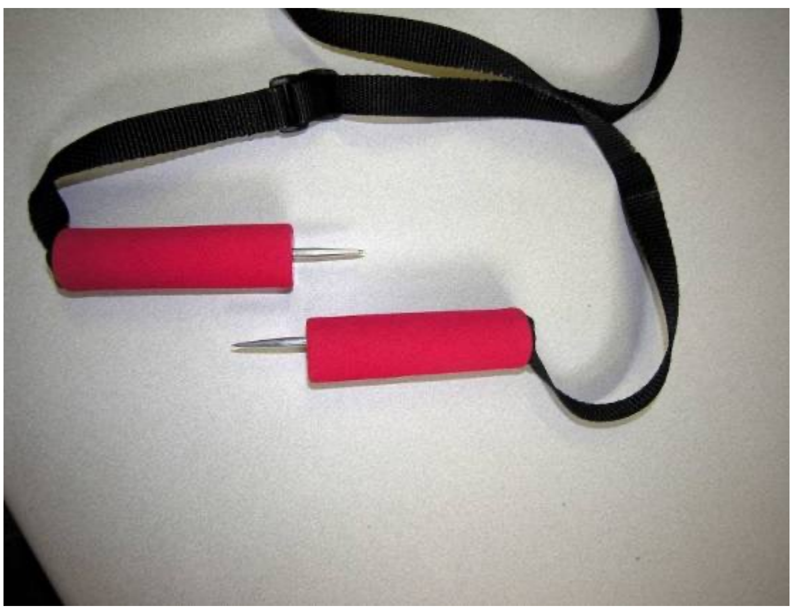


Figure 15.1: Commercial ice rescue picks © Courtney Mitchell

Figure 15.2: Using commercial ice rescue picks © Courtney Mitchell

15.5 | Inspections, Maintenance and Fuelling Guidelines

15.5.1 | Inspections

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

Pre-ride Inspection

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

Before starting the engine:

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

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

Start the snowmobile engine:

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

15.5.2 | Maintenance

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

- Follow the maintenance schedule and procedures outlined in the manufacturer's operator manual.
- Two daily maintenance measures are important:

  - Lift the engine hood and remove any snow or ice buildup in the engine compartment, including around the steering gear.
  - Clear the tracks to remove embedded ice and snow.
- If possible, store the snowmobile at the end of the day with the track elevated off the snow to prolong the life of the track.
- Protect the engine compartment with a cover or tarp when parking for extended periods (outdoors). In the Arctic, blowing snow can pack up in an engine compartment and cause icing so the machine will not operate. Shelters for snowmobiles are the best solution.
- Correct carburetor calibration is essential to prevent engine damage when the snowmobile is used in very low temperatures. Check the operator manual.
- Make sure the snowmobile is adjusted correctly for the altitude.
- Service the snowmobile at the end of the season before it is stored.
- Maintain a log book and record servicing, repairs and modifications to snowmobiles.

15.5.3 | Fuelling Procedures

- Use the correct fuel. Know which gas and which oil the snowmobile requires and the correct ratio. Newer models use gasoline in one tank and 2-stroke oil in a separate tank. Be very careful to fill each tank with the correct product. Snowmobiles in the far north may have the oil injection tank removed or turned off as they tend to freeze up, in which case the oil is mixed with the fuel.
- If the snowmobile is an older model that requires pre-mixed fuel, mix it in a safe location. Use a clean CSA approved container to mix the gas with the recommended amount of oil and shake well. Follow the specific procedure in the operator manual.
- Fuel a snowmobile in a well ventilated place with the engine stopped.
- Do not fuel a machine near another machine with the engine running or while it is in the bed of a pickup truck with a vinyl bed liner.
- Do not smoke. Do not allow open flames or sparks in a fuelling area.
- Use a dipstick or flashlight to check fuel levels. Never use a lighted match as fuel fumes are explosive.
- Do not fill the tank too full; close the tank cap securely when fuelling is completed.
- Add appropriate gas line antifreeze at each fuelling. Check the operator manual for details.
- Clean up any fuel spills completely with spill kit materials and dispose of contaminated materials in appropriately marked containers.
- Portable containers for fuel must be CSA approved. When filling them, always place portable

containers on the ground outside a pickup, an enclosed vehicle or a trailer so they are properly grounded (earthed). The vinyl bed liners in pickups prevent grounding. Fuel flowing into a container can create static electricity and it is possible to generate a spark and cause fuel vapors to explode if the container is not grounded. Only fill the containers to 95% capacity, as fuel expands as it warms. If possible, store fuel containers in a cool location out of direct sunlight.

15.6 | Training for Snowmobile Operators

As a minimum, companies should make sure employees have the necessary training and skills to operate snowmobiles safely and reduce risky behaviour. Training should cover fundamental risks and hazards of operating snowmobiles and how to prevent accidents through the use of SOPs, PPE, and safe riding skills. Make use of manufacturer's operator manuals in addition to material in this section to develop SOPs and topics for use in training sessions and safety meetings. Keep training records as required by Workers' Compensation Boards and to demonstrate due diligence.

Training programs are available from Canada Safety Council and should be taught by certified CSC snowmobile instructors.

1. Training should promote safe riding skills (see Chapter 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 Chapter 15.10).
   - Emergency braking practice to become familiar with required stopping distances
   - Inspection routines and safe fuelling procedures
   - Emergency maintenance – troubleshooting and minor repairs including how to prime and pull start a machine, if applicable
   - Variation in controls, handling and performance of the different snowmobiles on site
   - Safe loading and towing procedures
   - The responsible use of snowmobiles especially if company owned or leased snowmobiles are permitted for recreational use.
   - New riders should learn to ride in a restricted flat area.
   - Supervisors or trained employees should assess the competency of new riders before granting permission to travel alone to work sites
2. Each rider should learn to assess risks:
   - Evaluate and understand their personal skill level
   - Recognize how various terrain, weather, temperature and light conditions affect the level of risk and the ability to ride safely
   - Understand the risks of frostbite, hypothermia, and the preventive measures

(PPE, clothing, behaviour etc.) to counteract wind chill
  - Understand safe ice testing techniques and safe procedures for working on ice. Mentally assess the risks each time before working on ice, especially near freeze up and breakup.
  - Understand avalanche risks and avoidance. If avalanches are a risk, companies should engage expert help and employees should receive appropriate training from experts.
    Refer to Chapter 6. Safe Traversing Practices and Chapter 9.4 Avalanches.
3. Each rider should understand how snowmobile SOPs integrate with company and project/camp ERPs, communication procedures, survival and other safety procedures.

15.7 | Safety Precautions for Snowmobiles

General Recommendations

- Mark regularly travelled routes: Use flagging tape, wooden pickets painted with fluorescent paint, or even tree blazes (where legal). Marked trails are very helpful when:
  - Travelling in flat light and/or poor visibility conditions
  - Traffic is heavy
  - Safe routes are required when working around heavy equipment
  - Indicating the tested and proven safe route for crossing ice
- Hand signals: Be familiar with appropriate hand signals for communicating with other snowmobilers, as described by the Canadian Council of Snowmobile Organizations in alignment with international standards.
- 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 Chapter 15.10 Working on Ice.

- When crossing a road or railroad tracks, come to a full stop. Check carefully in both directions that there is no traffic, especially if there are more than one set of railroad tracks. Cross at 90°.
- Don't tailgate. Maintain a safe distance between machines.

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

Personal Protective Equipment (PPE)

- **Helmets:** Wear the correct helmet and fasten the chinstrap securely. Full face helmets offer the best protection. A safe helmet is one that is in good shape – no dents or cracks – with the inner foam padding also in good condition. Choose one large enough to wear a toque or balaclava under it. Snowmobile helmets should comply with federal standards and have a certification sticker from one of the following:
    - Snell Memorial Foundation M2005 Standard (Snell specifications are higher than DOT specifications)
    - US DOT sticker Standard FMVSS 218
    - Meet or exceed Standard D230 of the Canadian Standards Association (CSA)
    - Helmet Replacement: Replace any helmet that has been worn in an accident and damaged. Consider replacing helmets after four or five years, as their safety features (padding and construction materials) deteriorate over time and they do not offer the same protection as when new. Helmets are stamped with the month and date of production.
- **Goggles or a visor** should be worn to protect your eyes. Goggles should be free of scratches, shatterproof and well ventilated to prevent fogging up. Replace visors when they become scratched or cracked.
- **Boots:** Wear good boots to keep your feet warm – ones with thick felt liners are recommended. Take extra liners if they are likely to get wet. Do not use old worn liners as they will not provide good insulation.
- **Clothing**: Wear a comfortable, warm snowmobile suit that is not too tight. Tight clothing restricts blood circulation, which will increase the potential for frostbite and hypothermia. Dress in layers starting with long underwear that wicks moisture away from your skin. Choose polyester or microfiber rather than cotton, which takes longer to dry once it is wet. The middle layers should be fleece, wool, pile etc., for insulation. The outer layer should provide protection from wind and moisture yet "breathe" to allow sweat to evaporate through the fabric. Wearing layers makes it easier to cool down by removing one layer at a time as you work. Have a toque or balaclava available to protect against frostbite. Do not wear loose clothing that may get caught in moving parts of the machine (e.g., scarf). Keep clothing as dry as possible and dry out boots and clothing when you come indoors. Refer to Chapter 6.3.5 Clothing.
- **Gloves:** Wear proper insulated snowmobile gloves or mitts. They should be comfortable and allow the use of your fingers and thumb. Wearing thin inner gloves will protect your hands when you remove mitts to do precise work.
- **Floater snowmobile suit:** If working on ice, this is the safest suit to wear. It is very buoyant and will not absorb much water if you fall through ice in contrast to a regular snowmobile suit. While more costly, it can save your life. At the very least, wear a snowmobile suit that contains some buoyancy material and a personal flotation device (PFD).

Speed

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

Communications and Tracking Routines

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

Passengers

Riders are responsible for the safety of each passenger.

- It is advisable to carry a passenger only when a snowmobile is designed to carry two people. Do not carry more than one passenger at a time.

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

15.8 | Safe Riding Skills

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

15.8.1 | Riding Positions

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

15.8.2 | Visibility and Light Conditions

- Always ride so you are able to stop within the distance you can see.
- If it is necessary to ride at night, make sure the headlights are clean and clear of snow. Reduce speed. Be able to stop within the illuminated distance. Do not ride in unfamiliar territory at night.
- Snow blindness may develop if your eyes are not protected from UV radiation. Wear high quality UV protection sunglasses or goggles to cut down on direct and reflecting sunlight. In the Arctic, UV protection is more important during late winter and spring when the sun is higher in the sky. Refer to Chapter 9.10.5 Snow Blindness.
- Some light conditions make it difficult to see hazards.
    - In “flat light” conditions – when daylight is gray or without sunshine to provide shadows – the landscape may appear deceptively flat. It is hard to see ditches, ice ridges, snowdrifts, drop-offs or uneven ground. Reduce speed.
    - In bright sunlight it can be hard to distinguished obstacles and small changes in topography such as ditches. Wear coloured polarized lenses to counteract glare.
    - Consider the different types of available lenses and choose colours appropriate for the conditions you will most likely encounter. Gray or dark green lenses are useful on bright sunny days. Wear amber or yellow lenses on dark days, late afternoon or for flat light conditions. Do not wear sunglasses or tinted lenses at night.
- On sites with heavy equipment or where extra visibility is required, equip snowmobiles with a

whip – a bright-coloured antenna flag mounted on rods from 1.2 m to 2.4 m in length attached to the back of the snowmobile. If riding at night is required, the whip should also have a light at the tip. Apply reflective tape to snowmobiles. Riders should wear reflective vests over of their snowmobile suits. Use extreme caution when riding around heavy machinery. Radio communication may be required.

- Tie down or remove an antenna flag while riding in forested areas, as it can get caught on a branch and whip back to hit the rider.

15.8.3 | Towing

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

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

15.8.4 | Transporting Snowmobiles

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

- Choose a flat unobstructed site to load the snowmobile.
- Sometimes a stable snow bank can be used instead of a ramp by backing a trailer or pickup into it and driving the snowmobile onto the bed.
- If using a trailer, use the correct hitch and safety chains. Make sure all trailer lights for brakes and turn indicators function properly.
- To avoid spills, make sure the snowmobile oil reservoir and fuel tank caps are secure and the fuel line is shut off.
- If using detachable loading ramps, use cleats or brackets and straps that attach to the truck or trailer to make sure the ramps do not come off during loading procedures.

- When transporting a snowmobile in an open truck or trailer, the windscreen should be removed to prevent loss or damage.
- Load the machines with the skis forward and centred over the loading ramps. If possible, winch the snowmobile onto the carrier, as accidents may happen while riding onto the truck or trailer. If necessary, ride the snowmobile slowly and carefully up the ramp.
- If only one machine is transported, make sure it is centred on the trailer or pickup bed.
- Secure the snowmobile to the vehicle or trailer with approved straps, harnesses, blocks and/or chains that are in good condition. Make sure the snowmobile will not shift while en route, hit the back window or come free in an accident. Cover the snowmobile to protect it.
- Make sure any additional cargo will not shift en route and damage the snowmobile.

15.9 | Safe Riding Strategies

15.9.1| Weather and Terrain Tips

- Check forecasts and current weather conditions and ride accordingly. Postpone a trip if weather threatens to deteriorate or if there is a significant risk of avalanche conditions.
- The combination of speed and weather conditions may lead to severe wind chill and cause frostbite and hypothermia. Dress appropriately and stay dry. Refer to Chapters 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 Chapter 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 Chapter 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 Appendix I.XV for links.
- 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.
  - Avalanche Canada provides information about avalanche safety.

15.9.2 | Retrieving a Snowmobile

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

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

the tracks, moving ahead a short way (until it bogs again) and repeating this procedure until you reach good ground.

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

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

15.9.3 | Hazards on Land

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

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

15.10 | Working on Ice

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

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

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

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

15.10.1 | Risks and Hazards

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

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

15.10.2 | Ice Terminology and Features

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

- Clear blue ice is strongest. It forms when water freezes over a long period when the air temperature is below freezing. It is chunky – not flakey – when tested.
- White opaque ice (snow ice) is generally rated as half as strong as clear blue ice. This ice contains air which weakens the ice. It forms when wet snow freezes or when snow on ice freezes.
- Frazil ice (newly formed): While clear in colour, it is composed of loosely amalgamated crystals that make it weak and porous. It is flakey – not chunky – when tested.
- Candled ice or gray ice is least strong: The gray colour indicates that water is present in the ice. As ice melts, lines of weakness containing water and impurities effectively separate individual ice crystals and weaken an ice sheet so it will disintegrate easily. Ice prisms form perpendicular to the surface of the sheet – hence the term candling. Even before it "candles", the strength of gray ice is much diminished and it will not support the weight of people or snowmobiles. Never go out on candled or gray ice.
- Slush: Overflow conditions or melting are the usual causes of slush. Overflow results when a layer of snow depresses ice causing it to crack so water rises up and over the ice but remains under the snow. The overlying snow insulates the water so the water does not freeze, which forms a slush layer despite cold temperatures.
- Cracks: Dry and wet cracks form when ice moves and when it contracts. Cracks may or may not indicate weakening of the ice. It is necessary to locate cracks and recognize the different types to determine the safe load bearing capacity of ice.
  - Dry cracks develop when ice expands at the top of ice layers as it builds up and thickens from the bottom. Dry cracks can be repaired with water or slush.
  - Wet cracks are dangerous as they indicate the ice has fractured completely through to the water below. The load the ice bears must be reduced; the amount depends on the size, location and configuration of the cracks. Wet cracks will often refreeze and heal. After healing, the ice may be as strong as before, but it must be tested by drilling a core sample to tell how deep the crack has healed.
  - Radial cracks form when ice is overloaded. The cracks radiate outwards from the load.
  - Circumferential cracks form when ice is overloaded. They form surrounding the load and when circumferential cracks join radial cracks, ice failure is imminent.
  - Hinge cracks form along river or stream banks or lake shores where water levels fluctuate.
  - Tidal cracks form near the shoreline on sea ice due to tidal action.
- Pressure ridges may be due to ice movement, wind or currents. They contain piles of broken ice, cracks and perhaps hidden open water. Ice pressure ridges are very unstable. See the photos on the following pages for visual examples.

15.10.3 | Hazards Related to Ice

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

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

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

Lake Ice

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

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

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

River Ice

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

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

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

Sea Ice

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

- Thickness: Sea ice must be thicker than clear lake ice to support the same load. Find a reliable sea ice thickness chart and seek local knowledge.
- Weather: Poor visibility due to fog or blowing snow etc., will obscure features such as cracks and pressure ridges. It may be difficult to determine your location without a GPS.
- Wind, waves and swells all affect the stability of sea ice. They affect the formation of ice sheets and how quickly the ice becomes stable enough to travel on. A certain thickness of sea ice formed under calm conditions may be safe to travel on while the same thickness formed under rough conditions may not be stable due to hazardous cracks etc.
- Wind: Strong winds may blow sea ice away from shore in a very short time and leave open water. Cracks in sea ice provide planes of weakness that wind can utilize to move sea ice around. Continuously monitor wind and weather conditions so you do not become stranded.

- Tidal cracks develop parallel to the shoreline up to more than 100 metres off shore. They result from tidal action that raises and lowers ice along the shoreline. When travelling through areas of tidal cracks, it is safest to travel on bare ice rather than on snow covered ice in order to avoid hidden wide cracks. Use a probe to detect gaps and cracks under snow, as required.
- Pressure ridges and cracks develop due to actions of wind, tides, swells and heating and cooling air temperatures. Cross them with great care in the direction perpendicular to the ridge or crack. Probe ahead to test the ice and for open water.
- Colour of sea ice: Due to varying conditions during formation, the color of ice may change over distance. Learn from locals how to recognize what is safe and what is not safe.
- Sea ice forms pockets of brine as it freezes, which cause the ice strength to vary across the ice sheet. This variation in strength is especially important to consider when temperatures rise late in the season.
- Ice that forms in estuaries is often hazardous to ride on due to variation in water depth, salinity, currents etc.

Snow Cover on Ice

The amount of snow on ice affects safety.

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

Slush

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

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

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

Thawed and Refrozen Ice

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

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

15.10.4 | Ice Testing Equipment

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

Equipment for testing ice thickness

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

- Flotation snowmobile suit or a personal flotation device (PFD) worn over a snowmobile suit (1 per person)
- Waterproof boots, insulated waterproof gloves
- Full body harness – to attach to the rescue rope
- 20 to 30 metres certified polypropylene floating rescue rope, 1 cm (3/8th inch) thick
- Axe or ice chisel – may be used for ice up to 30 cm
- Power ice auger – drills up to about 125 cm and more with extension bits, as required
- Measuring stick with a hook on the bottom
- 2-way radios and/or cell phone or satellite phone (preferably 1 per person)
- GPS, as required
- Whistle
- Sunglasses
- Hypothermia kit – see Chapter 15.4 Equipment Lists

Tips for using a power auger

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

- Refer to the manufacturer's owner manual and follow the safe operating, sharpening and maintenance instructions.
- Wear gloves to protect your hands from sharp edges on the cutter heads.
- Check that the clutch works properly before use.
- Ice augers with a "safety arm" are preferable, as the rotation will stop if control of the auger is lost.
- Always stand on ice when operating the auger. Place your feet away from the hole but still maintain stability. Never stand on an oil drum etc., to gain height.

- Start slowly when starting the auger. Do not fully open the throttle when you start drilling.
- Periodically pull the auger up and down to help clear the hole of ice shavings.
- If the ice is thicker than one length of the auger shaft, drill to the maximum depth of the auger and shut it off before adding the extension. Do not join an extension to the auger before starting to drill the hole.
- Join each length of auger with the correct cotter pin. Do not use substitutes.
- If you lose control of the auger while drilling, release the throttle immediately to stop the machine. Let go of the auger rather than be thrown by the torque of the machine.
- Do not wear loose clothing that might get caught in the rotating auger shaft or blade (e.g. scarf).
- For additional information, refer to the following Appendices in *Best Practices for Building and Working on Ice Covers in Alberta*:
    - Appendix A Using an Auger to Measure Ice Thickness While on Foot
    - Appendix B Guide for GPR Ice Profiling
    - Appendix C Safety Equipment for Ice Safety Plan

Figure 15.9: Ice auger with extension © Iain Mitchell

15.10.5 | Planning and Preparation for Working on Ice

Ice safety plan for working on ice

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

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

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

- Section 3. Ice Cover Hazard Controls
- Section 4.1 Design Controls
- Section 4.2 Ice Monitoring Controls
- Section 5. Developing Your Ice Safety Plan
- Appendix D Emergency Procedures

15.10.5.1 | Guidelines for Testing and Assessing Safe Ice Thickness

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

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

- Section 2.5 Load Duration
- Section 4.1 Design Controls
- Section 4.2 Ice Monitoring Controls
- Section 4.1.5 Stationary Loads

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

Preparation for Ice Testing Procedures

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

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

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

- Do not begin testing ice if there is any doubt about its safety. Never attempt ice crossings during freeze up and breakup. Newly formed ice (frazil ice) is not strong, even when it looks solid. It requires an extended period of below freezing temperatures to produce strong safe ice cover. When the weather warms and snow starts to melt, thick ice is not necessarily safe. It may be candled in places, contain pockets or layers of water or brine and disintegrate easily.
- Make sure the ice is thick enough to bear the total load (people + equipment + fuel + snowmobiles, as required) to cross safely. Test it first if there is any question at any time about the safe thickness. Drill a hole and measure it.

- Check the ice thickness on foot using a hand or power auger before allowing snowmobiles or light equipment to travel on ice.
- Test the ice thickness at regular intervals.
  - Where thinner ice is detected or if the thickness is highly variable, adjust the position of the auger holes to closer intervals to determine the size of the abnormal area.
  - Repeat testing when significant temperature changes occur even when temperatures do not go above freezing.
  - For guidelines, refer to the following tables in *Best Practices for Building and Working on Ice Covers in Alberta*:
    - Appendix A Table A1: Recommended Maximum Spacing of Auger Test Holes for Measuring Ice
    - Appendix A Table A2: Recommended Minimum Frequency of Auger Test Hole Measurements
- Record measurements in a log book. Record the location with a GPS unit and/or on a map, temperature, the "effective ice thickness" and other information required by AHJs. Store the log book in a secure place.
  - "Effective ice thickness": When ice is composed of continuous layers of white snow ice and clear blue ice, calculate the "effective ice thickness" by measuring the thickness of each type of ice. White ice is rated as half the value of its measured thickness. Add this sum to the measurement of clear ice. Report the effective ice thickness in terms of clear blue ice. See Figure 15.10 below.
  - Take into account the presence and types of cracks and adjust the safe load bearing capacity accordingly. Exercise additional caution by leaving a comfortable margin of error.
  - For information regarding measuring and recording ice, refer to:
    - *Best Practices for Building and Working on Ice Covers in Alberta*:
      - Section 4.2.1 Measuring and Recording Ice Thickness
      - Section 4.2.2 Monitoring Ice Cracks
      - Appendix A Table A3: Ice Cover Profile Template
    - *A Field Guide to Ice Construction Safety*
      - Section 3. Ice Capacity and Testing

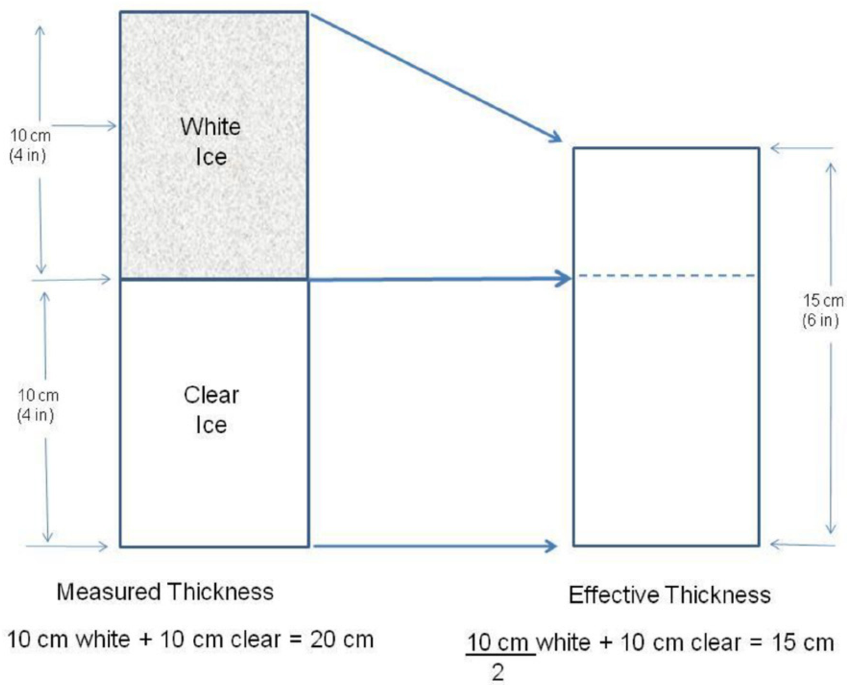


Figure 15.10: Computing the "effective ice thickness"

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

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

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

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

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

Source of ice thickness recommendations: Best Practice for Building and Working Safely on Ice Covers in Alberta.

15.10.5.2 | Guidelines for Testing Ice Thickness on Foot

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

- Testing crews should follow all company SOPs, ERPs and use required safety equipment.
- Never test ice thickness alone. Always work in pairs. It is advisable to have a third person as a spotter on shore to call for help if a crew member falls through ice.
- Check ice thickness at the entry point with an axe or ice chisel to determine if the ice will support the total weight of the crew member plus equipment. The ice should be chunky when hacked. Do not proceed if the ice thickness is less than 10 cm; wait until the ice is thicker.
- If the ice is thick enough to test:
    - The lead crew member should wear a full body harness and attached safety line. The lead should walk a predetermined distance and chip or drill the first hole while the second crew member remains on shore holding the safety line taut.

- Check for water at 10 cm. If there is none, drill to water and measure the ice thickness.
- If the ice is a safe thickness at the first test hole, the lead crew member may advance the predetermined distance and drill a second hole to the water. The second crew member should follow in the same path and remain behind the first test hole on safe ice.
- If the ice thickness is safe at the second hole, both crew members may advance the predetermined distance and continue the procedure.
- The second crew member should:
    - Hold the safety line taut. Stay on shore until the first hole is safely drilled.
    - Follow in the same path as the lead crew member where ice is proven safe. Remain at least 15 metres behind the lead crew member and behind a successful test hole.
    - Carry the 2-way radio or sat phone and stay in regular contact with the supervisor.
- Record the ice thickness, temperature, observations regarding cracks, presence of snow load and other details required by AHJs. Report the effective ice thickness in terms of clear blue ice.
- If at any time the ice thickness is less than 10 cm thick, remove equipment and retreat to shore. Wait until ice is thicker to test again.

15.10.5.3 | Guidelines for Safe Snowmobile Ice Crossings

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

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

15.11 | Cold Water Immersion Hypothermia – Falling Through Ice

Falling through ice into cold water is a serious emergency. Should it happen to you, react as soon as possible and attempt self-rescue. Many popular beliefs about how the body reacts when we fall into cold water are inaccurate and out of date. Dr. Gordon Giesbrecht, a Canadian authority on human response to cold environments, has written books, articles and made videos on the subject. Dr. Giesbrecht has generously provided information and photographs to illustrate the correct method of self-rescue if you fall though ice. Information in this section is compiled primarily from the following sources, which contain important, updated information about cold water immersion and the value of a flotation snowmobile suit if you fall through ice.

How your body reacts when you fall into cold water

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

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

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

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

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

One Minute — Ten Minutes — One Hour

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

1. Control your breathing.

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

3. Kick hard; get horizontal.

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

Figure 15.11: Surviving a fall through ice.

Ten Minutes:

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

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

One Hour:

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

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

Once on shore:

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

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

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

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 (1) 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.

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 Chapter 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

16.2 | Responsibilities (Due Diligence) Regarding Aircraft

Implementing training and safe operating procedures (SOPs) are important ways to reduce potential incidents, which are often fatal. As presented in Chapter 1.2 Due Diligence, companies should be able to demonstrate due diligence with respect to safety. For example, in Canada, Transport Canada regulations together with provincial and territorial Occupational Health and Safety legislation require companies to provide employees who fly and work around aircraft with training in safe work procedures regarding aircraft. The following are some requirements that demonstrate due diligence with respect to aircraft safety.

Exploration Companies

- Develop written safe operating procedures (SOPs), site specific SOPs (as needed), and SOPs for special aircraft operations (e.g., slinging, drill moves, hover manoeuvres, special surveys). SOPs should address flying to and from work sites and traverses etc. Some terrain requires specific safe operating procedures (mountains, glaciers, Arctic islands etc.).
- Develop a written emergency response plan (ERP) with procedures for overdue or missing aircraft.
- Hire (or train) supervisors who are competent, especially when slinging and drill move operations are required.
- Provide training and education for employees who fly or work around aircraft (e.g., traversing and slinging operations). Consider formal designation and training for those capable of supervising aircraft slinging operations to establish "load marshalls".
- See that piloting, inspections and maintenance of chartered aircraft are carried out by competent personnel.
- Provide required PPE.

- Monitor the use of aircraft, behaviour around aircraft and implement consequences when SOPs etc., are not followed.
- Documentation: Keep records of training, accidents/incidents and corrective actions, mitigation of hazards, safety inductions and meetings, inspections, maintenance, infractions etc., that apply to aircraft.
- Carry adequate insurance.
- Sometimes only military aircraft are available for charter in less developed countries. Exploration personnel should be aware that normally military aircraft do not have or require airworthiness certificates. Flying in an aircraft with no airworthiness certificate may invalidate some insurance, such as life insurance, medical coverage etc. Military pilots may have different safety standards than civilian pilots.

Project Manager or Supervisor

- Implement company SOPs regarding aircraft. Develop site specific procedures and train employees in SOPs, as required.
- Make sure all employees are familiar with the project ERP procedures and are trained to respond correctly if an aircraft is late, missing or crashes.
- Repeat training periodically – whenever there is a change of pilot and/or engineer, change of aircraft, when new employees start work, and any time there is a slip up or reason for refresher training.
- Be sure pilots comply with jurisdictional transportation regulations. Do not request pilots to exceed the allowable duty hours and flight hours.
- Make sure pilots provide written flight plan records for all flights from the project and that they check-in on schedule.

Employees

- Follow company SOPs and training regarding aircraft.
- Follow training and instructions given by the pilot.
- Be familiar with and keep away from the danger zones around aircraft.
- Use PPE and safety equipment as directed.
- Report hazards or dangers to the pilot while in flight or to the supervisor or pilot while on the ground.
- Never engage in horseplay in or around aircraft.
- Be aware of their right to refuse to fly if they feel the situation is unsafe or they need more training to do a job safely (e.g., hover manoeuvres)

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.

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.

1. 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.
2. 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.
   As a guideline, the International Airborne Geophysics Safety Association recommends the following hours:

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.

3. 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.
4. 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 Chapter 16.15 Emergency Procedures.
5. Pilots should file a written record of the passengers on board, the route and destination for every flight.
6. 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.
7. All passengers must be transported in anchored seats with seat belts fastened. Wear h earing protection (ear muffs) whenever possible. Carry and use disposable earplugs for additional protection.
8. 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.
9. 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.
10. 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.
11. Never overload an aircraft. Follow safe loading procedures. Plan for the increased weight of samples. Make an extra trip if necessary. (See Chapter 16.8 Safe Loading Guidelines.)
12. 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 Chapter 16.9 Transportation of Dangerous Goods.
13. All employees are required to maintain vigilant, safe behaviour and refrain from all types of horseplay in and around aircraft at all times.
14. No smoking within 30 metres of aircraft or fuel storage areas.
15. 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.

16. 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.
17. 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.

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.

16.6 | Float Planes

Due to their design, additional safe operating guidelines apply to float planes.

- Pay close attention to the pilot's safety briefing, especially regarding safe boarding and disembarking routines.

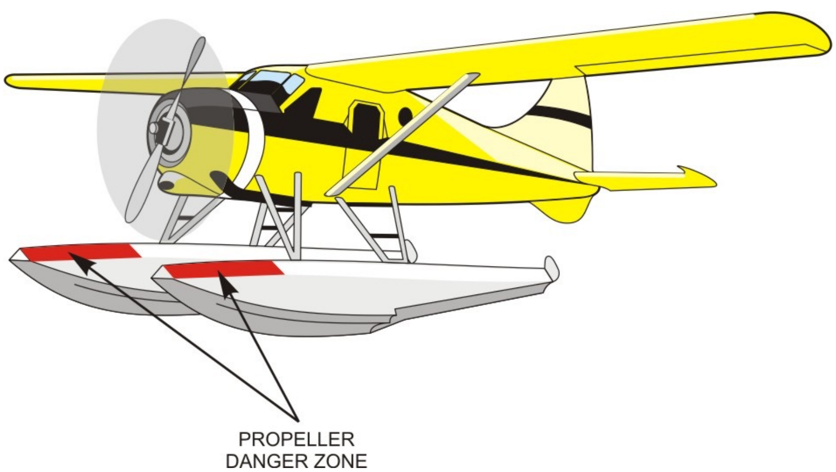


Figure 16.1: Float Plane propeller danger zone

- Danger zones: The propeller(s) is invisible and extends across the front of the floats. Watch out for the propeller overhang at a dock at all times.
- Be able to find and open the exits (situational awareness). In the event of an accident, float planes tend to come to rest upside down in water. See Chapter 16.15 Emergency Procedures.
- Float planes are required to carry one life jacket for every person on board. Know where your life jacket is located, how to retrieve it, and how and when to put it on.

- The pilot should brief at least one passenger on the mooring procedures no matter what arrangements have been made at the destination. The passenger should be familiar with float planes, if possible. Do not assist in tying up a floatplane unless you have been trained to do so.
- Always follow the pilot's instructions when mooring a float plane. Always use a strut for the initial tie-up. Wait until the engine is fully stopped before securing the front of a float, as the engine may backfire causing the propeller to spin.
- Remember that the cowling around the engines and the struts near the exhaust areas will remain hot after the engine stops.
- Never touch the rudder, elevators, ailerons or connecting wires on the aircraft.
- Avoid surfaces coarser than sand when beaching and tying up a float plane on shorelines with no dock.
- Before loading, make sure the dock is firmly secured to the shore and the float plane is firmly secured to the dock.
- Remote landings:
    - Before landing, the pilot should verify that the float plane will be able to take off again, as take-off requirements change with load, elevation, wind conditions etc. While this is the pilot's responsibility, passengers should be aware of these constraints and not encourage a pilot to take chances.
    - The pilot should overfly the landing area and the takeoff area to check for floating obstacles, submerged or semi-submerged logs or rocks, wind direction and strength, trees, structures such as buildings, wires that may connect islands and the mainland, and other traffic on the water.
    - Glassy water landings: When possible, people on shore should make waves with a boat to disturb the water surface, which will help increase the pilot's depth perception and ability to judge altitude when landing.
    - In snowy conditions or on frozen lakes, use evergreen trees as markers to line runways and provide the pilot with a horizon reference in flat light or near white out conditions.
    - On ice: Check for other traffic, snow and ice conditions, wind direction and strength, cracks, obstacles, pressure ridges, wildlife and trees. Prevent skis from freezing in by placing brush under skis when the plane is parked.

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 Chapter 16.4 Safe Operating Guidelines for All Aircraft, the following guidelines apply to helicopters.

16.7.1 | Safe Operating Guidelines for Helicopters

1. Avoid using piston engine helicopters.
2. Passenger safety briefings should stress the additional hazards associated with helicopters.
3. 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.
4. 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.
5.
6.

Figure 16.2 Maintaining eye contact with pilot to approach a helicopter.

7. 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.
8. 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.

9. 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.

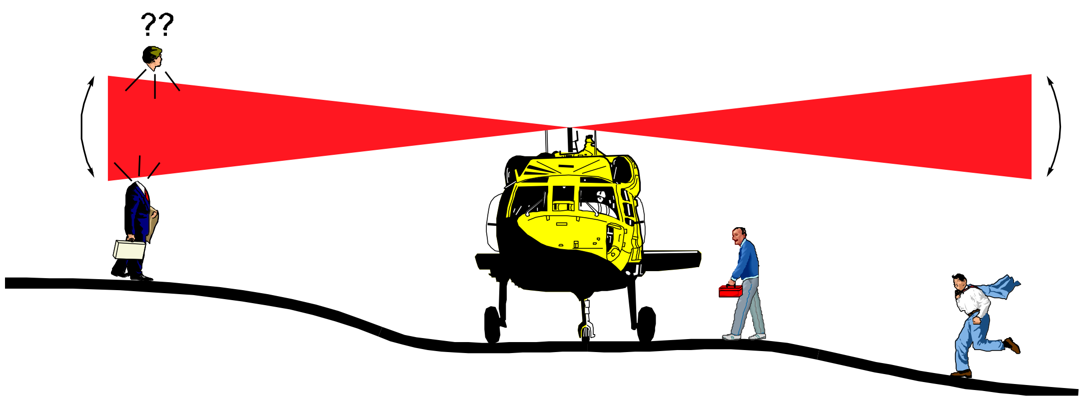


Figure 16.3: Approaching a helicopter

10. 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.

Figure 16.4: Helicopter blades can dip down in wind

11. 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.
12. 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.
13. 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.
14. 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.

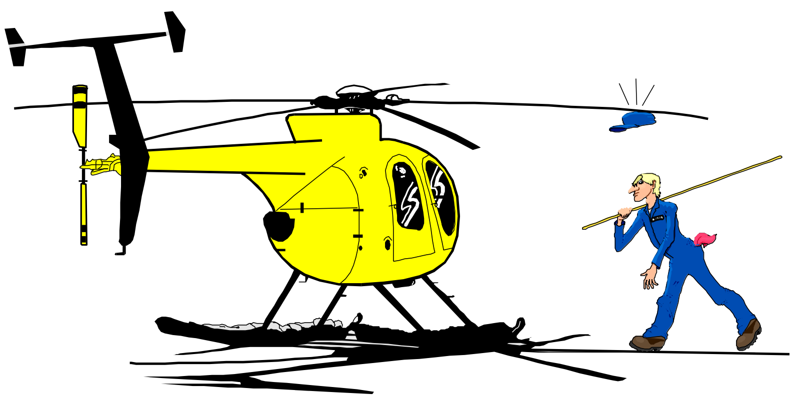


Figure 16.5: Secure loose items when approaching a helicopter

15. 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.
16. Never throw anything out of a helicopter. It may contact the rotor blades or be sucked into the jet engines.
17. 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.

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.

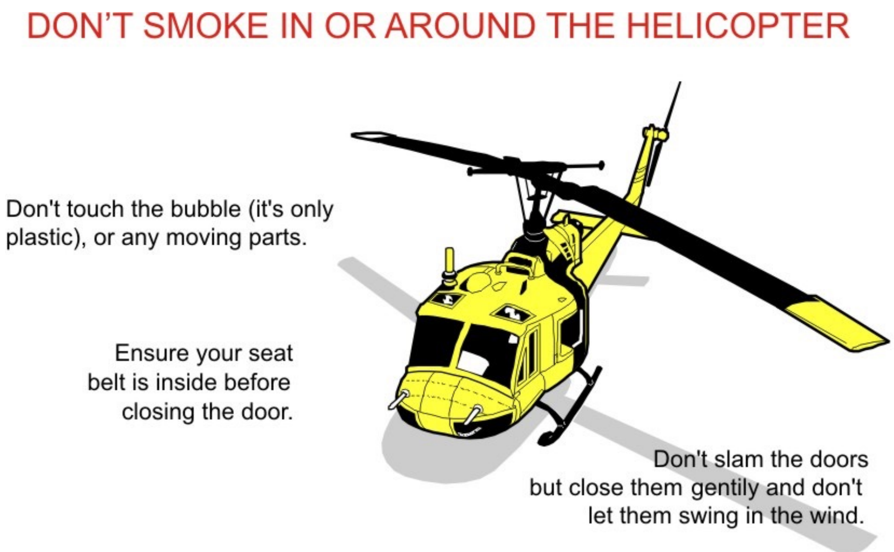


Figure 16.6: General helicopter safety.

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).

The helicopter downwash will lift and move an amazing variety of things.
Never throw an object in the vicinity of the helicopter.

Figure 16.7: Helicopter landing sites

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:

- 1. The pilot makes all decisions regarding the helicopter and its capabilities – no exceptions.
- 2. 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.

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 Chapter 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.

16.9 | Transportation of Dangerous Goods

The pilot must be notified in advance about all hazardous cargo. The pilot is in charge of loading or directly supervising the transportation of all hazardous or dangerous goods cargo. When the pilot does not perform this duty, the person in charge is required to have adequate training in loading, securing, inspecting for damage and proper segregation of the load. Many apparently harmless items that are routinely carried by ground transportation can become extremely hazardous when carried by air. Some items can cause immediate life-threatening situations (e.g., fire or leaked toxic gases); other items can damage an aircraft's structure over a very short period of time (e.g., spilled acid or other corrosive material that causes rapid corrosion leading to a structural failure in flight).

- Dangerous goods restrictions vary between passenger, cargo and chartered aircraft; they are imposed by relevant national regulatory authorities.
- Dangerous goods may only be packaged for and shipped by air transport by individuals who have received formal training and hold current dangerous goods certifications.
- A dangerous goods declaration is required to accompany all hazardous cargo. Pilots are required to reject any hazardous cargo that does not agree with the TDG declaration. Generally, the training given to pilots does not allow them to package dangerous goods or prepare relevant documentation.
- Examples of some common items typically used in exploration that are classified as dangerous goods include but are not limited to: lead acid batteries, acids, flares, ammunition, explosives, detonators, aerosol containers (bear spray), solvents. Regulations governing the transportation of dangerous goods by air are provided by Transport Canada. A detailed list of dangerous goods is included as schedule 1 of the Consolidated Transportation of Dangerous Goods Regulations including Amendment SOR/2008-34.
- Transport dangerous goods according to safe methods e.g., bear spray in sealed containers – never inside the aircraft cabin. See Chapter 16.9 Safe Loading Guidelines.
- TP 11504 – The Marks of Safety shows the symbols and placards of classes of hazardous goods.
- Access to a variety of links regarding dangerous goods is available on the Transport Canada website.

When placing a dangerous goods order from a supplier, have the supplier:

1. Deliver the goods directly to the field location
2. Make sure the supplier (shipper) ships the order as dangerous goods with the shipper's declaration form fully completed and attached to the dangerous goods. The consignee should be qualified to receive the shipment.
3. An alternative solution would be to use a dangerous goods shipper for regulated items.

16.10 | Training

Due to the potential for fatalities and serious injuries resulting from aircraft accidents, it is imperative that everyone who uses or works around aircraft is thoroughly trained in SOPs. Everyone must be aware of their responsibilities that contribute to safe operations regarding aircraft. This is best accomplished through well planned and comprehensive site safety inductions and thorough safety briefings before flights and special operations.

16.10.1 | Aircraft Safety Induction Meetings

A thorough aircraft safety induction should be part of the general site safety induction at the start up of the field season for all sites that use aircraft. Everyone (all employees and contractor's employees) should be required to attend. The appropriate topics should be thoroughly covered by the project manager and pilot with regard to landing sites, fuel storage and handling, remote airstrips or water/ice landings etc.

- SOPs
- Conduct around aircraft, landing sites and remote airstrips
- Fire prevention around aircraft and fuel storage areas
- Housekeeping around the landing area
- Communication equipment, channels and schedules and emergency communication procedures: Train employees how to place a call on the aircraft radio, if necessary.
- Responsibilities regarding trip plans, drop off and pick up points, check-in schedules for tracking aircraft and employee locations
- The ERP procedures regarding aircraft should cover:
    - An overdue radio call
    - An aircraft alert situation when an aircraft cannot be contacted after a specified length of time
    - An aircraft distress situation when an aircraft is overdue and cannot be contacted after a specified length of time
    - A declared aircraft emergency and other potential emergencies that might occur at the work site
- Safety at the aircraft:
    - Danger zones around aircraft: fixed wing, float or ski plane, helicopter, as required
    - Operations of features – doors, cargo storage, temporary tie up
    - Location and operation of emergency equipment – fire extinguisher, raft, life jackets, first aid kit; how to remove the ELT (Emergency Locator Transmitter) set up and activation; open and inspect the aircraft survival kit

- Capabilities of the aircraft and pilot – loads, possibility of hover manoeuvres
- Requirements for remote fixed wing aircraft landings
- How to create a safe temporary helicopter landing site for pick up, including the required dimensions for the helicopter in use.
- Personal emergency kit requirements for employees using aircraft

16.10.2 | Regular Pre-Flight Safety Briefings

Passengers should receive a safety briefing from the pilot before each flight. Repeat briefings when new passengers board flights with more than one stop. At the start of the season, briefings should be longer and more thorough than later when field crews are familiar with routines and procedures. However, problems sometimes arise when field crews and/or pilots become complacent and forget that each flight is unique and circumstances change each day and throughout the day. Passengers may begin to take safety for granted and not be fully attentive to all SOPs. Experienced people have walked into rotor blades and propellers.

Safety briefings are essential for passengers who fly intermittently. Conduct refresher training, as required.

Pre-flight safety briefings should include the following topics:

- Aircraft description: Capabilities of the aircraft, the capacity, cargo compartments, location of safety equipment
- Entry and exit
    - Hazards of main rotor and tail rotor for helicopters or
    - Hazards of propellers for fixed wing aircraft
    - Make eye contact with the pilot before boarding
    - Crouch when approaching a helicopter and hold onto your hat
    - Hazards of sloping ground, obstacles such as stumps or hummocks
    - Understand the pilot's field of view and always remain within it unless the pilot knows your actions e.g., loading, unloading cargo
    - Floats – safe area to step on or over
- Beware of antennas, pitot tubes and cargo baskets for helicopters
- Doors: Know the correct way to open, close and latch them securely
- Cargo and baggage
    - Dangerous goods requirements including for bear spray, bug spray and firearms
    - Safe loading methods and plan for the weight of samples on return

  - Electronic devices shut off
  - Opening and closing cargo doors, cargo compartment secured
  - Cabin baggage secured
- Seat belts and/or shoulder harnesses: Know how to adjust them, release them quickly and when to do so in an emergency.
- Communications
  - Appropriate radio and channels to use for communication, check that radios function before the aircraft departs
  - Use of headsets for communication – wear them when the pilot wears them
  - Correct hand signals
  - How to aid a helicopter landing with hand signals and your body position
- Emergency Procedures
  - Pilot will direct when to leave aircraft
  - Passengers – situational awareness – know the location of exits relative to your seat and how to exit
  - Emergency brace positions, ditching procedures
  - Life raft and life jacket location – how and when to operate and inflate them
  - ELT location, manual set up, antenna placement and activation
  - Briefing card with features of the aircraft – location, importance
- No smoking rules – not permitted with 30 metres of aircraft or fuel storage area

16.10.3 | Safety Briefings for Special Operations

Special operations: hover manoeuvres, slinging loads (drills, setting up camp etc.,) require special briefings.

- Hover manoeuvres briefing
  Hover manoeuvres should be avoided whenever possible. Refer to Chapter 16.7.3 for details. When a hover manoeuvre is unavoidable, the briefing and drill should cover the following points.
  - Pilot's line of sight for the particular helicopter
  - Seat belts – fasten before exit
  - Headsets – listen for instructions
  - Weight transfer – seating order – everything planned and executed carefully. Last one out is first one in; shuffle across the seats to exit; make a slow careful exit but hang on tightly
  - Mustering (gathering) point for pick up – define what makes a good location
  - Pilot signals and instructions
- Slinging briefing
  - All aspects of helicopter safety including the pilot's line of sight and blind spots for the particular helicopter

- Site selection: size requirements, terrain characteristics
- Approach and departure requirements: angle of approach, clearance from trees, power lines, cliffs and other hazards
- Site organization
    - Pick up and lay down areas, load organization
    - Personnel on site – only people with a work-related reason may be at slinging locations
    - Restrict vehicles from slinging locations during operations
    - Housekeeping – no loose objects such as plywood, tarps, clothing, rubbish
- Special equipment for slinging
    - Job allocation – who does what job
    - Long line – type, function
    - Carousel – type, function
    - Hook(s) – release function
    - Special equipment – e.g., for lifting drill rod
- Slinging procedures
    - Hook up procedures
    - Loading procedures
    - Unloading procedures
    - Special conditions
        - Pilot's instructions
- Ground crew safety
    - Radio communication
    - Hand signals
    - Safe positions – always in sight of pilot, never stand under the load, never turn your back on a load
    - Special cases – a long tall load (e.g., drill mast) can fall lengthwise trapping someone who is off to the side
    - Always have an escape route available
    - Never ride on a sling or skid
- Emergency Procedures
    - Where to go in the event of a helicopter emergency – in flight, in hover
    - How to handle load emergencies – groundman injuries, load problems

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 Chapter 1.2 Internal Responsibility System.

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 Chapter 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.
- 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.
- 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.

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 Chapter 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 Chapter 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 Chapter 16.5 Pilot Fatigue).

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 Chapter 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 Chapter 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.
- Transport Canada provides general information regarding passenger safety on helicopters and float planes.

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.

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

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 (reproduced from the original, 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

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.

1. 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.
2. Make sure the helicopter has the lifting capacity to do the job.
3. 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.
4. 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.
5. 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.
6. 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.
7. Hold briefings for each slinging job so everyone fully understands their responsibilities for the task at hand. Include clear instructions regarding potential emergency situations.
8. 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.
9. Use the correct type of slinging equipment for the job and be sure it is in good working condition.
10. Organize the loads taking into account the weight, shape and type of loads.
11. Plan flight paths so helicopters do not fly over built up areas, established project areas or where people are working.
12. Ground personnel should never place themselves beneath a suspended load under any circumstances.
13. 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".

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 Chapter 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.

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 Chapter 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 Chapter 16.10.3 Safety Briefings for Special Operations.
- Establish signals for communication – radio and hand – and make sure everyone is familiar with them. See Chapter 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 Chapter 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.

16.12.6 | Guidelines for Drill Slinging Operations

Be familiar with Chapter 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 Chapter 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, Chapter 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 Chapter 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.
    1. 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.
    2. 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).
    3. Fit the drill with a guide (welded guides) to force the base of the tower into the correct alignment.

4. 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.

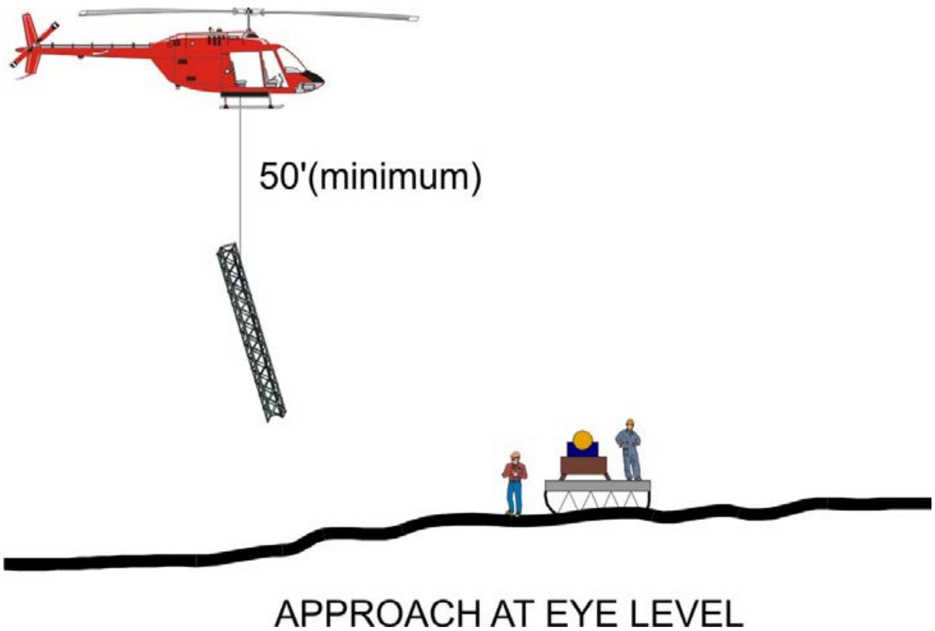


Figure 16.8: Drill slinging

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.

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 (1999, reproduced 2008); for a source current to 2023, refer to Transport Canada's Standard 325.

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.

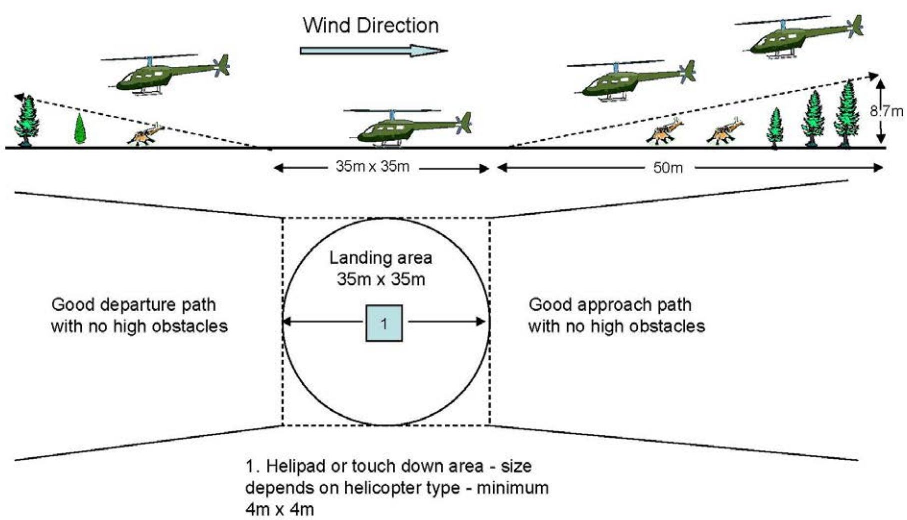


Figure 16.9: Elevation and plan views for suggested minimum dimensions of a temporary helicopter landing area

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.

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.

Figure 16.10: Try to verify the condition of a remote landing strip; this aircraft had to be towed to firmer ground before departure. © Bill Mitchell

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.

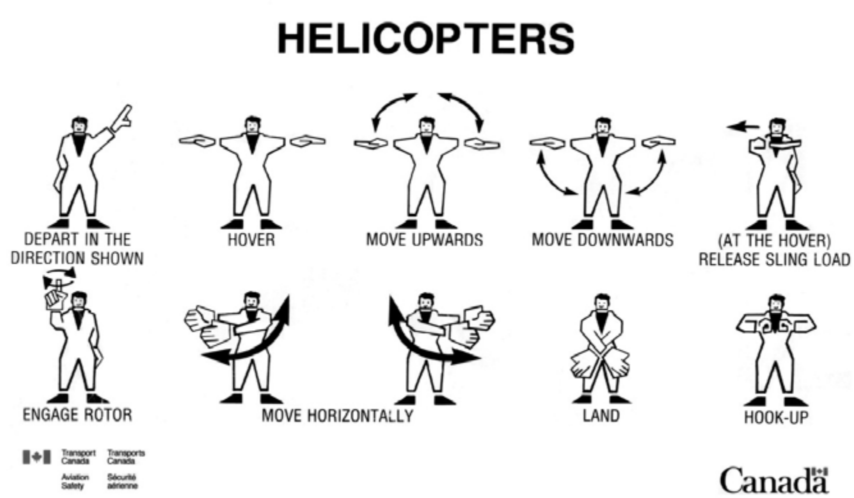


Figure 16.11: Marshalling signals for helicopters

Reproduced in 2008 from TP 9528-1-Marshalling Signals, Helicopters, Transport Canada in June 2000. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2008.

16.15 | Emergency Procedures

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.

Preparation for an emergency

1. 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.
2. 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.
3. 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.
4. 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

1. Follow any instructions issued by the pilot.
2. Do not distract the pilot.
3. Check that any loose gear in the cabin is secured.
4. Wear a helmet if provided.
5. Remove eye glasses and put them in your pocket. Loosen your collar.
6. 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

1. Wait for instructions to exit or until rotors stop turning if in a helicopter.
2. Assist others to evacuate well clear of the aircraft.
3. Remove the first aid kit and other emergency equipment after there is no threat of fire.
4. Administer first aid as required.
5. Remove ELT, read instructions and activate.
6. Set up camp to be as comfortable as possible.
7. Make the site as conspicuous as possible from the air.
8. 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.

1. Stay calm – Think about what you will do next. Wait for significant accident motion to stop.
2. 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.
3. 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.
4. 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.

5. 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.
6. 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.
7. 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.

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 Chapter 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.

Table 16.1 :Aircraft emergency assistance symbols

NUMBER	MESSAGE	CORE SYMBOL
1.	REQUIRE ASSISTANCE	V
2.	REQUIRE MEDICAL ASSISTANCE	X
3.	NO or NEGATIVE	N
4.	YES or AFFIRMATIVE	Y
5.	PROCEEDING IN THE DIRECTION	↑
6.	ALL IS WELL	LL
7.	REQUIRE FOOD AND WATER	F
8.	REQUIRE FUEL AND OIL	L
9.	NEED REPAIRS	W

Source: TP 14371 – SAR-4.0 Aircraft Emergency Assistance, Transport Canada, 2007 (updated 2020). Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2008.

17.0 BOATS, CANOES AND INFLATABLES

Introduction

When boats are used for exploration work, it is important to select the appropriate boat and motor for the type of waters where they will be used; use the largest, safest boat available for the job. For large bodies of water, coastal areas and on cold lakes, use large boats or rigid inflatable boats (RIBs) with keels, if possible. These have much greater stability than small boats or canoes. Canoes and dugouts should be avoided. However, if required, they should only be used on small lakes and streams.

Operators should be thoroughly familiar with the characteristics and limitations of their boat and motor; they should know their personal boating capabilities and not exceed them. When working on boats in unfamiliar or hazardous waters or where navigation is difficult, a company should consider hiring certified pilots or experienced locals who are familiar with the risks and hazards of the project area.

Due to the possibility of capsizing and falling overboard, everyone who uses boats should know how to swim. Training in boat recovery and rescue skills, cardiopulmonary resuscitation (CPR) and other resuscitation skills is essential. If you work in cold water areas, be prepared to deal with cold water immersion hypothermia at all times and wear a personal flotation device (PFD) with appropriate thermal insulating properties.

Transport Canada sets minimum requirements and standards for the operation of pleasure craft, non-pleasure craft, and commercial vessels. These requirements are found on government websites and, where relevant, are listed within the chapter and in the resources section to enable the reader to find additional information about boating safety.

Acronyms

CPR – Cardiopulmonary Resuscitation
CPSS – Canadian Power and Sail Squadrons
CSA – Canadian Standards Association
DSC – Digital Selective Calling
EPIRB – Emergency Position Indicating Radio Beacon
ERP – Emergency Response Plan

GPS – Global Positioning System
MMSI# – Maritime Mobile Service Identity Number
PCOC – Pleasure Craft Operator Card
PFD – Personal Flotation Device
PPE – Personal Protective Equipment
RIB – Rigid Inflatable Boat
ROC-M – Restricted Radiotelephone Operators Certificate
SOP – Safe Operating Procedure
VHF – Very High Frequency

17.1 | Risks and Hazards

Some of the risks and hazards related to boating include death due to drowning, capsizing, injuries and straiding.

Death due to drowning may be caused by:

- Not wearing a PFD (after capsizing, falling overboard)
- Trying to swim to shore without wearing a PFD after capsizing, swamping or falling overboard

Capsizing may be caused by:

- Using the wrong boat for the body of water
- Lack of training, lack of piloting skills
- Rogue waves and/or swamping
- Weather: Sudden storms or winds

Injuries may be caused by:

- Exposure to bad weather or sun caused by inadequate clothing (e.g., hypothermia, sunburn)
- Slips and falls on deck or while boarding the boat
- Fire and/or explosion due to improper fuelling procedures

Stranding may be caused by:

- Engine breakdown, lack of spare parts
- Lack of training to read charts, lack of navigation skills
- Lack of navigation and/or communication equipment
- Lack of required safety equipment (paddle, communication, signalling)
- Adverse weather
- Changing tides

DRIVING RESPONSIBLE EXPLORATION

17.2 | Responsibilities (Due Diligence) Regarding Boats, Canoes and Inflatables

As presented in Chapter 1.2 Due Diligence, companies should be able to demonstrate due diligence with regard to their employees' who use boats and work in, on or near water. Requirements to demonstrate this aspect of due diligence include but are not limited to the following measures:

Exploration Companies

- Develop written safe operating procedures (SOPs) and site specific SOPs (as needed) for the use of boats, motors and for employees who work near water.
- Develop written emergency response plans (ERPs) that address potential emergencies related to the use of boats, motors and for employees who work on or near water.
- Make sure supervisors are trained so they are competent; provide training and education for employees regarding SOPs, ERPs and hazards related to working on water and with boats.
- Carry out inspections and maintenance of boats and motors, docks etc.
- Monitor the use of boats and implement consequences when SOPs etc., are not followed.
- Documentation: Keep records of all training, accidents, incidents and corrective actions, mitigation of hazards, inspections, maintenance, infractions etc., that apply to boats and their use.
- Provide required personal protective equipment (PPE).
- Carry adequate insurance.

Project Supervisors

- Implement company SOPs and those in the manufacturers' operator manuals for boats and motors.
- Develop site specific SOPs that address hazards associated with boats and working on water, a s required.
- Advise, instruct, and monitor employees and contractors regarding company SOPs, health and safety regulations etc., and potential hazards of using boats and motors.

Operators

- Follow company SOPs and training regarding boats provided by the employer.
- Be familiar with any warning decals on boats and associated equipment.
- Use PPE and safety equipment as directed.
- Report hazards, dangers and defective boats and equipment to a supervisor.

17.3 | Safe Operating Guidelines for Boats, Canoes and Inflatables

Operators are expected to know the regulations that apply to the waters in the country where they work. It is the responsibility of the owner or operator (person entrusted by the owner) to make sure that all required equipment is on board and in good working condition.

1. Comply with the manufacturer's operator manual regarding safe operating procedures for the boat and/or motor. Most manufacturers supply comprehensive operations and maintenance procedures.
2. Be familiar with the Canadian Safe Boating Guide or equivalent. Be familiar with the Small Commercial Vessel Safety Guide if the boat is of this class, or equivalent.
3. Comply with the Canada Shipping Act, 2001 regarding registration and/or licence requirements for company owned boats.
4. In Canada, as of September 15, 2009 all operators of pleasure craft are required to possess a Pleasure Craft Operator Card (PCOC). Pleasure craft include power boats, personal watercraft and motorized sailing craft. The basic knowledge required to pass the test is fundamentally important. An operator will receive a fine of $250 if found operating a motor boat without it.
5. Wear an approved personal flotation device (PFD) or lifejacket suitable to your body size. Employees should be required to wear a PFD whenever they travel in small watercraft on company business. Wear a PFD when sampling or working on steep shorelines that border cold water bodies and wear a full body harness and lanyard if the situation requires it. Wearing a PFD should be mandatory whenever employees use small boats, even if they are not technically on "company business".
6. Know and adhere to recommended ratings for load, number of occupants and horsepower on the boat. Make sure the safety compliance notice, the capacity label and/or licence number is displayed, as required.
7. Use boats and motors that are fully equipped, safe and appropriate for the bodies of waters where you work. Do not use defective equipment.
8. Employees who use boats should be adequately trained and should be checked out by trained personnel before proceeding with work. More than one person on board should be able to operate the boat and motor in case of emergency.
9. Inspect the boat and motor before heading out. Make sure all required equipment, emergency supplies and adequate fuel for the journey are on board. Plan for 1/3 fuel outbound, 1/3 fuel inbound, and 1/3 fuel in reserve.
10. Have an emergency response plan (ERP) in place. Develop procedures for dealing with emergencies, including breakdowns, capsizing, a missing or overdue boat, and cold water immersion. "Cold water" is defined as that below 21°C (70°F). Therefore almost all bodies of water in Canada (except southern lakes during summer months) are classified as "cold water".
11. Establish a communication schedule with routine check-in times. Employees using boats should adhere to the check-in schedule and inform their base camp, person in charge or expediter etc., if plans are changed while en route.

12. Tracking system: File your daily trip plan (boating route) with the project or camp manager, the expediter or whoever is in charge of the tracking system. That person should be familiar with the ERP and know what to do if the boat does not arrive or return as planned, and what to do if you do not check in as scheduled.
13. Travel at a safe speed appropriate for the water conditions and maintain control of the boat at all times.
14. Be aware of the existing navigational conditions, taking into account factors such as tides, currents, ice, rapids, and potential obstructions. Have appropriate navigational charts and maps and tide tables.
15. Do not boat during inclement weather. Head for shore if bad weather threatens. Do not take chances.
16. Do not operate a boat at night except with appropriate navigation lights and in familiar waters.
17. Travel as close to shore as safely possible in case problems develop.
18. Refrain from smoking on any boat powered by an outboard motor.
19. Do not operate a boat if you have consumed alcohol or if you have taken medication or drugs that might affect your ability to operate the boat.
20. Contract a competent, experienced, licensed pilot for large boats and wherever there are difficult navigational hazards or other local hazards (weather, tides) beyond the skill level of the employees using boats.
21. Prior to beginning a trip, operators should instruct passengers where basic equipment is located – life ring, boat hooks, fire extinguisher, lines, first aid kit etc., in case they are asked to retrieve them in an emergency.
22. It is best to operate a boat with at least one crew member. If it is necessary to work alone, follow the guidelines in Chapter 2.1.1 Working Alone vs. the "Buddy System". It is advisable to carry a satellite phone, which is the most dependable means of communication, especially in a remote area.

17.4 | Safe Loading Guidelines

A safe load depends upon many factors: the type of boat, weather conditions, water conditions (waves), the size and weight of gear and cargo, the number and placement of passengers in the boat, and the experience of the operator and passengers. The maximum allowable load may not be a safe load. Boats capsize or swamp more readily if they ride too high, too low, or list (lean to one side). Allow extra freeboard for safety in case weather conditions change for the worse.

- Know and do not exceed the maximum load and allowable number of passengers for the class of boat. The permissible gross load capacity includes the weight of the engine, fuel, gear and all passengers. Make an extra trip, if necessary.
- Distribute the passengers and load so that the boat is "trim". Keep loads centred and as low as possible. This is especially important for canoes and dugouts. Place heavier items on the bottom and lighter ones on top. Passengers should sit on the bottom of canoes and dugouts.

- When travelling with a group of boats, distribute the food, equipment and survival kits as equally as possible between them. This reduces the chance of placing the entire field party at risk with the loss of a single boat.
- Secure all large items with strong ropes and cover them with heavy tarpaulins to prevent shifting or loss if the boat capsizes. Passengers must not get trapped with cargo should the boat capsize.
- Load inflatable boats so no sharp or pointed objects can pierce or damage the inflatable hull.
- Never load or unload a boat unless it is securely moored to a dock or is properly beached.
- If loading in calm water, allow enough freeboard for rougher water conditions.
- If travelling in rough water, make sure the boat has enough ballast for stability.
- Transport important cargo items in waterproof packs or several layers of plastic bags to keep them dry. Tie them to the boat. Keep essentials in your pockets (e.g., waterproof matches, whistle, knife, keys, identification papers and licences).

17.5 | Equipment – Required and Recommended

Exploration companies use a variety of boats. The type and size of boat chosen used should be determined according to the size and nature of the body of water where it will operate. While transporting boats by aircraft limits the size of boat utilized, the boat should still be as large and stable as possible to increase the safety factor.

Transport Canada prescribes the minimum required safety equipment for boats, which depends on their length and use.

17.5.1 | Required Equipment

Required equipment for powered pleasure craft less than 6 metres in length

Below is the list of required equipment for powered boats less than 6 m (19 ft 8 in) in length. This includes canoes that use outboard motors. The list is taken from Transport Canada's "Safe Boating Guide."

Personal protection equipment

1. One (1) Canadian-approved personal flotation device or lifejacket of appropriate size for each person on board
2. One (1) buoyant heaving line no less than 15 m (49 ft 3 in) in length

Boat safety equipment

1. One (1) manual propelling device (paddle or set of oars) or An anchor with no less than 15 m (49 ft 3 in) of cable, rope, or chain in any combination
2. One (1) Class 5-BC fire extinguisher, if the pleasure craft is equipped with an inboard engine, a fixed fuel tank of any size, or a fuel-burning cooking, heating or refrigerating appliance.
3. One (1) bailer or One (1) manual water pump fitted with or accompanied by sufficient hose to enable a person using the pump to discharge water from the bilge over the side of the vessel

Distress equipment

1. A watertight flashligh or Three (3) Canadian-approved flares of Type A, B, or C

Navigation equipment

1. Sound signalling device or sound signalling appliance
2. Navigation lights that meet the applicable standards set out in the Collision Regulations if the vessel is operated after sunset and before sunrise, or in periods of restricted visibility

Required equipment for canoes and rowboats less than 6 metres in length

Below is the list of required equipment for boats less than 6 m (19 ft 8 in) in length that operate without a motor. The list is taken from Transport Canada's "Safe Boating Guide."

Personal protection equipment

1. One (1) Canadian-approved personal flotation device or lifejacket of appropriate size for each person on board
2. One (1) buoyant heaving line no less than 15 m (49 ft 3 in) in length

Boat safety equipment

1. One (1) manual propelling device (paddle or set of oars) or an anchor with no less than 15 m (49 ft 3 in) of cable, rope, or chain in any combination
2. One (1) bailer or one (1) manual water pump fitted with or accompanied by sufficient hose to enable a person using the pump to discharge water from the bilge over the side of the vessel

Navigation equipment

1. Sound signalling device (whistle) or sound signalling appliance
2. Navigation lights that meet the applicable standards set out in the Collision Regulations if the vessel is operated after sunset and before sunrise, or in periods of restricted visibility

Required equipment for boats greater than 6 m in length

Below is the list of required equipment for boats greater than 6 m (19 ft 8 in) but less than 8 m (26 ft 3 in) in length. The list is taken from from Transport Canada's "Safe Boating Guide."

Personal protection equipment

1. One (1) Canadian-approved PFD or lifejacket of appropriate size for each person on board
2. One (1) buoyant heaving line no less than 15 m (49 ft 3 in)or One (1) approved lifebuoy with an outside diameter 610 mm or 762 mm that is attached to a buoyant line at least 15 m (49 ft 3 in)
3. A reboarding device if the freeboard is greater than 0.5 m (1 ft 8 in)

Boat safety equipment

1. One (1) manual propelling device (paddle or set of oars) or An anchor with no less than 15 m (49 ft 3 in) of cable, rope, or chain in any combination
2. One (1) bailer or One (1) manual water pump fitted with or accompanied by sufficient hose to enable a person using the pump to discharge water from the bilge over the side of the vessel
3. One (1) Class 5-BC fire extinguisher, if it is a power-driven vessel, plus another class 5-BC fire extinguisher if the craft is equipped with a fuel-burning cooking, heating or refrigerating appliance

Distress equipment

1. Watertight flashlight
2. Six (6) Canadian-approved flares of Type A B or C

Navigation equipment

1. Sound-signalling device or sound-signalling appliance
2. Navigation lights that meet the applicable standards set out in the Collision Regulations if the vessel is operated after sunset and before sunrise, or in periods of restricted visibility
3. Radar reflectors may be required under certain conditions. Vessels less than 20 m (65 ft 7 in) in length or that are constructed primarily of non-metal materials must have radar reflectors, unless they are not essential to the safety of the vessel, or the small size of the vessel or its operation away from radar navigation makes compliance impractical. If properly positioned, they help larger, less manoeuvrable vessels detect your presence on their radar screens. They should be located above all superstructures and at least 4 m (13 ft 1 in) above the water (if possible).

17.5.2 | Recommended Equipment

Recommended equipment will depend on the time of year, length of the trip, and expected weather. The items in bold should be considered essential in addition to those required by Transport Canada:

- **First aid kit, size appropriate for size of crew and region**
- **Radio, satellite telephone, as appropriate for region**
- **Location equipment – GPS unit, compass, up-to-date charts**
- **Emergency Position Indicating Radio Beacon (EPIRB), as required**
- **Signal flares, signal mirror**
- **Water**
- **Survival kit, size appropriate for size of crew and region**
- Axe
- Bow saw (if portages are expected)
- Food
- Additional clothing
- Additional Class BC Fire extinguisher(s) – a 5-BC is very small

Additional recommended equipment for boats that operate with motors

- Patch kit (inflatable boats)
- Air foot pump, pressure gauge (inflatable boats)
- Manufacturer's operator manual for motor
- Tool kit
- Rope of appropriate length to manually wind around the flywheel

Tool Kit – Suggested Contents

- Extra spark plugs
- Extra cotter and shear pins
- Funnel and filter
- Electrical tape
- Duct tape
- Tools: knife, screwdrivers, pliers, gap gauge, wire, adjustable wrench, spark plug wrench
- Extra propeller (if size is convenient to carry), extra cotter pins

NOTE: Store the tool kit, maps and charts in waterproof containers

Abandon Ship Bag (Ditch Bag)
Contents will depend on size of boat and crew

- Survival kit
- First aid kit
- Compass, GPS and extra batteries
- Signal flares
- Signal mirror
- EPIRB
- Portable radio

Tips about Equipment

- Fire extinguishers: A fire at sea is the most dangerous situation a mariner can be faced with. Therefore, it is a good idea to at least double the required number of extinguishers as a 5-BC has an effective range of about 1.5 m (5 ft) and a blast lasts less than a minute. Mount fire extinguishers near the engine, galley and berths.
- Keep extra paddles and emergency equipment readily available – not stowed under your gear.
- Lines and ropes and motors do not "mix" – be vigilant and keep lines from falling overboard. Never allow lines to drag in the water as they may foul the propeller. Carry 30 metres of rope so that you can "line" a boat through shallow water. Use a heavier natural fibre rope for towing. Do not use nylon rope for towing as it will stretch; if it breaks it will whip back. While polypropylene line that floats is best for docking, it may stretch, break and whip back if used for towing. The force of a parted rope can sever limbs or kill people.
- Bailing device: To make a simple one, cut the bottom out of a plastic bottle with a handle. Glue the bottle cap on and tie this device to the boat so it does not blow overboard.
- Abandon Ship Bag – also known as a "ditch bag" or "grab bag": It is recommended that the boat's emergency equipment be stored in an abandon ship bag. In an emergency situation you will generally not have time to collect the boat's emergency equipment. The bag should be waterproof to protect its contents and have sufficient excess volume to float, even when fully loaded. The bag should be attached to the boat with a few feet of lanyard and a secure snap clip or carabineer at the end to allow a person to quickly attach it to their PFD harness so the bag does not go missing in the chaos that often accompanies the abandonment of a boat. The contents of the bag should reflect the size of the boat and number of occupants. If a number of boats travel together, each boat should have a bag with appropriate contents.

17.5.3 | Information about Specific Equipment

Lifejackets and PFDs

In Canada, one properly fitting lifejacket and/or PFD, approved by Transport Canada, Fisheries and Oceans Canada or the Canadian Coast Guard, is required equipment for each person on board any boat. The definition of "PFD" differs between Canada and the USA. In Canada, lifejackets and PFDs are two separate classes of buoyancy aids. In the USA, the term PFD is a general term applied to lifejackets and several other classes of buoyancy aids. The Canadian definition of PFD is used in these Guidelines.

- Lifejackets are designed for use in an emergency, primarily for use in open and rough waters. They are designed to (1) keep your head out of water and (2) turn you onto your back should you be unable to do so. They are more buoyant than PFDs and are only available in high visibility colours – red, yellow or orange. Lifejackets are required on commercial vessels.
- PFDs are less buoyant than lifejackets although some may look very similar. They have a limited capacity to turn the wearer over in the water and come in a variety of colours. Most people choose a PFD because they are more comfortable and easier to wear than a lifejacket. Many PFDs are designed to be worn while working around or on water and some varieties have good insulating properties for working in cold water environments. Choose a bright colour to enhance your safety.
- Lifejackets and PFDs are available in different sizes to suit different body shapes; to comply with Transport Canada regulations, any lifejacket or PFD must fit the wearer properly. Choose a style that fits comfortably, allows freedom of movement and fits over both bulky and lightweight clothing. PFDs should be brightly coloured for increased visibility should you fall overboard. If a PFD does not fit correctly, the user should not wear it and should find one that fits properly.
- PFDs should be destroyed if they are faded, worn, scuffed, shredded or compromised in any way, as it is illegal to have them on board any boat in this condition, even as spares.
- Lifejackets and PFDs should be fitted with both a sound signalling device (i.e., whistle) and a light (ideally a waterproof strobe light).
- Some PFDs contain several plastic air sacs or compartments filled with buoyant material inside the cloth cover. A hole in the plastic may ruin the jacket so it will be unable to protect your life as it is designed to do. Treat your PFD with care; do not use it as a cushion, step on it, or use it for a boat fender etc.
- If you work on cold water or on ice, a flotation jacket or an immersion survival suit may be essential. A variety of styles provide insulation and wearing one will reduce the risk of hypothermia should you fall in. Compared to an ordinary PFD, a convertible flotation jacket with a crotch flap and hood offers you a 50% to 75% increase in predicted survival time in the event of cold water immersion. Under some conditions, it is advisable to wear an immersion survival suit plus a flotation jacket.

- Inflatable PFDs are available and have a variety of features:
  - Vest types are not inherently buoyant. They may be orally inflated, manually inflated, or automatically inflated.
  - Automatic inflating vest PFDs require replacement cartridges so they can be used more than once. If choosing this type, it is very important to carry extra CO2 cartridges. Automatic inflating PFDs may also be orally inflated if the CO2 mechanism fails.
  - Inflatable PFDs are more comfortable to wear than other varieties; they may be a good choice when performing some types of work. Check the legal restrictions for wearing inflatable PFDs, as they are not acceptable for all situations.
  - Inflatable PFDs require frequent inspection and maintenance. Follow the manufacturer's guidelines for storage.
- Care of PFDs:
  - Clean with mild soap and running water – never with strong detergents, by dry cleaning or with gasoline to remove spots.
  - Do not dry them close to a direct heat source or in continuous direct sunlight.
  - Do not store them in a closed heated space, a damp space or in direct sunlight.
- Wear your PFD whenever you work on or near water, as directed in Chapter 17.3 Safe Operating Guidelines for Boats, Canoes and Inflatables.

Rigid Inflatable Boats (RIBs)

- Correct assembly is important. Follow the manufacturer's assembly instructions to place the floorboards correctly.
- Proper inflation of RIBs is very important. Be sure to fully inflate the boat. If inflated on land, the internal pressure will drop when the boat is launched into water, as the water temperature will cool the air in the chambers. Check all chambers and inflate each one to the correct pressure after a short time in water.
- Carry a foot pump and appropriate spare parts for the inflatable.
- For stability, it is important to use the appropriate size of motor.
- Load inflatable boats so that no sharp or pointed objects can pierce or damage the inflatable hull.
- Keep speed under control. Inflatables can flip backwards – bow over stern – in high winds and turbulent water.
- Lift (never drag) the inflatable to avoid wear on the fabric. Do not moor them where sharp rocks may puncture the hull.
- Clean sand out of RIBs as it is gets stuck in the inflation valves and can be abrasive to the fabric.
- Maintain RIBs by washing it and regularly checking for small tears and rips. Repair them with the correct patch kit materials. Large rips or tears should be repaired by professionals.

- Apply patches to an inflatable boat only when it is completely dry. Only use the material provided in the manufacturer's patch kit as it is specific to the fabric of the boat. Never use silicone products as they prevent the patch material from adhering to the boat fabric.
- To increase stability, tow an inflatable using a bridle so that the tow line forms a V or a Y shape when attached to the two (2) lateral D rings, rather than a single line attached to the bow handle.
- Use the correct procedures outlined in the operator's manual to haul an inflatable on a trailer.
- Pack an inflatable boat away carefully for storage to avoid damage. The boat must be dry prior to storage to prevent the growth of mildew.

Flares

Transport Canada provides information about available types and the safe use of flares.
The following information is available on the website.

- Flares are meant to be used during times of true distress.
- Flares must be approved by Transport Canada. They have a shelf life of 4 years from the date of manufacture, which is stamped on each flare. For the proper way to dispose of out-of-date flares, contact a local law enforcement agency, a fire department or Transport Canada Centre.
- Store flares vertically in a cool, dry place. A waterproof container is best. They should be kept in an easily accessible location in case of an emergency. Do not store flares near combustible liquids such as gasoline or oil.
- Follow firing directions carefully. Do not rely on one flare to be seen. Launch several flares at one minute intervals.
- There are four (4) types of pyrotechnical distress flares:
    - Type A: Parachute – a single red star that reaches 300 m (984 ft) and falls slowly with the aid a parachute. They are easily observed and burn for 40 seconds.
    - Type B: Multi-star – two or more stars that reach 100 m (328 ft). Each star burns 4 or 5 seconds and are observed easily from the surface or air.
    - Type C: Hand-held – a red torch flame with limited surface visibility. They burn for at least one minute and are best for pinpointing location during an air search.
    - Type D: Smoke (buoyant or hand-held) – produce dense orange smoke for three minutes. Use for daylight signalling. Position the smoke downwind and follow the directions for use carefully.

Charts and Tide Tables

Charts contain important information regarding true directions, water depths, land masses, dangers, currents, etc., which maps to not show. Navigation can be challenging depending on the waterways, underwater hazards, tides, ice, etc. Small boats should steer clear of potential dangers such as rapids, currents and commercial shipping channels. Operators should know how to:

- Use a compass along with marine charts
- Plot a course
- Find their position by several methods
- Use electronic navigation equipment
- Use navigational references such as tide tables, the Canadian buoyage system, navigation lights and signals.

Information about paper and digital charts is available from the Canadian Hydrographic Service.

17.6 | Communications Guidelines for Boats, Canoes and Inflatables

Good communication equipment and check-in routines are essential. The communication requirements for boats depend to some degree on where they operate. Each crew needs communication equipment that fulfills the following requirements:

- Always to be able to report emergencies to obtain help
- Allow operators to respond to emergencies from other boaters
- Keep in touch with the base camp, office and/or expediter
- Keep informed about weather forecasts and warnings (if available in the area where working). This requires a marine receiver or marine radio.

Equipment

As crews require effective two-way communication equipment that operates in their field area, they need a reliable mobile/cell phone, satellite telephone, or a VHF (Very High Frequency) radiotelephone, or combination of these. It is advisable for boats to carry a marine VHF radiotelephone with the DSC (Digital Selective Calling) feature wherever there is VHF coverage. Maintain communication equipment in good working order.

A VHF operator should have a Restricted Radiotelephone Operator's Certificate (ROC-M). In addition to a ROC-M, boats working in US waters are required to have a VHF Station Licence. The Canadian Power and Sail Squadrons (CPSS) offer classes to obtain radio operator training.

Vessels over 8 m in length and ships carrying more than six passengers are required to carry a VHF-DSC Radio. (VHF) Digital Selective Calling (DSC) radios are based on satellite and digital technology. Each has a unique number – a Maritime Mobile Service Identity Number (MMSI#). With this radiotelephone, an automatic digital emergency MAYDAY call can be sent by pushing a "distress" button. The boat's identity and position are transmitted and any DSC radio in the area will be alerted to the distress signal and be able to identify the boat and its location coordinates. These radios may be portable or built into a boat. An ROC-M is required to transmit on a VHF radio.

Information is available regarding radio communications and radio navigational aids services in Canada provided by Fisheries and Oceans Canada and other government agencies that contribute to the safety of boats in Canadian waters. A simplified list of VHF channels is available online.

Emergency Communications

Learn to use your communication equipment proficiently so that you can use it automatically in the event of an emergency. Follow instructions in the operator's manual. Seek advice or assistance early when problems begin to develop rather than waiting until they have multiplied and you face a much more serious situation.

- A marine VHF-DSC radio connected to a GPS receiver provides reliable emergency communications for coastal Canada and the Great Lakes. Use channel 16 for emergency calling purposes. Use channel 70 for emergency DSC (digital) communications.
- Satellite telephones provide good communication but do not alert other vessels that you are in distress or provide a signal for search and rescue to follow in the event of an emergency. Be trained to use a sat phone correctly as they require special procedures. Post instructions onboard and keep them with the sat phone.
- Mobile/cell phones may be useful if they work in the field area. They are not always reliable and they won't work if they get wet or damaged. You can contact Rescue Coordination Centres by dialling *16 – if it is available from your wireless provider. A mobile/cell phone will not alert other vessels that you are in distress or provide a signal for search and rescue to follow in the event of an emergency.
- Emergency Position Indicating Radio Beacon (EPIRB): These are buoyant radio distress beacons that can be manually activated or they can float free from a sinking or overturned vessel. They transmit for hours. EPIRBs must be registered with the Canadian Beacon Registry.
- Emergency use of VHF channels:
  - VHF radio channel 16 is used for emergency and calling purposes only. Once you call another boat on channel 16, take your conversation to a working frequency to continue.
  - Keep the radio tuned to channel 16 so you are aware of emergency calls.

  - VHF channel 70 should be used only for DSC (digital) communication and not for voice communications.
- Urgent messages: When a situation requires immediate urgent action (e.g., a mechanical breakdown), but is not a life-threatening distress situation, you may interrupt another transmission as soon as possible by announcing PAN-PAN, PAN-PAN, PAN-PAN. Proceed with your message when communication traffic clears. An urgent message has priority over all other messages except distress calls. Examples of urgent situations are loss of power or loss of steering and you need a tow.
- Distress messages: Use channel 16 in Canadian waters. When you are threatened by grave and life-threatening danger requiring immediate assistance, announce MAYDAY, MAYDAY, MAYDAY. Never use MAYDAY unless the emergency is imminently life-threatening. Examples of distress situations are a sinking boat, a fire or a cardiac arrest on board.
- Give this information when you send an urgent or distress message:
  - Give the name of your vessel; repeat it three times.
  - Give the call sign.
  - State the position of the vessel.
  - Describe the nature of the emergency.
  - State type of assistance required.
  - State how many people are on board.

Transport Canada provides additional information about emergency communications.

17.7 | Guidelines for Motors and Fuel Handling

17.7.1 | Motors

- Read the manufacturer's operator manual carefully and follow the safe operating procedures.
- Use a motor appropriate for the job required of the boat. For example, an inflatable that must handle heavy surf requires a long shaft motor, but a short shaft motor would be preferable on navigable rivers. Do not use a motor that is too powerful for the size of the boat. Do not twin motors on a boat unless the motors and boat are designed for this purpose.
- Secure the motor and tie it to the boat; the motor mounting clamps may loosen due to vibration.
- Sit or squat while starting an outboard motor. Do not stand.
- Know the fuel consumption of the boat and motor combination. Check the fuel level before departure and check frequently during the trip. Use a dipstick; don't depend on a gauge. Reserve more than half the fuel for your return trip. A good plan is to count 1/3rd fuel for the outbound trip, 1/3rd fuel for the return trip, 1/3rd fuel for emergency consumption.
- Carry more fuel than required for the worst conditions or in case of an emergency. For example, boats consume more fuel when the water is rough. If necessary, carry extra fuel and oil, mixed to the correct ratio, in CSA approved containers. Label the contents correctly (e.g., mixed boat gas 50:1).
- To avoid damage, do not use the motor in shallow water. When in doubt about the depth of water, reduce your speed and post a lookout at the bow, if possible, to watch for underwater hazards. Lift the motor and paddle the boat. In swampy areas, check that the propeller does not become fouled with vegetation and that there is a proper discharge stream of cooling water. If you need to clean weeds from the propeller, make sure the motor is stopped – not just in neutral.
- Unhook the fuel hose and hoist the motor when you beach a boat for more than 15 minutes.
- Repair outboard motors on land rather than on water, whenever possible.
- Do not wear loose clothing that might get caught in motors. Never operate an outboard with the shroud removed as loose clothing can easily get caught in the flywheel.
- Check for the following common problems if the motor stops while underway:
  - Fuel supply
  - That the fuel hose is not kinked or otherwise obstructed
  - Rough water may cause dirt in the fuel tank to be stirred up and get into the fuel filter and fuel lines.
  - The plugs and points are clean and not worn.
  - The ignition system is free of water.
  - The tank vent is open and clear.
  - The water intake/discharge is blocked.
  - The water pump has overheated.

- Consider travelling with a second boat and/or carry a back up motor that uses the same hose linkage as the main motor. Otherwise a separate tank of fuel is required for the back up motor.

17.7.2 | Fuelling Procedures

Fuelling should be carried out on shore. Should a fire or explosion occur, then the crew will be safely on land.

- Secure the boat to a dock or on shore.
- All passengers are required to be on shore if they are not helping with fuelling.
- Fuel only when the motor is shut off; fuel in a well-ventilated place.
- Remove portable fuel tanks to shore to fill them.
- When fuelling inboard motorboats with non-removable fuel tanks, it is essential to prevent fumes from entering the boat and accumulating inside the cabin or in the bilges. If fumes are present in such places, a spark may cause an explosion. Complete the following practices before fuelling begins:
    1. Shut off all electrical switches and all motors on board, including portable radios.
    2. Extinguish all open flames including any pilot lights.
    3. Close all hatches, doors and windows on boats with cabins.
- Do not smoke. Do not allow open flames or sparks in a fuelling area.
- Use the correct fuel and ground the nozzle against the filler pipe. Allow fuel to flow into the fill-pipe only as fast as the pipe can handle. Do not overfill the tank. Close the tank cap securely when fuelling is done.
- Clean up any fuel spills completely with spill kit materials. Dispose of contaminated materials in appropriately marked containers.
- Restart an outboard motor after all spills are completely cleaned up.
- Inboard motorboats with non-removable fuel tanks: Open up an inboard motorboat with non-removable fuel tanks and ventilate it. Do not restart a gasoline engine until the engine and fuel tank compartments have been ventilated for at least 4 minutes using the blower and underway ventilation system, or for as long as stated in the operator's manual.
- Portable containers: Use CSA approved containers for fuel. When filling them, always place portable containers on the ground so the containers are properly grounded (earthed). Do not fill containers placed on vinyl bed liners of pickup trucks as that kind of bed liner prevents proper grounding. If the container is not grounded, fuel flowing into a container can create static electricity and generate a spark that will cause fuel vapors to explode. Only fill the containers to 95% capacity, as fuel expands as it warms. (Mark the containers with a "full" line.) If possible, store fuel containers in a cool location out of direct sunlight.

17.8 | Maintenance and Inspection Guidelines

Inspections

Inspect and test boats and motors before each field season. Report defects in writing to the supervisor, employer or owner and have the defects fixed that affect the safe operation of the vessel before further use. Carry out an inspection before heading out on each trip.

Verify the following before leaving the dock:

- Weather forecast known, trip plan filed
- Maps and charts on board
- Inspect the hull and gear for seaworthiness
- Inspect the motor: Check the hoses and lines, oil and water filters, battery is charged, clean spark plugs. Check for fuel leaks. Check the clamps, cotter pins, belts, and that the throttle operates smoothly. Tools and spare parts are present. Check the fuel and oil levels. Take reserves, as needed.
- All required safety equipment is present and in good order, survival and first aid kits, and sufficient food, water and clothing
- Communication equipment (VHF radio, mobile/cell phone, sat phone) is present and working and extra batteries are stowed on board
- Boat is correctly loaded
- Everyone should be wearing a PFD.
- Passengers know their responsibilities in the event of an emergency.

Maintenance

Regular motor maintenance reduces the likelihood of mechanical failure.

- Regularly check that the motor is securely mounted. There should always be a safety cable joined to the linchpin. Check this while en route – every trip, every day.
- Learn to make emergency repairs to the boat and motor. Learn to use the appropriate tools correctly.
- Perform periodic maintenance on the motor, as recommended in the manufacturer's operator manual.
- If working in salt water, keep the propeller and bottom of the boat clear of marine growth.

- Many boat fires are a result of poor fuel system maintenance. Always use marine engine parts when replacing engine parts, as they are ignition protected to reduce the likelihood of explosion due to lingering fuel vapors. Car parts are not ignition protected and must never be used as replacement parts in a marine engine.

17.9 | Training

Without training, many boat operators do not realize the limitations of their boating knowledge, skills and experience and may find themselves in situations that exceed their abilities. Crews should be made aware of predictable risks and hazards, and the precautions to take to avoid incidents and injuries while operating boats. Ideally, training regarding boats should be provided by certified instructors. The following lists some of the formal training that is available.

- A minimum of level of knowledge for everyone working on boats is the Power Craft Operator Certificate (PCOC), which can be obtained on an individual basis or in class settings throughout Canada. Information is available from:
    - Transport Canada has a course provider database website.
    - Canadian Power and Sail Squadrons (CPSS) offer PCOC classes.
- Anyone working on boats in excess of 6-7 metres should learn navigation and safe boating skills in classes taught by professionals.
    - The CPSS provides excellent classes in boating, navigation and seamanship at beginning through advanced levels.
    - A list of advanced level classes for small vessels and the class locations is available at the Transport Canada website.
    - If the transportation of dangerous goods is required, refer to Transport Canada guidelines to determine if training is required and where training classes are located.

All on-board training should be done in a safe location. Employees should know general boat-handling techniques and procedures appropriate for the type of boat and bodies of water where they will operate. If additional site specific training is necessary, try to obtain it from competent employees or people who are very familiar with the local risks and hazards. Employees should be checked out by a supervisor before receiving permission to proceed with work that requires the use of boats. General boat-handling skills should include:

- General boating safety awareness
- Maintenance of equipment and trouble shooting for mechanical problems
- Load management skills
- Shore and dock landings and departures under a variety of circumstances

- Anchoring and securing methods
- Boat-handling techniques for tides and currents, rough weather conditions and ice conditions (as relevant)
- Rescue practice
- Crew responsibilities in the event of an emergency
- Learn the capabilities of your boat. These include speed, fuel consumption, handling abilities under various sea conditions. Know the bottom clearance of the boat.

17.10 | Safe Boat Handling Guidelines and Techniques

General safe guidelines include:

Tracking system: File daily trip plans with the field supervisor, designated camp manager, expediter or a responsible person who will know what to do if you do not check in on schedule. Post the plan in the camp or with the responsible person. Always notify them of changes to plans. For longer trips, file the general planned routes including time estimations and stopping points.

- On one way trips, inform someone at both the point of origin and the destination of any schedule changes and your safe arrival.
- Leave the following details as a minimum:
  - Date and time of departure
  - Date and estimated time of arrival
  - Names of persons on board
  - Point of origin
  - Destination
  - Proposed route (and all known stop points for a longer trip)
  - Leave a photo, diagram or full description of the boat so it can be easily identified in an emergency.
  - Post the communication schedule and adhere to check-in times. Communicate all changes in plans to the appropriate contacts.

General safe boat-handling techniques include:

- Avoid steering a course that permits waves to hit the boat broadside. Try to steer a course so the bow heads or angles into the waves. Avoid travelling too close to a lee shore.
- If you turn or stop a boat too quickly, the wake may swamp the boat. Negotiate stops and turns slowly. Do not create a wake that damages the shoreline.
- Look out for floating or semi-submerged logs, debris, rocks and shoals etc.
- One of the most common causes of breakdown is a fouled propeller caused by dangling lines or weeds. Use polypropylene bow and stern lines that float and use caution in shallow water.

- Use caution when coming ashore. Do not run aground and damage a propeller or the body of an inflatable boat.
- Do not jump from a boat onto a dock. If you cannot step off, make another approach. If you fall overboard, you may be crushed between the dock and the boat.
- When approaching a dock, instruct passengers to keep their hands in the boat.
- Keep your weight low. Do not stand up in a canoe, a dugout or small boat. If necessary, paddle while sitting on the bottom to increase the stability of a canoe or dugout. Passengers should not sit on the gunwales of a boat while underway.
- Loosen the laces if wearing heavy field boots before you start a journey in a canoe, inflatable or small boat. If you capsize, you can discard them quickly. Consider wearing light weight boots or shoes while in a boat.
- Learn the appropriate knots to use around boats. They save effort.
- Hire an experienced pilot or guide when faced with hazardous work (in Canada or elsewhere).
    - Seek a person who is thoroughly competent and licensed where required by law and who has experience with the type of boat being used.
    - If hiring a boat and pilot in another country, adhere to Canadian safety standards, including required equipment, maintenance and inspections.
- Learn how to avoid wildlife hazards associated with water, if present (e.g., crocodiles, hippos).

17.11 | Recognition of Boating Risks and Hazards

The interaction of weather conditions, water and landforms may create unique problems on the water. Learn the signs that indicate hazards, such as obstructions or wave patterns that change around headlands, shoals and entrances of bays. Learn what hazards to expect in different localities. Typical problems one may encounter on open water are quite different from those one may experience in rivers or on small lakes.

Weather

- Monitor weather reports for several days before a planned departure to be fully aware of current and projected weather forecasts. Watch the barometer for rapid pressure changes. If weather is forecast to deteriorate, be prepared to postpone the trip. Don't take chances. Environment Canada provides weather information.
- Learn to recognize the signs that indicate changing weather that may create problems. Some examples are: the sudden appearance of dark clouds, increasing winds, building waves, distant lightning and heavy static on an AM radio, which may indicate a nearby thunderstorm.
- Always head for shore and safety when bad weather threatens. Don't be caught out in a storm. Winds can quickly whip up waves that can swamp a small boat.

- Know the areas where the terrain and wind can combine to cause hazards. For example, afternoon storms frequently develop with little warning on lakes in mountainous areas.
- If you are caught out in heavy weather, do the following:
    - Close all portholes and hatches.
    - Make sure that everyone is wearing their PFD. Passengers should sit on the floor near the centre line of the boat.
    - Switch to a full fuel tank.
    - Secure any loose gear that might shift and cause damage.
    - Head the boat so the bow encounters the waves at an angle of 45º; this effectively increases the distance between wave crests, which will reduce the impact of waves. If necessary, reduce speed.
    - Keep water bailed or pumped out of the boat to keep it stable.
    - Steep following seas are particularly dangerous, as they may break over the stern of the boat and swamp it. Maintain power so the boat rides the back of a wave, if possible.
    - In an extreme emergency where the vessel is at risk of sinking, be prepared to lighten the vessel by discarding cargo.
- Lightning: Get off the water immediately when threatened by a lightning storm. If this is not possible put on a PFD, expect rough seas, crouch low in the boat below deck if possible. Stay away from the mast or antenna, any attached wiring and rigging, and any metal.
- Fog: Do not set out if fog is present; postpone your trip. If it develops while underway, reduce speed, post a lookout, sound the fog signal, turn on any navigation lights and raise a radar reflector to make your presence known. Remain in sight of shore during foggy weather. You should be able to stop the boat within half the distance you can see.
- Apply sunscreen frequently and use good quality polarizing sunglasses when you work on water.
- The Beaufort Wind Scale Table is a useful tool for estimating wind speed when a boat is not equipped with an anemometer.
- Marine weather forecasts are issued several times a day and updated as required. Post the times when new forecasts are issued so you do not forget to check.
    - Understand terminology used in marine weather forecasts: one knot equals one nautical mile per hour, which is equivalent to 1.85 km/h or 1.1 mph.
    - Marine Warning Criteria: Warnings are issued 12 to 24 hours in advance for predicted, sustained winds and for other weather-related phenomena that may affect boats (Freezing Spray Warning, Storm Surge, Ice).
    - Strong wind warnings (formerly small craft warnings or advisories) are issued when sustained winds and frequent gusts are forecast between 20-33 knots. While there is no legal definition of “small craft”, any boat that might be negatively affected by the warning should heed “Strong winds warnings”.

Table 17.1: Wind Descriptions

WIND DESCRIPTION	WIND SPEED
Light winds	1-10 knots
Moderate winds	11-19 knots
Strong winds	20-33 knots
Gale force winds	34-47 knots
Storm force winds	48-63 knots
Hurricane force winds	64 knots or more

Table 17.2: Wind Warnings

WIND WARNINGS	WIND SPEED
Strong wind warning	If winds of 20-33 knots are forecast
Gale warning	If winds of 34-47 knots are forecast
Storm warning	If winds of 48-63 knots are forecast
Hurricane force wind warning	If winds of 64 knots or greater are forecast

Shallow Water

- Navigate cautiously. Watch out for protruding objects such as rocks, semi-submerged objects and shoals. Hint – a flock of birds in the middle of a lake usually means a shoal.
- Use up-to-date charts and mark safe navigation channels on them.
- Weeds, often associated with shallows, cause problems by fouling the propeller and the motor's water intake. Listen for changes in the sound of the engine and watch the cooling water discharge.

Open Water, Coastlines or Ocean Shores

- Make use of local knowledge to answer questions about tides, hazards and safe boating operations in the field area. If planning a journey on water, plan the route to provide a safe harbour in case the weather changes.
- Carry a GPS unit, a good compass and up-to-date charts that indicate the water depth. Mark safe navigation channels on your charts. Always travel with local tide tables or charts in tidal regions and learn to use them correctly.
- Remain in sight of shore during foggy weather or postpone your trip. Remember that fog can last two or three days so be prepared with adequate provisions for this possibility if a planned trip will last more than a day
- Stay close to shore, but in rough conditions, keep well clear of the shore breakers.
- The presence of numerous islands, inlets and/or channels can be very challenging to navigate. Carry a GPS unit as a backup navigation system.
- When you haul boats out of the water, make sure they are above high tide. Secure boats carefully and thoroughly.
- Avoid camping on islands subject to high tides. In some areas, islands may become submerged (Bay of Fundy, Ungava Bay).
- Watch out for larger than usual waves.
- The safest time to travel through narrows or a tidal bore is at slack water. Consult tide tables.
- In areas with ice, make sure the wind is low before you set out. Beware that the movement of ice could block your return passage.
- The safest time to explore unfamiliar waters and inlets is at low tide so there is a margin of safety if you are grounded.

Lakes

- Make use of local knowledge whenever you work on lakes. Learn about local weather patterns and local hazards.
- Plan the routes so you have protection from winds. Stay as close to shore as reasonably possible. However, unexpected winds and waves sometimes occur near leeward shores (shoreline effect). Be vigilant.
- Keep a close watch on the wind and developing weather, as squalls can develop very quickly, especially on small lakes.
- On large lakes, winds often build during the course of the day and die down in the evening. Cross large bodies of water when weather conditions are the best and most stable. This may be in the early morning or in the evening.
- Never cross lakes during high winds or if a thunderstorm threatens. Postpone your trip until winds and the threat of lightning diminishes.
- Wave action may vary considerably on a lake. Waves will build if the wind direction has been consistent over a long stretch of water. Remember to head into waves at a 45º angle.

Rivers

- Use sequenced aerial photos to predict where you might encounter hazards such as rapids, waterfalls, fallen trees (sweepers) or logjams. Use the photos to keep track of your progress. Whenever possible, fly over the traverse route along rivers to check out these hazards. Remember that water conditions appear less dangerous when seen from above.
- Carry a GPS unit whenever there are navigation hazards such as numerous islands and channels, smoke from jungle-clearing fires etc.
- If you have any doubt about the conditions ahead, get out and scout out the situation from shore.
- Do not run rapids. Always be prepared to transport the boat and supplies on foot rather than risk your safety. "Line" the boats through from shore with lines attached to the bow and stern.
- Avoid fallen trees and logjams. These are major hazards. The current flowing through these can pull you under. If you are drawn into one, make every effort to jump or hoist yourself up onto it. If you are drawn underwater, it may be impossible to free yourself or for others to rescue you.
- Control speed of a power boat, especially in rivers with heavy local traffic and when approaching blind bends.
- When operating downriver from a dam, be prepared for an unexpected release of water. When operating upriver from a dam, stay a safe distance back from the spillway.
- Contract to use experienced local pilots, especially in areas with navigational or local hazards.
- To avoid cuts and scratches, wear adequate clothing and safety glasses when travelling by dugout or canoe along narrow rivers or streams, especially in jungles.

Figure 17.1: Wear PFDs and line boats through rapids. © Iain Mitchell

17.12 | Water Survival

When working on water, unless you are well prepared and lucky, capsizing or falling into cold water far from shore in a remote area most likely means death by drowning or hypothermia – even if one is wearing a PFD. By planning ahead and paying attention to the risks, one can greatly reduce the chances of unexpected immersions. It is essential to have a project communication check-in schedules and emergency response plans that are appropriate for the working conditions.

17.12.1 | Risks and Hazards

- Drowning caused by not wearing a PFD, trying to swim to shore rather than staying with the boat
- Capsizing caused by:
  - Using the wrong boat for the water
  - Lack of piloting skills
  - Overloading, incorrect loading, or shifting cargo
  - Weather – unexpected winds or sudden storms, rogue waves
- Hypothermia or cold water immersion hypothermia caused by
  - Wearing inadequate clothing
  - Lack of survival equipment
- Serious survival situation caused by:
  - Not following safe operating procedures
  - Loss of supplies (gear, survival equipment, food and water, the boat)
  - Lack of check-in procedures and project emergency response plans
  - Loss of communication equipment
  - Hypothermic victims unable to help themselves

17.12.2 | Prevention and Preparation

To diminish the risks associated with cold water immersion:

- Operate the boat at all times to prevent capsizing and falling into cold water. Knowledge, training and prudence all help to prevent a potential disaster.
- Wear your lifejacket or PFD. If you capsize or fall overboard and are not wearing a PFD, your chances of survival are greatly diminished. The surprise, combined with the gasp reflex and cold shock, plus the swim failure reaction to immersion, can easily overcome even the best of swimmers. It is very difficult to put on a PFD while in the water, IF you can even locate one. Your PFD should be appropriate for your work conditions and fit when used in combination with additional clothing.
- Include cardio pulmonary resuscitation (CPR) and other resuscitation skills in your first aid training (e.g., Heimlich manoeuvre).

- Anyone who works on boats should try to become a competent swimmer. Good swimmers do not panic as easily when faced with an emergency situation in water. Inform co-workers if you are a non swimmer or a poor swimmer and use extreme caution when you work with boats. Wear your PFD at all times.
- Practice recoveries from capsize situations if using canoes or rafts. Your party will know better what to expect, how to react and what to do in an emergency situation.
- Use an automatic shut-off device (stop engine switch) on the motor. If you fall overboard, the motor will automatically stop and you will have a better chance to regain the boat.
- Consider installing a small rope ladder at the side when using a boat that is difficult to climb into from the water. A reboarding device is required equipment on any boat with freeboard exceeding 0.5 m (19.5 in).
- Always carry waterproof matches and a knife in your pocket so you can build a fire to dry out and warm up.
- Know how to prevent, recognize and treat cold water immersion hypothermia.

17.12.3 | Cold Water Immersion Hypothermia

Information in this section is compiled primarily from the following sources. They contain excellent and important updated information about cold water immersion and hypothermia.

- *Hypothermia Frostbite and other Cold Injuries: Prevention, Survival, Rescue, and Treatment* by Gordon G. Giesbrecht Ph.D., and James A. Wilkerson M.D.
- Survival in Cold Waters by Dr. C. J. Brooks, available via Transport Canada.
- The Cook-Rees Memorial Fund For Water Search And Safety website provides general references and information to increase awareness of cold water immersion.
- Cold Water Boot Camp is a project with a website that demonstrates the realities of falling into cold water using nine volunteers. It contains excellent information with downloadable video clips that demonstrate "cold shock", "swim failure" and how long it actually takes to develop hypothermia. It is an excellent teaching tool that clearly demonstrates the importance of wearing a life jacket to survive more than a very short time if you fall into cold water.

How your body reacts when you fall into cold water:

If you fall into water, your most important defence against cold water immersion hypothermia is to be wearing an appropriate PFD. Falling into cold water (<21ºC or 70ºF) is a serious emergency. Death from cold water immersion may occur at any of time during the following stages.

- First stage: Cold Shock: You will immediately suffer cold shock and be unable to breathe well. You may drown almost immediately if you gulp in water or cannot keep your head above water.

- Second stage: Cold Incapacitation develops during the next 10 to 30 minutes. Your extremities cool quickly and your limbs and hands become numb so you lose the ability to grasp and swim. You have about 10 minutes to perform self rescue tasks. As time passes victims cannot maintain a horizontal swimming posture, which is known as "swim failure", so they often drown during this stage.
- Third stage: Hypothermia: It takes about 30 minutes for your core body temperature to drop so that true hypothermia sets in. Your body loses heat 25 times faster in cold water than when exposed to cold air. Shivering intensifies and you lose good judgment quickly, yet you probably will not become unconscious for one hour. Hypothermia advances at a faster rate as the water temperature decreases.
- Fourth stage: Circumrescue Collapse: Death may occur due to post rescue collapse (cardiac arrest) during rescue or within hours of rescue.

Dr. Gordon Giesbrecht promotes this principle to help remember what will happen and what to do should you fall into cold water:

"One Minute — Ten Minutes — One Hour"

One Minute
You will suffer "cold shock". Do not panic. The gasping and hyperventilation lasts about one minute. Work to regain control of your breathing – if you inhale water you may drown almost immediately. Wearing a lifejacket will keep your head above water so you can breathe.

Ten Minutes
Once you can breathe more easily, immediately work at self-rescue. Climb out of the water and into the boat. Signal for help. As ten minutes pass, your fingers, hands and limbs will become progressively incapacitated from the cold; you will be able to accomplish less and less. If you cannot get out, stop struggling to preserve body heat and assume the HELP position (below). You must keep your head above water until rescue arrives, which is why wearing a lifejacket is so important.

One Hour
If you cannot get out of the water within about 15 minutes, chances are you will be unable to do so. However, you will not be truly hypothermic for about an hour. Wearing a life jacket increases your chances of rescue even if you are hypothermic, as it keeps your head up and allows you to continue breathing.

Follow these guidelines if you capsize or fall overboard into cold water:

- Do not panic. Keep your head above water and regain control of your breathing.
- Do any necessary jobs requiring your hands once you can breathe more easily. Retrieve your whistle and flare gun and signal for help. Climb back into the boat – or onto it – if it is overturned and you cannot right it. Work at tasks before you succumb to cold incapacitation.
- Stay with the boat. Get as much of your body as possible out of the water. Try to climb back into the boat and bail water out. Crouch low to stay out of the wind as you paddle to shore. If you cannot get back into the boat, climb up onto the overturned boat and tie yourself to your partner with a belt or rope. This will delay the onset of hypothermia.
- If you cannot get out of the water: Remain still. Do not swim or tread water, as moving water conducts heat away from your body 35% faster than still water. Due to diminished swimming abilities, heavy clothing and "swim failure", you can only swim one-tenth to one-fourth the distance you can normally swim in warm water. Do not overestimate your ability to swim. It is usually much safer to drift to shore with the boat.
- If you decide to swim for shore, do it only if the shoreline is very close. Check the wind direction to be sure it will not blow you offshore. Most victims drown within a few metres of safety.
- Consider swimming for shore only:
    - If there is no chance of rescue at all
    - If you are wearing a lifejacket and you are very close to shore.
    - Be very careful as people always underestimate the distance to shore and overestimate the distance they can swim.

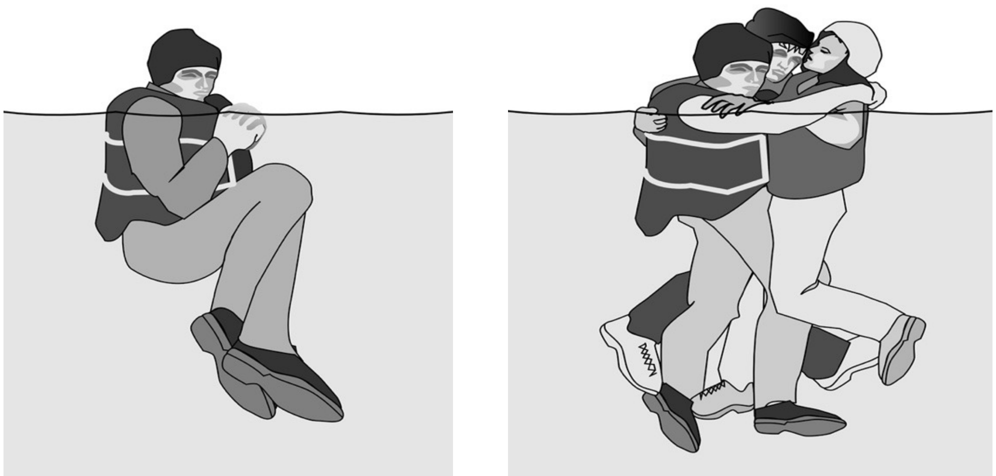
In addition:

- Do not discard clothing or light weight shoes; they help retain body heat while you are in the water. Get rid of boots only if they are very heavy. Button up clothing and cover your head to help preserve body heat. In cold water, up to 50% of heat loss can be from your head and neck area.
- Eat any available food in your pockets to supply energy to combat hypothermia (candy bars etc.).
- Once on shore, build a fire immediately using the contents of your survival kit (distributed in your clothing). Concentrate on warming your head and trunk area. 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.

NOTE: It is important to treat all people rescued from cold water immersion as hypothermia or shock victims. Treat victims very gently and whenever possible, lift them from the water in a horizontal position rather than with a vertical lift to prevent cold blood pooling in the legs. Transport them horizontally to a medical centre. Treat victims gently and as directed in Chapter 9.9.3 Hypothermia.

Heat Escape Lessening Posture (HELP)

If you cannot get out of the water, assume the HELP position. This position preserves body heat in the chest, sides and groin areas. HELP is an acronym for the Heat Escape Lessening Posture



If you are alone

Huddle if you capsize with a group

Figure 17.2: Heat Escape Lessening Posture (HELP)

If you are alone, this position minimizes heat loss from the torso area. You must be wearing a PFD. Try to wear a hat to minimize heat loss from your head.

1. Cross your arms tightly across your chest.
2. Draw your knees up close to your chest.
3. Stay still. Do not expend energy by moving around.

If you capsize with a group, huddle together to minimize heat loss. Remember that you must all be wearing PFDs.

1. Form a circle facing inward so that your chests are close.
2. Place your arms around the back of each person next to you.
3. Intertwine your legs.

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

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

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 Indigenous 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 the mining industry. The jurisdictional Workers' Compensation Board or equivalent authority and the government department that includes mines are sources of information.

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 Chapter 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.

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.

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

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.

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 Indigenous, 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.

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 10.3.1 Precautions and Preventions for information regarding trained bear guards. Also refer to Chapter 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 of the Basic Firearm Safety of the Canadian Firearms Safety Course: Student Handbook.

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.

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 (1) 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 Canada[1] . 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 from the Canadian Centre for Occupational Health and Safety.

Information regarding various hazardous materials used in mineral exploration and which are commonly found in camps and drill sites is available in Chapter 20.4.7 Hazardous Materials and in Chapter 10. Hazardous Material on the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

[1] Regulatory proposals to update WHMIS are expected in 2010.

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.

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 from the Canadian Centre for Occupational Health and Safety.

Table 18.1 WHMIS Classifications and Symbols for Hazardous Chemicals

	Class A: Compressed Gas Products under pressure. For example, oxygen, propane, acetylene, fire extinguishers
	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
	Class C: Oxidizing Materials Materials may not burn, but provide oxygen to a fire. For example: nitric acid, hydrogen peroxide, sodium hypochlorite – bleach
	Class D, Division 1: Materials Causing Immediate and Serious Toxic Effects For example: sulphuric acid, hydrofluoric acid
	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
	Class D, Division 3: Biohazardous Infectious Materials Commercial cultures containing infectious organisms: For example: viruses: Hepatitis B; bacteria: salmonella; parasites: Giardia
	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
	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 from the Canadian Centre for Occupational Health and Safety.

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

Table 18.2 Example of a workplace label

METHANOL
• Wear chemical resistant goggles and gloves. • Wash thoroughly after handling. • Keep container tightly closed.
SEE MATERIAL SAFETY DATA SHEET

An example of a workplace label and information about them is available from WorkSafe BC.

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.

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[2].

1. Hazardous ingredients: The ingredients, concentrations and estimates of immediate and severe health effects, Chemical Abstracts Service (CAS) number.
2. Preparation Information: Name and telephone number of party responsible for the preparation of the MSDS, date of preparation
3. 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)
4. Physical data: A physical description: physical state, boiling and freezing points, pH, appearance, specific gravity, smell
5. Fire or explosion data: Conditions of flammability, means of extinction, flash point, hazardous combustion products, explosion data
6. Reactivity data: Reactivity, conditions of chemical instability, names of incompatible substances or classes of substances, conditions of reactivity, hazardous decomposition products
7. Toxicological properties: Route of entry to the body, effects of short and long term health exposure, various types of toxicity
8. Preventative measures: Specific control measures: engineering controls, PPE, safe work procedures, handling, storage and disposal measures, spill procedures
9. 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:

1. Match the name of the product to the MSDS to verify the product being used.
2. Be familiar with the hazards.
3. Understand the safe handling, storage and disposal requirements.
4. 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.

[2] 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.

As the GHS will eventually standardize the content of MSDSs (SDS under the GHS), the [United Nations Economic Commission for Europe (UNECE) website] provides the status of implementation of GHS.

Figure 18.1 Keep copies of MSDSs in a convenient location for easy referral. © Bill Mitchell

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 from the [Government of Ontario].

Figure 18.2 Site specific emergency response equipment: eye wash station (left) and spill kit (right). © Bill Mitchell

18.3 | Responsibilities (Due Diligence) and Camp Management

A camp manager must carefully plan all aspects of camp management. He or she must have the highest regard for safety and convey this attitude to all employees. In addition to hiring terrain experts as required (e.g., mountaineering, working on ice), managers should consider the need to hire specialists for health related reasons such as designing drinking water treatment and sewage treatment systems.

Some management responsibilities include but are not limited to:

- Compliance: Make sure that all necessary permits and permissions are in place.
- Risk assessments: At the onset of the project, carry out a risk assessment of the site and surrounding terrain, as necessary. Develop and implement plans to eliminate or mitigate the risks and hazards. See the following section "Site Risk Assessments" and refer to Chapter 2.1.5 Risk Assessments.
- Safe operating procedures: Establish and implement site specific SOPs that augment the general company SOPs, as necessary. Take the results of the risk assessments into consideration. See the following section "Site Risk Assessments".
- Emergency response plans: Establish a site specific ERP that conforms to the company ERP. Post the plan at each communications station. Each field employee should have a copy of the ERP and be trained to carry out assigned duties. Include contractors' employees when planning site emergency response procedures to avoid confusion and additional problems during emergencies. Place a copy of the ERP in each vehicle, boat and/or aircraft and at the drill site for reference, as required. At the onset of field work, test the ERP contact frequencies and numbers to see that they work as expected. Examples of some of ERPs procedures are given in Chapter 3. Emergency Response.

- Equipment: Select appropriate equipment for field use. Make sure all equipment functions properly; test and maintain equipment when necessary. Make sure there is an adequate supply of tools, spare parts and fuel. Consider the need for spares of essential items such as radios and antennas. Depending on the location, it may be difficult to replace or repair some items, especially communication equipment. When planning a camp, an equipment check list is useful to be sure all necessary equipment, spare parts and supplies are mobilized into camp.
- Communications: Make sure all communication equipment is appropriate for the field area and that employees are trained to use it, especially the equipment at the communication centre. Establish and adhere to communication routines and schedules between field crews and camp. This includes daily check-in and emergency routines.
- Safety meetings: Make sure all site personnel receive a safety induction at the start up of camp or field season. All employees starting work throughout the season should receive the same induction. Hold regularly scheduled safety meetings and extra safety meetings to deal with specific tasks or topics, as required.
    - Hold health and safety committee meetings as required. When a camp employs more than the designated number of employees – usually 20 or 25 employees – OHS regulations may require a joint health and safety committee composed of equal numbers of workers and management representatives. Refer to Chapter 2.1.2 Safety Meetings for additional information.
    - When a camp uses air support, make sure the pilot conducts appropriate briefings. Special briefings should be held before slinging work and when unusual manoeuvres are used (e.g. toe-in landings). A complete safety orientation is required when there is a new aircraft or a new pilot. Refer to Chapter 16. Aircraft.
    - Make sure visitors receive a safety induction, which may be abbreviated if the visit is very short, although anyone staying on site for (perhaps) more than 24 hours should receive a full induction.
- Training: Make sure employees are trained to do their jobs safely.
- First aid: Make sure that all first aid kits meet the required standards of AHJs and are replenished as needed. Make sure additional appropriate first aid equipment is available at all times including stretcher(s) will fit into the emergency means of transportation.
- Maintenance: Establish a maintenance schedule for the camp and equipment that includes regular inspections of all generators, pumps, hoses and fittings and other mechanized equipment, including all means of transportation. Follow maintenance schedules for water treatment and sewage treatment systems.
- Inspections: Conduct spot checks. Include the kitchen, kitchen staff, latrines and waste disposal sites – on a daily basis, if necessary. Inspect firefighting equipment and caches, first aid treatment area, fuel storage areas and drill sites, as required.
- Documentation: Maintain records as required by AHJs for inspections, training, first aid, safety

meetings, and equipment maintenance records and communications logs.

- Forms: Keep an adequate supply of forms for reporting incidents/accidents to AHJs, such as required by the jurisdictional Workers' Compensation Board, spill reports, inspection and audit forms, maintenance check forms, TDG forms etc.

Site Risk Assessments

Complete a thorough risk assessment of any new project or camp site taking into consideration physical location, human safety and the environment. It is necessary to reassess some risks every year (or more often) and when the site expands activities (e.g., trenching, drilling and bulk sampling). Include the following in the site risk assessment and develop risk mitigation processes and procedures.

- Site location: Consider the arrangement of the camp in relation to the required setback from water bodies, the organization and optimum space requirements for tents, water and sewage systems, fuel storage area, road access, air strip or helicopter landing pad, work areas, drill sites, core handling areas, as required.
- Communications: Assess the requirements for communication equipment taking into consideration the degree of remoteness or isolation of the site. Determine the most appropriate means of communication and whether backup is available. Remember that some foreign countries restrict the importing of communication equipment.
- Fire: Assess the potential fire hazards, whether for forest fire, bush fire, tent fire or lightning strike. Consider the prevailing wind direction and the requirements of emergency evacuation plans when organizing the site layout. Include an examination of MSDS sheets for controlled products that may pose a fire risk.
- Wind: Pay special attention to wind direction and the possibility of (1) the spread of fire to or from fuel storage areas, (2) blowing dust from road, vehicles and drilling activities, (3) drifting snow for winter camps and (4) the potential cooling effect of wind in warm climates.
    - Locate vehicles, fuels, waste disposal areas etc., downwind from camps.
    - Avoid windswept areas such as ridges or gullies to minimize wind damage.
- Terrain: Assess hazards in each locality and avoid the following:
    - Dangerous trees and overhanging branches that may fall on tents or workers, or stumps that may impede equipment
    - Areas prone to seasonal flooding, flash flooding, potential inland flooding from large storms, including dry streambeds and the immediate shorelines of lakes or streams
    - Steep terrain or unstable ground with potential for land slip, including potential rock falls, landslides, mudslides, avalanches, the base of cliffs and recently cleared areas
    - Soils that may become dusty when dry and/or muddy when wet
- Animal hazards: Avoid setting up a camp on or near game trails and feeding areas that attract bears. Locate camp sites far away from water where predatory animals (especially crocodiles,

alligators, hippos) may reside, even at the expense of a convenient, safe drinking water supply. Avoid or eradicate bee, wasp, ant or other insect nests. Refer to Chapter 10. Wildlife.

- Disease risks, according to location:
  - Whenever possible, locate camps at least one kilometre away from swampy areas, stagnant waters or areas with drainage problems. This will reduce the numbers of insects and the risk of mosquito-borne diseases such as malaria. Avoid rocky areas if sandfly-borne diseases such as leishmaniasis are a risk. Screen and spray camp structures with insecticides as required.
  - Determine the requirement to treat water to prevent water-borne diseases such as Giardia, other diarrheal diseases and schistosomiasis.
  - Refer to Chapters 12.8.5 Diseases and 18.6.5 Diseases for information about specific diseases.
- Special site risks:
  - Determine any specialized equipment requirements for the field project. For example, equip high altitude camps with oxygen tanks and portable hyperbaric chambers.
  - In areas where tsetse flies are a hazard, remove all tall vegetation and brush near camp so the flies have no place to rest.
  - In areas where malaria is a risk, do not allow any standing water to accumulate. Remove old tires, containers and equipment where water can collect and provide breeding places. Follow screening and spraying procedures. These precautions will help reduce the incidence of all mosquito-borne diseases. Refer to Chapters 12.8.4 Protection from Insect Bites and 12.8.5.9 Malaria.
  - Consider the risks when returning to an established camp with standing structures that have not been used for some time. To mitigate the risks, check the structures for wildlife that may have taken up residence (e.g., snakes, scorpions). In Central or South America where Chagas' disease is a risk, fumigate the structures before you sleep in them to eliminate any infected Reduviidae insects (cone-nosed bugs).

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.

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.

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.

18.4.1.1 | 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 Chapter18.4.3 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 Chapter 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 Chapter 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 Chapter 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 Chapter 18.6.4 Waste Management.

18.4.1.2 | 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:

1. Determine the best communication equipment for the geographic location and terrain, and supply the camp with sufficient equipment, including an independent backup system.
2. Designate a communication centre that also functions as a means of tracking the location of all employees.
3. 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.
4. Train all employees to use the communication equipment. It is essential that everyone is able to follow the posted instructions.

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.
- Construct firebreaks around camps where applicable (e.g., in grasslands, dry season in Africa or Australia). The firebreak should be at least 5 to 10 metres wide. Follow the recommendations of AHJs.
- 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.

18.4.2.1 | 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.

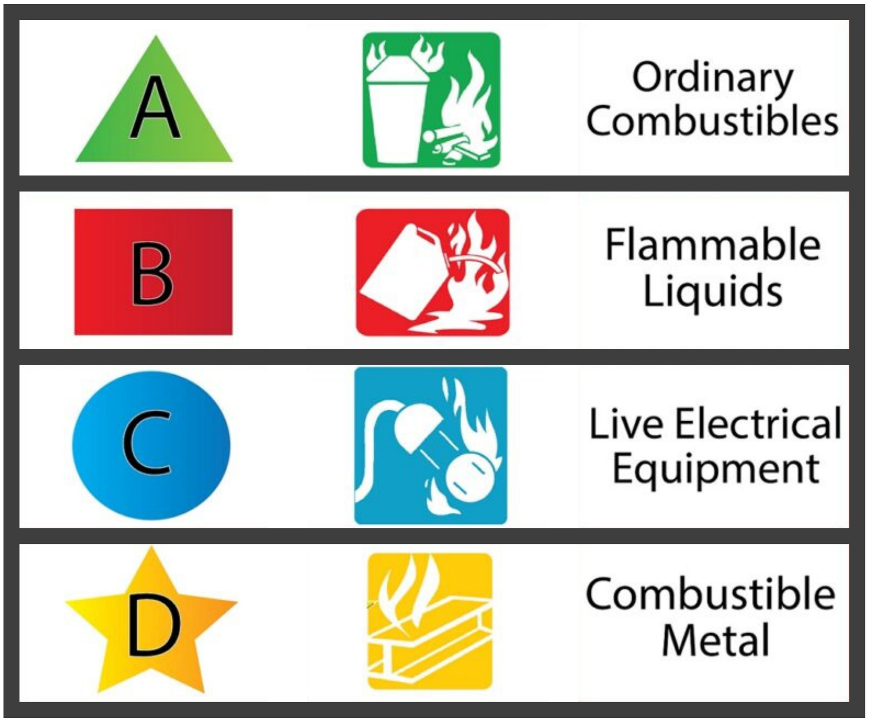


Figure 18.3: Class of fire, letter symbol and pictographs.

Generally, only three types of fire extinguishers are used in camps:

1. Water or foam
2. Carbon dioxide (CO2)
3. Dry chemical – regular dry chemical (BC) extinguishers use sodium bicarbonate or potassium bicarbonate, while multi-purpose dry chemical (ABC) extinguishers use monoammonium phosphate

Table 18.3 Classifications of fire

CLASS OF FIRE	FIRE EXTINGUISHER TO USE	DO NOT USE
CLASS A Ordinary combustibles	Pressurized water Foam Multipurpose dry chemical	Carbon Dioxide (CO2) Ordinary dry chemical
CLASS B Flammable liquids	Foam Carbon Dioxide (CO2) Ordinary dry chemical Multipurpose dry chemical	Pressurized water
CLASS C Electrical equipment	Carbon Dioxide (CO2) Ordinary dry chemical Multipurpose dry chemical	Pressurized water Foam

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.

Figure 18.4: Refilling a (BC) fire extinguisher with extinguishing powder (sodium bicarbonate).
© Courtney Mitchell

18.4.2.2 | 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.

Figure 18.5: Firefighting practice – extinguishing a fuel fire © Erika Tamboline

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 Indigenous lands. Storage tank systems must be registered with Environment and Climate Change Canada and meet standards to prevent leaks and spills.

This section contains limited information about fuel storage, handling, and transportation as the subjects are covered in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit. Refer to Chapters 10.1 Fuels and Petroleum Products and 10.2 Propane and Other Liquefied Petroleum Gases on the DRE (pdac.ca) website.

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 preve[nt 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 Transport Canada website provides information about dangerous goods training and links to a variety of topics regarding dangerous goods.
- 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 Chapter 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 Chapter 10.2 Propane and Other

Liquefied Petroleum Gases in the Excellence in Environmental Stewardship Toolkit.

- 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.

Figure 18.6: Correctly stored compressed gas cylinders – upright, secured with safety caps in place and off wet ground to prevent corrosion. © Courtney Mitchell

Additional information about storage and handling flammable fuels and compressed gases is available from the Canadian Centre for Occupational Health and Safety.

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 Chapter 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 Chapter 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:
    1. Turn off all control valves at the stove or appliance.
    2. Turn off the shutoff valve on the gas cylinder.
    3. Change the gas cylinder.
    4. Open the valve on the new gas cylinder and check for leaks.
    5. 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.

Figure 18.7: A refillable heating oil tank and berm lined with chemical resistant fabric. © Bill Mitchell

18.4.4.1 | 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 Chapter 22.7.3 Carbon Monoxide for information about carbon monoxide and for information about the occurrence in old underground workings.

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.

Table 18.4 Fuel characteristics

FUEL	USE	DISTINGUISHING FEATURES
JP-4, also known as Turbo B, Jet B, Jet A	Jet Helicopter Twin Otter Turbo Beaver Sharp Heater	Very pale straw colour, Could be confused with Naphtha Has oilier smell than Naphtha
Avgas 100/130	Non-Jet Aircraft Single Otter Beaver DC-3 Cessna 180/185	Green colour Sickly sweet smell
Naphtha (not recommended for use due to its flammability)	Coleman Stoves Lanterns Coleman Heaters	Clear colour This is a lighter fuel than JP-4. Leaking drums may have a crystalline deposit at the leak site in cold temperatures.
Propane	Kitchen appliances Propane heaters Tiger torches	Manufacturers add an odorant to create a distinctive smell like rotten eggs or boiling cabbage so vapors can be detected when there is a leak.
Regular Gasoline or Petrol	Generators	Slightly yellow colour Same smell as gas you put in a car
Diesel	Diesel Generators Oil Stoves Drill Engines	Noticeably heavier than other fuels Oily smell of old stoves
Stove Oil	Oil Stoves	

NOTE: If in doubt about the identity of a fuel – DO NOT USE IT. Report it to your supervisor.

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.

18.4.6.1 | 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 Chapters 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).

18.4.6.2 | 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 (1) 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:

1. 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.
2. Shut off the equipment or machine and make sure that all moving parts are completely stopped.

3. 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.
4. 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.
5. 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.

18.4.6.3 | 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.

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.

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
  - Snakebite – know where antivenin is available for treatment
  - 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:

1. Name(s) of first aid attendant and work location on site
2. Telephone number, radio frequency or sat phone number to reach the first aid attendant from any location at any time
3. Operating instructions for both radio and sat phone
4. Contact number(s) for the nearest medical treatment centre and transportation providers (helicopter, fixed wing etc).
5. The times required to reach the medical centre by each and every available means of transportation

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.

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.

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

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.

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.

18.6.2.1 | 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 Chapter 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 Chapter 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.

18.6.2.2 | 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 Chapter 10.3.6).

18.6.2.3 | 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 Chapter 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 Chapter 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 Chapter 10.3 Bears for additional information.

Figure 18.8: A large camp kitchen – clean, organized and with food tightly covered that can remain at room temperature.

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 Chapter 9.0 Water Use and Conservation in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

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.
- 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*.
- 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 12.8.3.3 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.

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 Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit. Refer to Chapter 12.0 Waste Management for details regarding waste identification, classification, management, camp sewage and wastewater and hazardous wastes.

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.

Figure 18.9: Burn barrel © Trauma TechIncinerator © Bill Mitchell

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.

18.6.5 | Diseases

This section addresses diseases that present a risk in North America. Immunization is available for most of them because they also present a risk worldwide. A few of the diseases present the greatest risk in North America (e.g., Lyme disease, West Nile virus, Rocky Mountain spotted fever and Hantaviral pulmonary syndrome). Some diseases, including Hepatitis A and B, HIV/AIDS, and tuberculosis present potential health risks in field camps in North America and worldwide.

Cross references to other diseases: Travel related diseases are covered in Chapter 12.8.5 Diseases and include the following:

Travel related diseases are covered in Chapter 12.8.5 Diseases and include the following: Chagas disease, cholera, dengue fever, viral hepatitis, histoplasmosis, Japanese encephalitis, Legionnaires' disease, leptospirosis, malaria, meningococcal disease, plague, rabies, schistosomiasis, travellers' diarrhea, typhoid and yellow fever.

18.6.5.1 | Diphtheria

Description

Diphtheria is a serious bacterial disease. In northern and temperate regions, it occurs more frequently during colder months of the year. In the tropics, it occurs year round. The disease is spread by direct contact with infected persons through coughing and sneezing, or rarely by contact with articles that contain the discharge of diphtheria lesions. Lesions develop at the site of the infection in the throat, nose or on the skin.

- Faucial or laryngeal diphtheria affecting the mouth and throat is a serious disease with a fatality rate of 5% to 10% or higher in some regions. It usually affects infants, young children and adults who have not been immunized. Severe side effects to the heart may develop. This form is more common in northern and temperate climates.

- Nasal diphtheria is a mild form but it may become chronic.
- Cutaneous diphtheria affecting the skin may resemble impetigo. It occurs more commonly in the tropics than in temperate regions.

Symptoms

- Symptoms develop within two to five days of exposure and include sore throat, nausea, fever, chills and vomiting.
- Severe sore throat with patchy white/gray membrane in the throat and swelling in the neck area develop with faucial diphtheria
- Skin lesions develop with cutaneous diphtheria.
- Cardiac complications may develop and result in death.

Prevention

- Be immunized. Without immunization, the infection may reoccur.
- Seek medical attention.

Areas of concern

- Worldwide, especially countries of the former Soviet Union
- Additional information regarding diphtheria is available from the CDC.

18.6.5.2 | Giardiasis

Description

(Other names: beaver fever, backpacker's diarrhea)
Giardiasis is a diarrheal disease caused by a common parasite with worldwide distribution. Giardia lamblia parasites commonly occur in rural or mountainous areas and may occur in some urban areas, so be educated about the disease. People may contract giardiasis through direct contact with contaminated animal or human feces or by drinking or accidentally swallowing water containing parasites in lakes, rivers, streams, springs or ponds. The parasites may disappear but the disease may become chronic and last a long time.

Symptoms

- Symptoms may take one to two weeks to appear. They include severe diarrhea, bloating, severe gas, burping, cramps and nausea, headache, fatigue or chills.

- Seek medical treatment for this type of diarrhea. Medication reduces the duration of the symptoms.

Prevention

- Treat all water used for drinking, cooking or making ice etc., when working where the disease occurs. Chemical treatment may not be sufficient if the water is cold and/or cloudy. It may be necessary to filter and/or boil the water to make it safe. Carry drinking water on traverses – do not rely on finding safe water.
- Practice good hygiene. Wash hands thoroughly with soap and water before preparing food, before eating and after using the toilet.
- Never swim in a beaver pond or in water that may contain human or animal sewage.
- Do not drink untreated water or use ice made from untreated water in countries where the water supply is not dependably safe.

Areas of concern

- Western and northeastern North America, Nepal, Russia (urban and suburban), tropics

Additional information regarding giardiasis is available from the CDC.

18.6.5.3 | Hantaviral Diseases

Description

(Other names: Hantaviral pulmonary syndrome (HPS) – Hantavirus adult respiratory distress syndrome; Hemorrhagic fever with renal syndrome (HFRS) – Epidemic hemorrhagic fever, Korean hemorrhagic fever, Nephropathia epidemica, Hemorrhagic nephrosonephritis)
There are two types of hantaviral syndromes: pulmonary and renal. Hantavirus pulmonary syndrome (HPS) occurs primarily in rural western North America and is a rare but very serious disease. Hemorrhagic fever with renal syndrome (HFRS) is more widespread, occurs mainly in the eastern hemisphere, and causes hemorrhagic fever and renal (kidney) damage. Hantaviral diseases are most frequently transmitted to humans through breathing air contaminated with the saliva, urine and feces of mice and rats. Outbreaks of HPS seem to coincide with expanding rodent populations due to increased food supply following abnormally wet spring weather.

Symptoms

- Hantavirus pulmonary syndrome
    - Initial symptoms are flu-like and include fever, muscular aches, dry cough and shortness of breath.
    - Symptoms may rapidly progress to pulmonary edema and death. The mortality rate is between 40-60%.
    - This life-threatening disease requires urgent medical attention.
- Hemorrhagic fever with renal syndrome
    - Headache, backache, fever and chills, bleeding, renal (kidney) failure
    - Requires urgent medical attention although it does not have the high mortality rate of HPS.

Prevention

Be vigilant if deer mice live in the area and/or the rodent population has increased noticeably. While deer mice are the primary reservoir, cotton rats and rice rats carry Hantavirus in the southeast USA, and the white footed mouse is a carrier in the northeast USA and parts of Canada. Other species of rodents carry the virus in other parts of the world. The CDC website has links to maps showing the geographic range of carrier species in North America and occurrences of HPS in the USA.

- Risk factors: Contact with fresh rodent droppings, urine, saliva or nesting materials, which includes cleaning out seasonally used cabins or storage buildings, entering crawl spaces buildings, cleaning out infestations of potential carriers, handling dead or living rodents
- Use respiratory protection where air, dirt and dust may be contaminated by rodent saliva, urine or feces or nesting materials. Avoid direct contact with potentially contaminated dust and dirt.
- Follow safe cleaning procedures that include but are not limited to the following:
    - Air out seasonal structures or other closed potentially contaminated buildings for one hour before cleaning. Stay out of the building during this time.
    - DO NOT remove droppings and nests by dry vacuuming or sweeping as this causes particles to become airborne.
    - Disinfect the rodent materials. Use a spray rather than a stream with 10% bleach-water solution to wet down dust and dirt before cleaning to keep dust from becoming airborne. This is very important as the virus is easily killed with disinfectant (and exposure to sunlight).
- PPE: Use respiratory PPE with the proper rating for the cleaning tasks at hand, wear disposable gloves and washable clothing. Wear an appropriate NIOSH-approved filter mask that is fitted with 100 series filters or a respirator with a P100 cartridge. When finished, follow disinfecting and washing procedures for PPE.
- Trap and kill rodents in buildings and tents. To dispose of dead rodents, wear disposable gloves and disinfect the trap and mouse with a bleach/water solution before disposal and double bag the remains. Avoid poison as this allows infected mice to live longer and continue to spread infecting body fluids and feces.

- Pay scrupulous attention to maintaining a clean camp. Wet mop floors to dampen dust when cleaning. Protect food in rodent-proof containers. Do not eat food contaminated by rodent excrement.
- Refer to the WorkSafeBC publication "A Hantavirus Exposure Control Program for Employers and Workers" for detailed information regarding employer and employee responsibilities, exposure control plan, essential and recommended PPE, general hygiene precautions, rodent handling and decontamination procedures.

Areas of concern

- Hantavirus pulmonary syndrome – most cases have occurred in rural western North America. HPS has been confirmed in South America. Hantavirus is known to be present in deer mice in Yukon and all provinces except PEI and Nova Scotia.
- Hantavirus hemorrhagic fever – worldwide, mostly in the eastern hemisphere

Additional information regarding Hantavirus is available from the CDC.

18.6.5.4 | HIV/AIDS

Description

HIV/AIDS is a disease caused by the family of viruses known as the Human Immunodeficiency Virus (HIV). The viruses attack the immune system and central nervous system, which makes a person susceptible to unusual infections, tumours and cancers that are often fatal. AIDS (acquired immunodeficiency syndrome) is the final stage when the body can no longer fight the infections. The virus is spread from person to person through the transfer of body fluids, as in sexual intercourse (vaginal, anal and oral), blood transfusions, injection with unsterilized needles, during childbirth, inadequately sterilized medical/dental and acupuncture equipment, tattooing, electrolysis and IV drug use. While there are drugs that slow the progression of HIV, there is no cure and there is no vaccine. AIDS is not transmitted through social contact such as touching, through food, water, air, or activities such as swimming. It is not transmitted by insects or animal bites.

You risk acquiring AIDS through casual sexual contact. Travellers throughout the world face the additional uncertainty of exposure to contaminated blood in the event of an emergency. Many African countries have a particularly high risk of AIDS transmission. To minimize the risk of acquiring this fatal disease, use good judgement in your daily life and use additional vigilance during travel and work abroad.

Precautions

- Practice safe sex at all times.
    - Use latex or polyurethane condoms and use them correctly. Do not have unprotected sex with anyone but your usual partner.
    - Avoid contracting other sexually transmitted diseases (STDs). Being infected with an STD makes you more likely to become infected by the AIDS virus during sexual intercourse with an infected person.
- In developing countries, avoid vehicle accidents to prevent the potential need for blood transfusions.
    - Drive defensively and use seat belts at all times. Don't drink and drive.
    - Hired drivers should be persuaded to drive cautiously.
    - Whenever possible, avoid driving at night where animals or pedestrians are a hazard.
- Avoid unnecessary needle injections and blood transfusions in developing countries or where there is a risk of rescreened blood products.
    - Be fully immunized prior to travel.
    - Prior to travel, find out the location and contact telephone numbers of safe health services (local doctors and/or clinics) in each country where you will travel or work. A travel medicine clinic or doctor can provide this information. It is best to be prepared before you require emergency medical services. In the event that you lack this information and need medical help, your home country embassy can usually supply a list of medical contacts for services within the country.
    - Ask the treating medical person if an oral medication (e.g., malaria) is available. Decline injections if an oral medication is available.
    - In the event of an accident etc., ask the treating medical facility if a blood transfusion is really necessary. If you are in a condition to ask, it is probably not necessary. Request intravenous fluids such as normal saline, ringers solution and plasma expanders that are not blood products.
    - Carry sterile needles in your travel medical kit should you require them for regular treatment e.g., diabetes, or if there is any possibility that you may need an injection or blood test during your travel. Take the supplies to a medical facility and have a trained person use them, as required
- Do not share razors or toothbrushes, which may facilitate the transfer of blood from cuts or bleeding gums.

Additional information regarding HIV/AIDS is available from the CDC.

18.6.5.5 | Lyme Disease

Description

Lyme disease is transmitted to humans by the bite of infected black legged deer ticks (Ixodes scapularis and Ixodes pacificus) in either the adult or nymph stage. Ticks are most abundant during spring, summer and autumn. They occur most commonly in areas of brush or tall grass. The deer ticks and nymphs are very small making detection difficult.

Symptoms

If it is unrecognized and untreated, Lyme disease can cause severe arthritis, neurological and/or heart problems.

First Stage: It is vitally important to obtain medical treatment at this stage. Doxycycline is an appropriate antibiotic that can be used for tick-borne illnesses.

- A characteristic bull's-eye rash may appear at the site of a bite three to 30 days after becoming infected. Be aware that this rash only appears in about half the infections. Seek medical advice immediately if you find a suspicious ring-like rash area on your body. This symptom will disappear on its own after one to three weeks.
- Flu-like symptoms are common along with the rash. These include sore muscles, stiff neck, painful joints, fatigue and coughing. While most symptoms abate in a couple of weeks, the fatigue and muscle aches may last for months.

Second Stage: Neurological and cardiac problems may develop weeks or even months after the initial infection.
Third Stage: Chronic arthritis and chronic fatigue may develop months or even years later.

Prevention

Preventing tick bites is the key to minimizing the risk of Lyme disease.

- Clothing: Wearing light coloured clothing makes ticks more visible. Wear long, tucked-in pants, long sleeves and footwear that completely cover your feet.
- Apply insect repellents containing DEET to your skin and spray clothing with permethrin products.
- Conduct daily checks on clothing and on your body for attached ticks.

- Removal of ticks: The transmission of the bacteria requires only approximately 24 hours of attachment, so it is important to find and remove ticks quickly. For instructions to safely remove ticks, refer to Chapter 10.7.3 Ticks.
- After an attached tick is removed, watch for symptoms or signs of tick-borne disease for 30 days. Watch specifically for a skin lesion or rash at the site of the bite and for fever over 38ºC (100.5ºF). If these symptoms occur, seek prompt medical attention for assessment for possible tick-borne disease.
- Refer to 10.7.3 Ticks for additional tips to prevent tick bites.

Areas of concern

- The Americas (endemic areas: northeastern USA and southeastern Canada), Europe and parts of Central Asia

Additional information regarding Lyme disease is available from the CDC.

18.6.5.6 | Measles

Description

(Other names: rubeola or red measles)
This moderately severe viral disease is easily transmitted between people by airborne droplets and direct contact. Complications from measles may include pneumonia and encephalitis. The disease affects adults and infants more seriously than children. Employees who travel or work in developing countries should make sure they are vaccinated.

Symptoms

- Fever, rash, cough, conjunctivitis
- Serious complications occur in 20% of reported measles cases. They may include ear infections, pneumonia, blindness or encephalitis, which may lead to permanent brain damage or death.

Prevention

- Be immunized with measles or MMR (measles-mumps-rubella) vaccine.

Areas of concern

- Worldwide, but measles is most common in parts of Africa, Asia and the eastern Mediterranean

Additional information regarding measles is available from the CDC.

18.6.5.7 | Mumps

Description

This viral infection is spread by airborne droplets and by direct contact with saliva of infected persons. Employees who travel or work in developing countries should make sure they are vaccinated.

Symptoms

- Fever, swelling of the salivary and parotid glands

Prevention

- Be immunized with MMR (measles-mumps-rubella) vaccine.

Areas of concern

- Worldwide

Additional information regarding mumps is available from the CDC.

18.6.5.8 | Polio

Description

(Other names: Infantile Paralysis, Acute Poliomyelitis, Polioviral fever)
Polio is a serious viral disease that attacks the nervous system and may result in paralysis or death. The virus is spread through close contact with infected people and through contaminated food and water.

Symptoms

- Mild cases may last a few days and involve fever, sore throat, stomach ache and headaches.
- Severe cases involve severe muscle pain, inability to move the limbs and severe breathing difficulties.
- People who experience paralysis may develop permanent weakness in the limbs.

Prevention

- Be vaccinated against polio.
- Where the wild type virus still exists there is risk of infection unless you are vaccinated. Employees who travel or work in high risk areas – countries where polio is endemic, countries where cases have been recently imported, or countries that are near these regions – should check with their healthcare provider and make sure they are vaccinated.

Areas of concern

- Africa, Asia, the Middle East and Eastern Europe

Additional information regarding polio is available from the CDC.

18.6.5.9 | Rocky Mountain Spotted Fever

Description

(Other names: North American tick typhus, New World spotted fever, Tick-borne typhus fever, São Paulo fever)

The rickettsia parasite that causes this rare disease infects humans through bites of the wood tick, dog tick, or lone star tick. The disease is serious and requires antibiotic treatment. Severe cases have a shorter incubation period. If untreated, it is occasionally fatal.

Symptoms

- Flu-like symptoms occur two to 14 days after infection. These include severe headache, fever, nausea and vomiting and confusion.
- A red rash appears on the wrists and ankles and then spreads to the rest of the body. Abdominal and joint pain may develop.

Prevention

- Take active measures to prevent tick bites. Use insecticide on clothing and insect repellent containing DEET on exposed skin.
- Check frequently for ticks on your clothing and body during the day and at night.
- Refer to Chapter 10.7.3 Ticks for additional information about preventing tick bites and removing embedded ticks.

Areas of concern

- North America – the mid-Atlantic coastal states, Rocky Mountain states, Washington state, and British Columbia, Canada
- Central and South America – Mexico, Panama, Costa Rica, Columbia, Brazil

Additional information regarding Rocky Mountain spotted fever is available from the CDC.

18.6.5.10 | Rubella

Description

(Other name: German measles)
Rubella, a viral infection, is spread by airborne droplets and direct contact with infected persons. While it is a mild rash illness, it produces anomalies in 90% of developing fetuses, especially if the mother contracts rubella during the first trimester of pregnancy. The risk of rubella is high in many developing countries so it is important to be vaccinated.

Symptoms

- Diffuse rash, low grade fever, headache

Prevention

- Be immunized with MMR (measles-mumps-rubella) vaccine.

Areas of concern

- Worldwide

Additional information regarding rubella is available [from the CDC].

18.6.5.11 | Tetanus

Description

(Other names: Lockjaw)
Tetanus is a disease associated with wounds. They may be relatively minor wounds that are contaminated with dirt, feces or saliva, or they may be more severe such as burns, crush injuries, and deep wounds. The disease develops when tetanus bacteria C. tetani enters the body, often through a puncture wound or blister, where they produce neurotoxins that grow in the anaerobic environment at the site of the injury.

Symptoms

- Symptoms usually develop five to 10 days after the injury.
- Sore throat, stiff muscles, painful muscle spasms, fever, headache
- Death may result when respiratory muscles fail to function.

Prevention

- Be immunized. Keep immunization up-to-date with a booster every 10 years. This is important so you need not risk an injection with contaminated needles/syringes if you are injured in a developing country.
- Carefully clean puncture wounds and leave them uncovered to reduce the risk of creating an anaerobic environment conducive to the growth of tetanus toxins.
- If you receive a “dirty” wound such as a bite, crush injury or puncture, make sure you have had a tetanus immunization within the past 5 years. If not, get another immunization.

Areas of concern

- Worldwide

Additional information regarding tetanus is available [from the CDC].

18.6.5.12 | Tuberculosis (TB)

This bacterial disease is still common throughout the world. To become infected it is usually necessary to have prolonged contact with a diseased person who has an active case of tuberculosis. The tuberculosis bacillus is spread through cough droplets in the air or through saliva. The disease can be dormant in the body for many years (latent TB). When active, the disease causes cavitation in the lungs, cough, fever, weight loss and coughing up of blood. There are also extrapulmonary forms of tuberculosis that can infect parts of the body other than the lungs.

The dormant stage can be detected by a skin test called a Mantoux test (or PPD) or by a Tine test. A chest X-ray and sputum smear and culture can detect the active stage. The TB skin test is an important screening tool. If it is positive, the next step is a chest X-ray. If the chest X-ray is positive, you will receive treatment with three medications. If the chest X-ray is negative, you may or may not be treated with one medication depending on your age, the time period from the last negative skin test and other factors.

Tuberculosis is a serious health problem in many parts of the world.

- TB infects one-third of the world's population. Once infected, a person may develop an active case of TB and spread the infection to others.
- Unless successfully treated through a sustained course of medication, a patient may relapse and/or may develop a drug-resistant strain of TB. He or she will continue to spread TB to others.
- A person infected with TB who subsequently becomes infected with HIV has a greatly increased chance of developing an active case of TB.
- A person infected with HIV who subsequently becomes infected with TB is at much greater risk to develop life-threatening tuberculosis. In fact, some patients die within weeks of becoming infected with TB. In 2009, one out of four TB deaths was HIV-related.

Symptoms

- A bad cough lasting longer than three weeks
- Coughing up blood or bloody sputum, weakness, chest pain, loss of appetite, weight loss, fever, chills and night sweats

Precautions

- Company employees who move to work and live in developing countries should have a skin test every year. If the test is positive, further investigation is necessary.
- A skin test should be done after exposure to an active case. If it is initially negative, repeat the test in three months.

- In developing countries, companies should screen prospective cooks, teachers and household employees for tuberculosis with sputum smears and X-rays before hire. If there is an active case, the person is infective until he or she has completed two weeks of treatment. A treatment course of nine months should be completed as a condition of hire, but he or she may begin work after the first two weeks of treatment.
- Avoid unpasteurized milk and dairy products. TB-causing bacteria can be spread through milk from infected cattle.
- It is imperative for anyone receiving treatment for TB to complete the full course of antibiotic to protect others and reduce the risk of developing drug-resistant TB.

Areas of concern

- Worldwide.

Additional information regarding tuberculosis is available from the CDC.

18.6.5.13 | West Nile Virus

Description

West Nile virus is primarily transmitted to people through the bite of an infected mosquito.

Symptoms

- Symptoms usually develop from two to 15 days after infection. Most infected people have no symptoms, or they have mild flu-like symptoms that usually only last a few days, although they can last a few weeks.
- About 20% of infected people develop West Nile fever, which may include fever, headache, body aches, fatigue, and sometimes a skin rash on the trunk and swollen lymph glands.
- Less than one per cent of infected people, often those with weakened immune system or over the age of 50, may develop severe West Nile disease. West Nile meningitis or encephalitis, or West Nile poliomyelitis with symptoms that include rapid onset of severe headache, high fever, stiff neck, nausea, stupor, disorientation or coma. The symptoms of severe disease may last several weeks or even result in death.
- There is no specific treatment.

Prevention

- Prevent mosquito bites. Wear light coloured clothing that covers your skin and use insect repellent that contains DEET on exposed skin. Apply an insecticide or DEET to clothing. Take extra caution to protect against bites between dusk and dawn, but protect yourself during the day as well, as some carriers are day biting mosquitoes.
- Control mosquito populations around the site by emptying all standing water from containers.
- Refer to Chapters 10.7.1 Mosquitoes and Flies and 12.8.4 Protection from Insect Bites for additional information to prevent mosquito bites.

Areas of Concern

- Parts of North America, Europe, the Middle East, Africa and Asia

Additional information regarding West Nile virus is available from the CDC.

18.7 | Manual Handling

Manual handling includes lifting and carrying and any activity where workers are required to raise or lower, push or pull, or otherwise move or hold objects. Common manual handling tasks include moving sample bags and core trays, operating rock sample or core cutting tools, lifting heavy boxes of supplies, moving 205 L fuel drums and propane gas cylinder tanks. When setting up a new camp take the opportunity to plan and organize the site to facilitate manual handling, which will help reduce common injuries. Established camps will benefit from a thoughtful analysis of manual handling risks and hazards.

Risks and hazards

- Serious back injuries, back strains and joint sprain injuries caused by using poor lifting and techniques, lifting heavy loads
- Slips, trips and falls caused by carrying heavy items on slippery, wet, icy, or rough surfaces, wearing improper footwear, working in a disorderly work site.
- Collapse of shelving or stacked materials caused by insufficient support

Preparation and prevention

When carry out a site risk assessment, include handling processes. Address the identified risks and hazards and mitigate the problems. Consider the following:

- Training: Train employees in proper lifting techniques and carry out refresher training several times a year, including several times during field season, as required. Training should include proper stretching and warm-up exercises.
- Workplace and work station layouts: Arrange layouts to eliminate manual handling as much as possible. Consider the required movement of different loads. When possible:
  - Arrange work to be done at waist level in a position that does not require much bending, twisting or reaching.
  - Avoid moving loads to a position below mid-thigh or above shoulder level.
  - Avoid movements that require a worker to place a load very accurately or carry a load a long distance.
  - Use provided equipment to prevent and reduce injuries (e.g., hand trucks).
- Worker actions and postures: Avoid movements that are erratic, hard to control, twisting, bending low, or stretching high. Do not sustain awkward body positions for long periods of time.
- Weight: Consider the weight of objects in conjunction with their size and shape. Heavier objects are more risky to move, and those of the same weight that are compact are easier to grip and move than bulky, awkwardly shaped items.
- Lighting: Provide good lighting. Workers must be able to see well in order to work safely.
- Hot or cold climate conditions: Control temperatures, wind, sun exposure and exposure to rain or snow as much as possible. Warehouses and core shacks should be comfortable to work in.
- PPE and clothing: Wear gloves, eye protection and restrict loose clothing that might catch on machinery or tools. Loose sleeves, drawstrings and long unrestrained hair are hazards.

Planning storage facilities

Storage areas should be spacious enough and arranged to reduce potential hazards. When laying out storage, work areas such as core logging facilities and drill sites, consider the following:

- Size, surface characteristics, shape, stability and weight of objects. Know the characteristics of the materials so they can be handled as safely as possible.
- Assess the space requirements to store equipment and materials and the required vertical and horizontal movements for handling them.
- Materials should be easy to access and easy to stow to avoid unnecessary lifting, twisting, bending or reaching by employees.
- Keep storage areas free of tripping and fire hazards.
- Plan storage of hazardous chemicals and materials according to requirements for the isolation, compatibility and containment. Check the posted MSDS sheets.
- Storage locations should have proper signs to indicate what is permitted for storage.
- Plan the site layout to include potential growth.

Handling tips

- Eliminate handling heavy objects as much as possible. To reduce risks, use mechanical handling devices (e.g., small hand trucks or trolleys). Make use of waist high spaces for interim transport or temporary storage. For example, put core boxes temporarily in the back of a pickup truck rather than on the ground.
- Know the rated capacities for materials handling equipment to avoid overloading.
- Two persons should lift and stack heavy core trays (e.g., massive sulphides).
- Do not carry out manual handling tasks when fatigued; it is easier to injure yourself.
- Use appropriate PPE (e.g., gloves, eye protection) when handling wire rope, drill rods and any sharp, hot or slippery objects, core boxes and rough samples.
- Stack heavier items on lower shelves, preferably about waist level. Avoid overhead lifting whenever possible.
- Remove all nails from used timbers (lumber) before stacking.
- When storing loads on blocks, do not release a load until your hands are clear.
- Forklift trucks: The operator must be trained and certified, as forklifts can be dangerous to operate. Centre a load on the forks as close as possible to the mast. Drive slowly.
- Follow safe and correct stacking procedures. Know the height limitations for stacking various materials.
    - Stack bags and bundles in interlocking rows. Stack bagged material by stepping back the rows and cross-keying the bags at least every 10 layers.
    - Do not stack pipes and bars in racks so they protrude into an aisle as this may create a hazard to passers-by.
    - Provide adequate end supports for stacked materials to prevent collapse and spreading.
- For storage, block fuel drums on the bottom tier when they are placed on their sides to prevent shifting and spreading. Elevate the bottom layer on timbers. For safety, only stack drums two tiers high.

Figure 18.10: A dangerous pile of geofabric rolls: provide adequate end support to prevent collapse. © Courtney Mitchell

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 Chapters 6.2 Housekeeping and 6.3 Housekeeping and Hazardous Materials in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

19.0
GENERAL SAFETY PRINCIPLES

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

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

19.2 | Responsibilities (Due Diligence) Regarding Communications

Exploration Companies

- Comply with occupational health and safety (OHS) regulations regarding required communications for employees working in isolated locations, working alone etc.
- Comply with government requirements by obtaining all necessary and appropriate licenses to operate communication equipment. Some countries have regulations regarding importing of communication and electronic equipment.
- Carry out a risk assessment to determine the most appropriate types of communication equipment for a project site. Refer to Chapter 2.1.5 Risk Assessments.
- Supply projects with sufficient, appropriate and functioning communication equipment.
- Make sure there is a fully functioning communications backup system for each project.

Project Supervisors

- Develop communications standard operating procedures (SOPs) for the project and communications procedures for site specific emergency response plans (ERPs).
- Provide adequate training for employees regarding the communication SOPs and communication procedures in the ERPs. Make sure all employees are trained to use each type of communication equipment they may have to use. See Chapter 19.4 below.
- Post operating instructions for all communication equipment in central and visible places and/or at each communication station. Operating instructions should accompany complicated portable equipment and communication equipment in vehicles, boats and aircraft etc.
- Post ERP communication procedures in central and visible places and at each communication station. Emergency communication information should accompany all portable communication equipment and all vehicles, boats, aircraft etc.
- Create and implement employee check-in schedules and a tracking system that complies with OHS regulations for various work situations and conditions at the project (e.g., working alone, stranded by weather). The system should include a communications log.
- Understand the idiosyncrasies of the service plan for the satellite telephone system so that an individual using a handheld phone or the project is not suddenly left without service.

Employees

- Be trained to use all communication equipment at the project. This is essential during an emergency when anyone may be required to use the equipment due to unusual or crisis circumstances.
- When working on or off site, take all communication equipment, contact numbers and frequencies that may be required. Verify that equipment is working and fully charged before departure and after being dropped off (e.g., traverse, work site, drill site etc.).
- Adhere to check-in schedules, especially if you are working alone or change plans. Failing to check in may result in a needless search if you do not make contact at the scheduled time.

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.

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:

- IsolationTerrain
- 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)

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 Chapters 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.
- 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.
- 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.

- 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.
- Rentals can be arranged through numerous communications companies.

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.

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.

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.

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.

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.
- 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).

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 Transport Canada website has additional information regarding EPIRBs for marine use.

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.

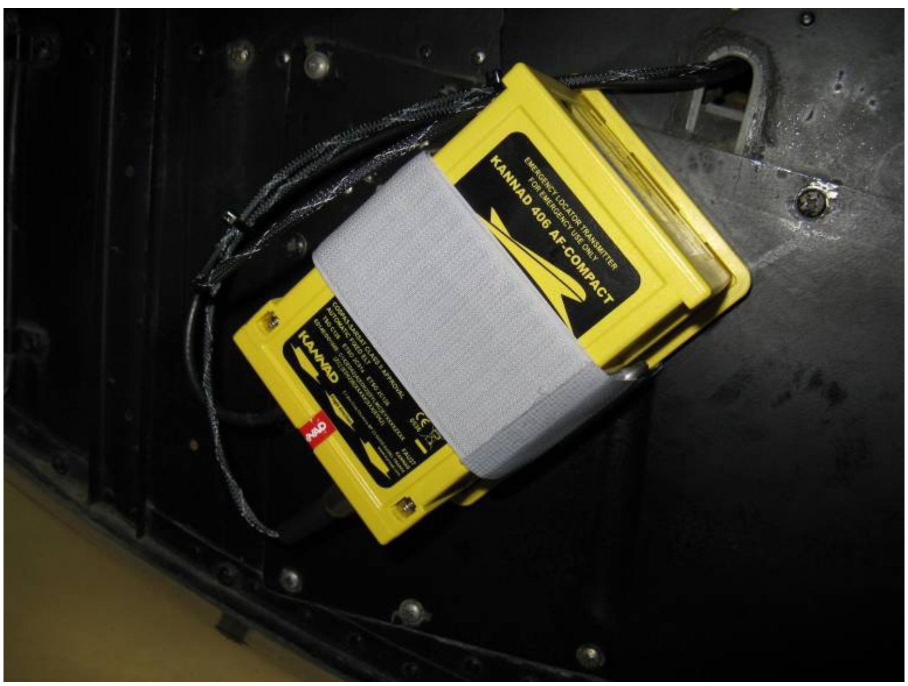


Figure 19.1: Emergency Locator Transmitter © Great Slave Helicopters

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 Chapters 7.7 Batteries and 18.4.6.3 Batteries.

19.4 | Training

Proper training in the use of up-to-date equipment, radio protocols and radio techniques simplifies both regular and emergency communications routines. The project/camp manager is responsible for seeing that employees are trained to use communication equipment correctly.

- Train employees to correctly set up and operate the communication equipment they will use when working both on and off the site.
- When a project uses satphones, it is essential to train everyone how to operate them properly. Different models have different methods to switch them on; they require dialling international access codes to place a call. They are not intuitive to use. During an emergency is not the time to learn to use a satphone – or any other piece of equipment.
- When a project or camp uses a satellite communications system, make sure there is a backup system. Make sure people are trained to operate both systems. Post concise operating instructions for both systems at the stations (including the muster station, which should have backup communication equipment).
- For emergency purposes the pilot should train all employees who use air support regarding the location, removal, and positioning the ELT so it transmits the maximum signal. Refer to Chapter 16.10.2 Regular Pre-Flight Safety Briefings.
- Train and check out employees who use radio equipped vehicles. Store clear, concise operating instructions for radio use, emergency frequencies and emergency procedures in the glove box of all vehicles. Vehicles should be stopped in a safe place when communication equipment is used.
- Employees who do intermittent field work should update their training so they are knowledgeable about current communication equipment. Employees visiting a project could hinder safety during an emergency if they cannot use the equipment properly.

19.5 | Communications Routines, Schedules and Protocols

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.

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 that 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 Chapter 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.

Table 19.1: International Phonetic Alphabet

A	ALPHA	N	NOVEMBER
B	BRAVO	O	OSCAR
C	CHARLIE	P	PAPA
D	DELTA	Q	QUEBEC
E	ECHO	R	ROMEO
F	FOX-TROT	S	SIERRA
G	GOLF	T	TANGO
H	HOTEL	U	UNIFORM
I	INDIA	V	VICTOR
J	JULIET	W	WHISKEY
K	KILO	X	X-RAY
L	LIMA	Y	YANKEE
M	MIKE	Z	ZULU

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 Chapter 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.

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:

1. Your name – that your call is an emergency
2. Your location – both latitude and longitude and UTM units

3. Nature of the emergency
4. Type of assistance required

NOTE: Be ready to relay messages for other parties in need of assistance.

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

19.7 | Communications Tips Regarding Transportation

Vehicles

- Before departure each day, check the radio to make sure it functions correctly. Carry extra fuses if the system requires them.
- Stow whip antennas correctly. Know how to rig an emergency antenna to replace a broken one. Carry a dipole antenna as a spare; it may work when laid out on the ground.
- Verify emergency procedures and operating instructions for the radio (or satphone) are in the glove box.
- When more than one party uses a vehicle, each party must return the vehicle with all radio equipment in good working condition, including antennas. Inform the supervisor of any broken equipment.
- Refer to Chapter 13. Vehicles for additional information.

Aircraft

Communications between employees and the pilot:

- Several methods of communications may be necessary (two-way radios, HF radio, satphone).
- If using a two-way HF radio to communicate with a pilot, make sure that your two-way radio has the correct aircraft radio frequency.
- Refer to Chapter 16. Aircraft for additional information.

Slinging operations

Radio communication between the pilot and the ground person is essential for safe slinging operations. However, employees must also be competent using hand signals for communicating with the pilot, as radios and headsets may be ineffective while the ground person is under the helicopter. The ground crew should be equipped with handheld FM radios that are fitted with headsets or speaker microphones. Only one person may relay information to the pilot.

- Headsets are preferred as they provide the following features:
    - Hearing protection
    - Noise reduction
    - Boom microphone at the mouth position so there is no need to avert your eyes from the task
- Radios should be holstered in such a way to provide:
    - Protection from entanglement
    - Relatively hands-free operation
    - Unencumbered movement of the wearer
    - Protection for the radio from inclement weather, dirt, dust

Boats

- Depending on the area, employees using boats should consider carrying a regular 406 EPIRB unit that floats and will activate when it comes in contact with water.
- Test EPIRBs strictly according to the manufacturer's instructions to prevent triggering a false alarm. For further information, consult the SARSAT website.
- Information about Canadian requirements regarding marine radios, radio licenses, operator's licenses and much more can be found online.

- The following phrases are used routinely in marine alert and emergency communications. They may not be familiar to many employees but are useful to know:
  - When a situation requires urgent action (but is not actual distress) you may interrupt radio transmissions to gain access as soon as possible by announcing "PAN-PAN-PAN" or "BREAK-BREAK". Proceed with your transmission when traffic clears. An urgent message has priority over all other messages except distress.
  - When you are threatened by serious and life-threatening danger requiring immediate assistance use "MAYDAY-MAYDAY-MAYDAY". Never use "MAYDAY" unless the emergency is imminently life-threatening (e.g., a downed aircraft, a sinking boat, cardiac arrest, bear attack).
- Refer to Chapter 17. Boats, Canoes and Inflatables for additional information

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.

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).

20.2 | Responsibilities (Due Diligence) Regarding Drilling Sites

Drill site safety has to be a joint effort between the exploration company and the drilling contractor. Every employee on the drill project site has a role to play regarding safety.

Exploration Companies

- Companies should use drilling contractors with a reputation for good performance, safety and environmental responsibility. Work with the contractor to select the right drill for the job and avoid the risks and hazards of situations where machinery or equipment is stressed beyond its capacity. Use a contractor accreditation process (see 20.10 Selecting a Drill Contractor – Evaluation Criteria).
- Develop site specific safe operating procedures (SOPs) and emergency response plan (ERP) procedures.
- Make sure the project manager has experience in working on drill jobs and is appropriately trained. All exploration company employees should be trained to safely carry out their jobs when working around drills.
- Protect the health and safety of all employees.
- Comply with all legislation and regulations of the authorities having jurisdiction (AHJs).

Exploration Company Project Manager or Supervisor

- Choose the appropriate drill and drilling contractor for the job. The equipment should be the correct size and have sufficient power for the job and be properly maintained. Make sure the contractor knows the hole specifications before the project starts and mobilization begins.
- Carry out a drill site risk assessment. Develop a plan to eliminate or mitigate the identified risks. Work with the drill supervisor. Refer to 2.1.5 Risk Assessments.
- Obtain, or make sure the contractor has obtained, all permits required by the authorities having jurisdiction (AHJs). Make sure the appropriate authorities are informed about details of the project.
- Clearly communicate with the drill contractor and make sure the contractor is familiar with the potential hazards and risks of the drill site. If necessary, the drill contractor should visit the site prior to set up.
- Consult with the drilling contractor prior to site preparation to determine the minimum size, shape and preferred layout of the drill site to accommodate drill equipment, ancillary equipment and required vehicles. Helicopter supported drilling, underground operations or drilling on ice may require special site preparations.

- Hold a site induction safety meeting for all employees before work commences. Provide necessary training (e.g., site specific Workplace Hazardous Materials Information System (WHMIS) training).
- Make sure that all employees and visitors are informed and understand the potential hazards and risks at the drill site.
- Hold weekly surprise health and safety audits and weekly drill inspections, as well as safety meetings with mandatory attendance by drilling company employees. These encourage good communication between the exploration company and contractor.
- The onsite drilling supervisor must be able to communicate clearly or provide a means of communication in the required language(s) with all drill site personnel so instructions, requirements, safe operating procedures etc., are fully understood.
- Make sure appropriate PPE is used.
- Be proactive. Monitor the drilling contractor's work to make sure the highest possible safety standards are followed. Work with the onsite drill supervisor or foreman to rectify unsafe practices. Report to the drilling company management and demand action in cases of infractions of safe practices that cannot be dealt with at the work site.

Exploration Company Employees

- Follow company and site specific health and safety policies and SOPs.
- Be familiar with the ERPs and know your personal responsibilities for each situation.
- Attend safety meetings and participate in emergency training exercises (practice drills).
- Wear PPE and protective clothing as required. Maintain PPE and replace it when it is worn, defective or damaged.
- Be familiar with the hazards at the drill rig and stay away from specific exclusion zones unless you have a job related reason to be there.
- Watch out for the safety of co-workers.
- Report unsafe acts and hazards to the drill supervisor and correct the situation, if possible.

'Drilling Contractor

- Comply with all legislation and regulations of the authorities having jurisdiction (AHJs).
- It is advisable to hire drillers and driller helpers (drilling assistants) who are trained and certified or have an adequate training program in place. Standardized instruction, such as the Common Core Training Program is recommended. The Common Core (Helper and Runner Level) contain modules which specify the knowledge components of diamond drilling operations and the minimum performance standards required for either underground or surface. The surface diamond driller helper training program is composed of course work and on-the-job training. It is a legislated requirement in Ontario and Québec and is currently being adapted by other provinces in Canada.

- The drilling company should supply a qualified drilling supervisor (drill foreman) or a running foreman in the case of a one-drill operation. It is advisable to hire supervisors who are qualified with the Supervisor Common Core Training Program modules, which are required in Ontario and Québec.
- Supply appropriate drill equipment in safe working condition for the job. Maintain and service equipment as required.Remove all temporary installations and markings after drilling has been completed and leave the site clean and free of hazards to people, wildlife or livestock.
- Work with the exploration company to implement safe practices at the site, and take action in cases of violation of good practice.

Drill Supervisor or Drill Foreman

- Supervise drilling employees to make sure that the safety of all employees is protected.
- Instruct and train workers, as necessary. Implement health and safety policies, safe operating procedures (SOPs), and make sure PPE is used correctly.
- Carry out a drill site risk assessment. Inspect the work area; identify and correct health and safety hazards. Work with the exploration company project manager or supervisor to address problems.
- Implement a written fall protection plan that protects employees who must work on the drill mast or at height. Make sure workers use fall arrest equipment as required.
- Be familiar with and implement emergency response plans (ERPs) as required.
- Make sure warning labels are present and legible on all drill equipment. Replace the labels if they are worn or damaged.

Responsibilities that the exploration company should expect from the driller and/or driller helper and "fifth man."[3]

- Follow the company and contractor SOPs; wear and maintain required PPE.
- Operate the drill and all accessory equipment in a responsible manner in order to eliminate injuries.
- Make daily inspections to make sure the drill unit is in good repair and safe. Carry out maintenance of the rig and equipment according to manufacturer's recommendations.
- Know how to operate all emergency shut off switches and all safety and emergency equipment on the drill and accessory equipment.
- Keep the drill site neat, organized and free of debris that could cause trips; keep the drill platform and steps free of grease, mud and ice that could cause slips and falls.
- Take all possible precautions to make sure that the drill is moved safely from one site to another with minimal environmental damage.

[3] The "Fifth Man" is a person often added to a drill crew where extra duties are too time consuming for one drill helper. Normally the person is an employee of the drill contractor.

- Provide adequate supervision of the driller helper.
- Be aware of the dangers of working around helicopters, skidders, excavators, dozers or any type of machinery at the drill site and when the drill is moved to a new site.
- Report unsafe acts, hazards, near misses, accidents, injuries and illnesses immediately to the supervisor. Correct unsafe work conditions, if possible.
- Be trained and have current certificates in first aid, cardio pulmonary resuscitation (CPR) and Workplace Hazardous Materials Information System (WHMIS), plus any other government or company mandated certificates.

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.

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 Chapter 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 Chapter 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 Chapter 5.7 Special Terrains in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

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.
- Urban areas: Drills sometimes operate in urban areas with only one shift during the day due to noise restrictions. Guards or caretakers should be hired to oversee the drill site at night.

Figure 20.1: Drilling on steep slopes requires attention to drill pad stability and fall prevention. © Hy-Tech Drilling Ltd.

20.3.2 | Drilling Near Power Lines

When drilling near power lines, use the same precautions as when operating heavy equipment near power lines. Refer to Chapter 21.3.4 Working Near Power Lines for specific details about (1) safe procedures for both overhead power lines and underground power lines, cables and pipelines, (2) the "minimum clearance distance" or "limits of approach"[4] requirements for overhead power lines, and (3) emergency procedures to follow if unintentional contact is made with overhead or underground power lines, cables or pipelines.

Although jurisdictional regulations may state you should maintain a minimum clearance distance of 3 m (10 ft) from some high voltage power lines, a greater minimum clearance distance of at least 6 m (20 ft) is recommended for all power lines. As specified minimum clearance distances vary by jurisdiction and are subject to change, drill operators should consult the regulations of the AHJs before commencing any drilling near overhead high voltage power lines. To be safe:

Verify the following each time it is necessary to drill near overhead power lines. Power lines expand and then sag with changes in temperature and are swayed by winds.

- 1. Verify the required minimum clearance distance with the AHJ.
- 2. Verify the height of the equipment (mast), worker(s) and tools at full extension.
- 3. Verify the height of the power lines.

[4] "Limits of approach" is a typically Canadian term and "minimum clearance distance" is used in the United States, United Kingdom and Australia. Minimum clearance distance is used in this publication.

It is often very difficult to tell high voltage from low voltage power lines; underground utilities, cables, or pipe lines may be in unexpected locations. Always use extreme caution while drilling near these hazards. The following points are minimum safe precautions to take:

- Carry out a site risk assessment to determine the hazards. Comply with regulations regarding permits, permitted methods of digging, blasting plan submissions, and supervision by the utility company etc. Notify utility companies well in advance because they require time to come to the site to locate and mark underground hazards or de-energize, barricade or move overhead power lines.
- Develop site specific SOPs that address drilling near power lines and train employees appropriately. Have ERPs in place to address potential contact, including potential electrocution and burn injuries. Train employees in the correct response if contact is made.
- Maintain the safe minimum clearance distance from power lines. Where no regulations exist, apply a minimum of 20 metres clearance from all power lines.
- To prevent contact with overhead power lines: (1) move the drill only when the mast is completely lowered, (2) be vigilant about maintaining the appropriate minimum clearance distance when placing and operating the drill, (3) use a spotter to inform the drillers when they are approaching the minimum clearance distance and (4) do not move the drill at night unless there are very unusual circumstances and then only with permission from appropriate exploration company and contractor authorities.
- In rural areas there may be only a single power line that may be difficult to see. Where electric trains operate, pay extra attention to the height at designated crossings, especially private crossings.

20.3.3 | Drilling on Ice

Winter drilling programs on ice are relatively common in some regions[5] . Exploration companies are advised to develop an ice safety plan for drilling operations on ice and hire drilling contractors with experience drilling on ice and that use trained and experienced employees. All work including transportation to and from a drill site must be carried out only when ice thickness has been tested and determined to be safe. For some projects it may be advisable to consult a professional engineer with expertise in ice mechanics to establish the safe load bearing capacity of the ice cover for stationary and dynamic loads over 5000 kg.

Due to the difficulties in gauging an accurate thickness of ice cover, it is advisable to contract specialists to use ice profiling equipment with ground penetrating radar (GPR). The equipment can produce a detailed picture of the local variations in thickness and features (e.g., cracks hidden under snow, incompletely frozen layers, bubbles). However, it is important to remember that even in sub-freezing temperatures ice thicknesses can change rapidly – especially where water currents

[6] This section addresses drilling on frozen surfaces such as lakes, rivers and streams. Drilling on glaciers requires special procedures and is not addressed in this publication.

are present – and monitoring ice conditions needs to be a continuous process during winter drilling programs. When ice profiling equipment is not available, the ice thickness and quality must be measured by hand, which increases the risks.

Information in this section is based primarily on the following documents, which should be referred to for detailed information:

- *Best Practice for Building and Working Safely on Ice Covers in Alberta*;
- *A Field Guide to Ice Construction Safety*.

For additional information about working safely on ice, refer to the following sections in these Guidelines:

- 9.9 Cold Injuries: For recognition and treatment of hypothermia and frostbite
- 15.10 Working on Ice: For ice terminology and features, hazards related to ice, equipment lists, guidelines for initial safe ice crossings, and ice testing procedures on foot and by snowmobile
- 15.11 Cold Water Immersion Hypothermia – Falling Through Ice: For self-rescue and rescue procedures when a co-worker has fallen through ice
- 21.4.3 Winter Access Routes: For ice roads, moving loads on ice, escape procedures when a vehicle breaks through ice

Risks and Hazards

Specific risks and hazards associated with drilling on ice

- Drowning or cold water immersion hypothermia caused by:
  - Breakthrough due to unsafe practices such as:
    - Not calculating the dynamic loading (reactive forces) generated by the drill on the ice cover
    - Inaccurate calculation of the total weight of the drill, equipment and supplies PLUS the maximum pullback capacity of the drill
    - Inaccurate or unreliable thickness measurements
    - Undetected features such as cracks and subsurface thinning
    - Using the wrong load bearing capacity tables/charts, using the wrong scale on a chart
    - Lack of or not following site specific safe operating procedures (SOPs), not enforcing SOPs
  - Lack of emergency response plan (ERP) procedures, lack of ERP training
- Hypothermia, frostbite caused by working in cold temperatures with inadequate clothing, too few warm-up breaks, wind chill

- Falls and slips caused by slippery surfaces, ice-covered steps and platforms
- Stranding caused by whiteouts, blizzards, transportation breakdown
- Pushing the limits: working on ice too early or too late in the season

Ice Safety Plan

As discussed in 15.10.5 Planning and Preparation for Working on Ice, it is strongly advised that companies develop an ice safety plan that incorporates risk assessment, mitigation of hazards, and a site specific ERP with rescue procedures. Guidance is available specifically directed toward developing an ice safety plan and the relevant emergency response procedures in Best Practices for Building and Working on Ice Covers in Alberta.

Training

Employees are subject to additional risks and hazards because working on ice is never entirely safe. Additional training and preparation should cover:

- Safe operating procedures (SOPs) – general and site specific:
    - SOPs for testing ice thickness on foot, using a snowmobile, using other equipment, as appropriate
    - Required personal protective equipment (PPE): In addition to regular PPE, employees should wear a flotation snowmobile suit, or a personal flotation device (PFD) or life jacket as long as there is a risk of ice failure during the initial testing and construction phases. Keep a hypothermia kit available and know how to use the contents.
    - Required safety and survival equipment for vehicles, ATVs, snowmobiles, heavy equipment
- As a minimum, training in ERP rescue procedures should include (1) self-rescue, (2) rescuing a crew member who has fallen through ice, (3) escape when a vehicle breaks through ice, (4) escape and rescue when equipment and the driver break through ice and (5) treatment for cold water immersion hypothermia. Refer to "Training for emergency response procedures" in Chapter 21.4.3.2 Planning and Preparation for Winter Access Routes.
- Never wear a seat belt on ice. Roll down vehicle windows or keep a window punch tool immediately accessible. A functioning escape hatch is required in the cab of all heavy equipment.
- Educate workers about the physical properties and characteristics of ice so they understand why it is essential to adhere to safe load limits and comply with safe speed limits.

Planning for drilling operations

Start planning well in advance of the anticipated date for moving equipment onto ice. Pay careful attention to details when calculating the safe load bearing capacity of ice for drill pads. Because the reactive forces involved in drilling processes generate dynamic loading on the ice cover, drill pads must be much thicker than required for static loads. It is best if one experienced person is designated to be responsible for evaluations of ice thickness either by contracting ice profiling specialists or using appropriate equipment and ice testing methods. Engineering expertise in ice mechanics may also be required.

Dynamic loading: During drilling operations, dynamic loading occurs when additional forces beyond the weight of the drill and support equipment are transferred to the ice surface. Maximum dynamic loading takes place when extracting stuck rods. To extract the rods, a pullback force is applied by alternately pushing and pulling against the drill string until the drill string is freed. This alternating action causes dynamic loading on the ice cover so it flexes rapidly; the ice may even flood during deflection, which adds more weight on the ice cover.

It is essential to factor in the effects of dynamic loading in your calculations; you must also include the additional weight the ice will be subject to by adding in the maximum pullback force the drill is capable of exerting on the ice cover. The pullback force (which is entirely specific to each drill) may effectively double the weight of the drill; it should be noted that when dynamic loading is factored in, required safe ice thickness may be four times that required to support the drill and ancillary equipment alone.

Requirements for drill projects on ice

Follow the requirements of authorities having jurisdiction (AHJs) and best practices and test the ice thickness and load bearing capacity on a regular basis. Regulatory authorities may require the use of specific tables to compute the load bearing capacity.

- Carry out ice assessment procedures and record the results in a log book. Take measurements to determine the ice thickness and quality. Record the test hole locations and any hazards on a diagram. Adjust the test schedule (frequency) and test hole distribution to take into account snow cover, temperature variations and hazards that may develop (cracks, thinning).
- During the drill pad preparation and construction phases, measure the ice thickness frequently and assess ice growth and characteristics (perhaps daily).
- During the drilling phase – if the weather and ice conditions are stable – measurements can be taken less frequently, but it is still necessary to verify and monitor the ice thickness routinely as long as work is carried out on ice.

- Test hole spacing: The required space between test holes depends on the type of water body. Take sufficient measurements to confirm the ice cover is thick enough to safely bear the weight of equipment during drilling activities and the support vehicles for the duration of the drilling project. Refer to Table A1 in Best Practice for Building and Working Safely on Ice Covers in Alberta.
- Ice thickness records: Local authorities (AHJs) normally require companies to document ice thickness and features in a log book for the duration of a program on ice. Record all measurements in terms of the "effective ice thickness" (refer to #5 in Chapter 15.10.5.1 Guidelines for Testing and Assessing Safe Ice Thickness). Specific record keeping requirements may vary by jurisdiction. For examples, refer to Best Practice for Building and Working Safely on Ice Covers in Alberta.
- Record the colour and quality of ice, which indicates its strength (e.g., clear blue ice, white opaque ice). Note and record the thickness and bonding of each layer of ice and the effective thickness.
- Weather changes: Measure the ice thickness at each location immediately after all extreme temperature changes, heavy rains, and if the temperature rises to near or above freezing. Temperature changes may require adjusting work and travel schedules and/or the load limits permitted on the ice. See #4 below.
- Cracks: Note and record the types, size, location and distribution of cracks. Monitor cracks throughout the project. Dry and wet cracks form when ice moves or contracts and they may or may not indicate weaker ice. Follow the guidance of best practices, the recommendations and regulations of AHJs and reduce the load as necessary. Note that references cited do not agree regarding load reductions for specific ice conditions so exercise caution and leave a margin of safety. For definitions and information about cracks, refer to Best Practice for Building and Working Safely on Ice Covers in Alberta.
- Calculating safe ice thickness for drilling on ice: During drilling, additional forces are exerted on the ice. The ice deflects from the weight of the drill (and equipment); ice deflects even more when the drill pulls the rods up, especially when rods are stuck. It is essential to:
  - Base calculations on the thinnest ice measurement in the test area.
  - Use the correct allowable load tables and ice bearing capacity charts. Load bearing tables and charts for stationary loads (e.g., drills) differ from those for moving loads because ice beneath a stationary load will deform continuously (creep) until it fails.
  - Calculate the total weight of: the number of people + drill + maximum rod string + water in the rods if experiencing a "wet pull" + ancillary machinery + supplies that can potentially travel on ice and remain at the drill pad at one time + the pullback capability of the rig.
  - Consider the "dynamic loading" the drill rig will exert on the ice when pulling rods or when the drill is required to overcome stuck rods or added rod friction due cave-ins, faults etc.

The safe load bearing capacity of the ice required for drilling equals the thickness of ice that can support the combined weight of all equipment, supplies and people *plus* the reactive load generated by the drill. Do *not* underestimate the total weight – add a safety factor. The most stringent and conservative standards are recommended in the PDAC Health and Safety Guidelines. It is advisable to always exceed the minimum ice safety standards. Remember that tables and graphs for determining the safe load bearing capacity of ice are only guidelines.

- Install markings and signage:
    - Designate the boundaries of safe ice along the access route and around the drill pad with cones, trees or other means. Surround the perimeter of the drill pad with orange snow fencing to prevent unauthorized visitors and place a sign indicating "DANGER – Heavy Equipment Operating" at the entrance. Maintain markings from the preparation stage through the completion of project work.
    - Determine the safe vehicle speed limits to prevent ice rupture. Post signs with the permitted speed limit and maximum allowable weight for vehicles and equipment. If parking is permitted, signs should indicate the location and length of time vehicles and equipment may remain in the designated area. Update information on road signs to indicate changes in speed limit and permissible vehicle weight as temperature and ice conditions change.
    - Mark the locations of test holes with cones or fluorescent pickets, especially if they may be a tripping hazard.
- Monitor and verify the ice thickness throughout the drill program. Repairs may be required to maintain the load bearing capacity. Monitor the ice for deflection by measuring the "freeboard" and by other methods as determined through consultation with experts.
    - Take ice samples frequently enough to confirm that the ice remains thick enough to safely support the maximum load. Design the test hole distribution pattern to detect potential hazards such as thinning of the lower ice surface.
    - Freeboard: Monitor ice deflection by drilling a hole to measure the freeboard – a term for the distance between the upper ice surface and the water level in the hole. Ice floats on water and the freeboard measurement should equal 10% or more of the thickness of the ice cover. If freeboard is less than 10%, it indicates that ice is deflecting due to the load and the freeboard should be monitored while the load remains on the ice. Remove loads before freeboard reaches zero and water flood onto the ice.
    - Monitor the daily temperature fluctuations and ice conditions. Increase testing as necessary.
        - An extreme drop in temperature can cause ice to become brittle so the strength is severely compromised. The ice may not be safe to use for at least 24 hours.
        - A sudden rise in temperature can cause ice to thin unexpectedly and dramatically – even when the temperature does not go above freezing. Changes in water temperature and underwater currents may erode the lower surface without any indication on the upper surface. Only GPR ice profiling equipment or other method of testing at close intervals will reveal this.
        - If the temperature rises above freezing for 6 of the past 24 hours, the load bearing capacity of ice is diminished. If the temperature stays above freezing for 24 hours or more the ice will rapidly lose strength and the safe load bearing capacity tables will no longer apply. The ice will no longer be safe.
        - Where cracks are present, do not load the ice to its limit under very cold conditions or when there has been a rapid drop or rise in temperature.
        - Test repaired cracks by drilling into them to determine the depth of healing and whether they pose a safety hazard.

Additional safety tips:

- Ice thickness can be built up by pumping water to flood the access road and drill pad. These "lifts" should be thin enough to freeze rapidly (within 12 to 24 hours).
- Carry out all work and travel within the defined limits of the safe ice.
- When drill equipment travels on ice:
    - Make sure both tractors and sloops have loops welded on the front and rear for inserting a long log. The log will stop the machine from sinking immediately if it breaks through. Use the logs when accessing and departing from the drill site, as required.
    - Never wear a seat belt. Verify that heavy equipment has a functioning escape hatch from the cab. Consider lashing it open or removing doors and hatches, which may be required in some jurisdictions. Otherwise keep the windows open and/or have a window punch tool immediately accessible.
- At the drill pad:
    - Do not place the drill near fractures and/or the outer limits of the ice confirmed to be safe. Do not place the drill near other heavy equipment unless the weight has been taken into account (#2 above).
    - Stationary loads must be adequately spaced to prevent sustained ice deformation and eventual failure. This includes storage areas for drill rods, fuel drums and designated vehicle parking areas. Park vehicles and equipment off the ice if possible. When parked on ice, space them at least two vehicle or equipment lengths apart for no longer than two hours unless the drill pad is designed to support them as stationary loads.
    - Do not place a water heater directly on the ice.
    - Never bank up snow or ice around a drill shack. Always leave it open underneath so cold air circulates and dissipates the heat.
    - The drill pad should have a lifebuoy attached to a 15 m long floating line.
    - Collect all sludge or cuttings and properly dispose of them according to requirements of the AHJs.

- Make sure return drill fluids are pumped away from the set up or into containment. Make sure the casing is well seated in bedrock to prevent up-welling of warmer return fluids up along the casing and under the drill site (if total return is not seen at the collar). Collect fluids as required by AHJs.
- For additional information refer to Chapter 16.1 Drilling from Lake Ice on the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

Figure 20.2: Building a thicker drill pad by flooding the ice to create lifts that freeze in 12-24 hours. © Chris Pedersen

20.4 | General Safety Guidelines for Drill Sites

Good planning, organization and standards of conduct help drill projects run smoothly.

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)

Figure 20.3: Survival shack adjacent to a drill. © Hy-Tech Drilling Ltd.

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 Chapter 3. Emergency Response and 19. Communications for information regarding communication equipment, general communication procedures, emergency procedures and contact lists.

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 Chapter 2.1.2 Safety Meetings for additional information including suggested agenda topics.

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).

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 Chapter 1.2.5 Documentation for relevant information.

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.

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.

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.

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 Chapter 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 Chapter 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 Chapter 4. Personal Safety for additional information regarding PPE.

20.5.2 | Working at Height – Fall Protection

Unrestrained falls due to improper fall protection have been the cause of fatalities and serious injuries. Comply with the regulations of the AHJs regarding the use of fall protection. When drilling employees climb the drill mast they are required to wear and use fall protection equipment. If working in an area where there are no regulations, the exploration company should implement stringent fall protection standards and enforce them.

A fall protection system may be required (1) for work that could result in a fall of over a certain specified height (1.5 m is usually specified) or (2) to prevent a fall from a lower height that could result in injury greater than the risk of injury from the impact on a flat surface (i.e., working over dangerous equipment or objects). A fall protection system includes both a travel restraint system[6] and a fall arrest system. Travel restraint and fall arrest equipment must meet CSA standards and approved engineering standards.

- A travel restraint system prevents an employee from approaching an unguarded edge. A work-positioning system includes the use of a body belt or full-body harness attached to a lifeline and anchor, which is set to a length that prevents a worker from approaching a hazard. A travel restriction system prevents a worker from falling from a hazardous edge (e.g., guardrails, guards or protective barriers). Guardrails must be built to meet regulations of the AHJs. They must be high enough to prevent a fall and strong enough to bear the employee's weight during a fall. Guardrails are required to have mid-rails and toe boards.
- A fall arrest system protects after a fall so you stop before hitting the surface below. A fall arrest system requires a full-body harness and shock-absorbing lanyard or lifeline and a secure anchorage. The lanyard must be a length at full extension that will prevent impact on the surface below.
- A written fall protection plan may be required for employee safety. Components include but are not limited to:
    - Risk assessment and identification of fall hazards at the site
    - Training: Before employees are permitted to work at heights, they require training regarding (1) when fall protection is required, (2) the fall protection systems used at the site, (3) instruction and training regarding both the use of correct fall arrest equipment and (4) the rescue of a fallen worker who cannot initiate self-rescue.
    - Appropriate training also includes inspections, maintenance, cleaning, storage, and the removal from service requirements of fall protection equipment.
- Inspect all fall protection equipment each time before use – including new equipment. Check for damage, discolouration, wear, insecure fastenings, ripped stitching etc. When receiving new equipment, check out every detail to make sure it is correctly assembled. Just because it is new does not mean it is perfect quality. Check that all stitching is present, all clips and clamps are securely mounted etc. Lanyards and harnesses have expiry dates, usually five years after the date of manufacture.
- Do not reuse fall protection equipment that has arrested a fall. The equipment may have been stressed so it no longer functions properly.
- Additional information regarding fall protection is available from the Canadian Centre for Occupational Health and Safety.

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.

[6] Also referred to as a fall restraint system

- 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.

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 Chapter 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.

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.

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.

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 Chapter 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 Chapter 9.2 Lightning.
- Do not operate truck mounted drills during high winds or any drill when there is insufficient light.

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.

20.6.3.1 | 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 Chapter 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.

Rotary air blast drills (RAB)

RAB is a dry drilling method. Compressed air circulates down the drill hole to remove cuttings that are blown up outside the drill rods and collected on the surface.

- 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.

Auger drills

Augers are used for drilling through soils and unconsolidated sediments to take geochemical and alluvial mineral samples. Handheld augers are also used for soil sampling and test holes to measure ice thickness.

- Many of the principles of working with drill rods apply to working with augers. Auger flights are very sharp and cuts are common. If loose clothing is caught, the operator can be drawn into the rotating flight resulting in serious injury or death. Augers that drill through buried geotextile etc., can pull the operator off his/her feet and into the flight unless the drill is operated from a platform.

- For large augers, use tool hoists to handle auger sections whenever possible.
- Use a long-handled shovel to move auger cuttings away from the auger. Never use your hands or feet.
- Refer to Chapters 5.4 Augers and 15.10.4 Ice Testing Equipment for information about working with handheld augers.

20.6.3.2 | 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.

20.6.3.3 | 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.

20.6.3.4 | 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.

20.6.3.5 | 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.

20.6.3.6 | 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).

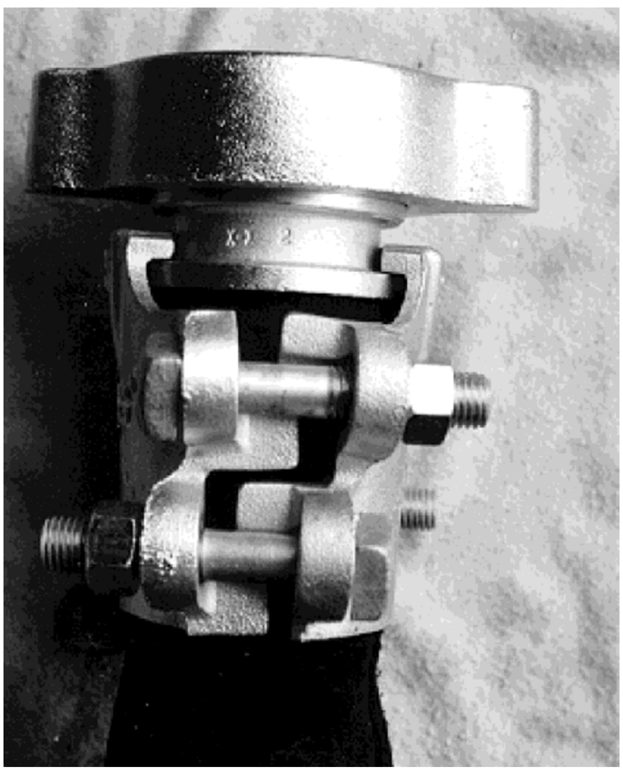


Figure 20.4: Hose clamps are locked correctly into the stem groove.

- 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.

Figure 20.5: Standard whip check (left) and cable stocking whip check (right) © Bill Mitchell

20.6.3.7 | 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.

20.6.3.8 | 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 Chapter 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 Chapters 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.

20.6.3.9 | 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.

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.

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 Chapter 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 Chapter 4.2.4 Hearing Protection.

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 Chapter 20.5.1 above and Chapter 4.2.7 Lung Protection.
- Stand upwind whenever drilling additives (powders) are used.
- For additional information, see Chapters 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 Chapter 10.9 Dust on the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

20.7.3 | Radioactive Mineral Sampling and Storage

Extensive safety information is located in Chapter 15. Guidelines for Radiation Protection during Exploration for Uranium in the DRE Environmental Stewardship Toolkit.

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 Chapter 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)

20.7.4.1 | 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.

20.7.4.2 | Asbestos and Amphiboles

Asbestiform minerals: Work with asbestiform minerals can release very small sharp mineral fibres that become embedded in the lungs. The fibres are carcinogenic. With sufficient exposure (long term or heavy short term), employees may eventually develop asbestosis, mesothelioma and other forms of lung cancer. Exploration companies must be aware of and comply with jurisdictional OHS regulations regarding exposure limits to asbestiform minerals (which includes all amphiboles minerals in some jurisdictions). Regulations may stipulate core shack set up, ventilation specifications, required PPE including respirators and separate work clothing that must be washed and kept only for core logging purposes.

To protect employee health, it is advisable to set up sample handling facilities with the following features:

- Equip facilities with high quality ventilation systems.
- Use wet core saws rather than dry splitters.
- Provide asbestos rated dust respirators, as required.
- Provide clothing such as overalls that are kept and laundered at the facility, as required.
- Provide a floor surface that is easily cleaned. Maintain clean facilities and use wet mopping techniques and/or a compound that keeps dust down.

20.7.4.3 | 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 Chapter 10.5 in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

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.

20.7.4.4 | Other Hazardous Materials

Most of the following materials are commonly found in drill camps. Most materials are cross referenced to the Driving Responsible Exploration (DRE) 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 Chapter 10.7 Acids and Bases in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.
- Antifreeze: Refer to Chapter 10.8 Antifreeze in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.
- Bear bangers.
- 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.
- 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 Chapter 12.8.3.3 Water Treatment in Remote Areas or Developing Countries.
- Fuels and petroleum products: Refer to Chapter 10.1 Fuels and Petroleum Products in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.
- 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 Chapter 20.9.6 Toxic Substances used for Mineral Identification.
- Propane, propylene, butane, butylene: Refer to Chapter 10.2 Propane and Other Liquefied Petroleum Gases in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.
- Solvents and paints: Refer to Chapter 10.4. Solvents and Paints in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

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 Chapter 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 Chapter 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 Chapter 16. Aircraft.

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.

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

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 Chapter 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).

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.

Figure 20.6: Unexpected visitor in a tool box. © Kim Bilquist

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 Chapter 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.

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 Chapter 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 Chapters 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 Chapter 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 Chapter 15. Guidelines for Radiation Protection during Exploration for Uranium in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

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 MSDS directions for safe handling.

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.

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.

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.

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 components should be consulted prior to handling.

20.10 | Selecting a Drill Contractor – Evaluation Criteria

When selecting a drill contractor, look for contractors whose management demonstrates leadership accountability for health and safety. Look for reputable contractors that have well trained workers who know the safety expectations, have a positive attitude and behaviour (e.g., Safety Culture – Zero Harm). Note whether or not the contractor has the appropriate equipment for the job and the condition of the equipment, which may disclose a lot about the contractor's ability to do the job and attention to maintenance. Contact other companies that may have used the drill contractor in the past and check references.

Documented proof of the following should be considered as essential requirements when evaluating proposals from a drill contractor:

- Contractor is registered with the jurisdictional Workers' Compensation Board authority or regulatory equivalent
- Contractor has a Health & Safety Statement, Health & Safety Policy and Program
- Contractor has a structured program of Health and Safety training and education
- Contractor does regular inspections and audits of the workplace (e.g., safety and environmental)
- Contractor records, tracks and communicates his safety performance
- Contractor has a 24-hour Crisis Management Program
- Contractor can provide proof of adequate vehicle and third party liability insurance

When evaluating a contractor, look for these additional criteria:

- Qualified and experienced personnel
- Training provided by the contractor
- Safety plans, procedures, protocols, guidelines (SOPs)
- PPE requirements
- Emergency procedures
- Occupational Hygiene Program
- Safe, Fit for Work Program
- Risk Management Program
- Fire protection
- Isolation (Lockout and Tag Out) Program and procedures
- Incident Management Program
- Injury Management Program

20.10.1 | Suggested Drilling Contract Requirements

In addition to stipulating the general work provisions for drilling, the contract should include a requirement for the contractor to provide a site specific safety plan that includes details of the health and safety requirements for carrying out the work. There should be a requirement for the drill contractor to provide workers with appropriate experience and training. Employees with surface "Common Core" training, a required training program in Ontario and Québec, will fulfil many of the requirements. Ideally, the training requirements should include but not be limited to:

- First aid, CPR
- WHMIS
- Fall arrest
- Propane handling
- "Common Core" (Ontario and Québec surface driller and driller helper qualifications)
- Chainsaw operation
- ATV training
- Contractor policies and procedures, such as:
    - Company induction
    - Contractor's Emergency Response Plan
    - Contractor's policies regarding Environment, Health, Safety, Sustainable Development, and Community Relations

List the required PPE in the drilling contract schedule.
The following should be included:

- Steel toed safety boots with good tread on sole
- Hard hat
- Hearing protection
- Safety gloves (insulated in winter)
- Safety glasses with side shields/prescription safety glasses/safety sun glasses, a required
- Proper clothing and gear (snug, long sleeve, approved reflective markings)
- Approved helmets for ATV and snowmobile use
- Approved chainsaw gear (hard hat, face shield, chaps, gloves, safety boots)

List the minimum safety requirements for the drill.
Verify that the contractor uses rod handling procedures/systems that eliminate the need for crews to lift heavy weights, jump off elevated platforms or run with drill rods. Use engineered and inspected towers only; confirm this through inspection before drill operations commence.

The following should be required:

- Mechanical rod handler
- Guards on all rotating parts
- Kill switch (emergency shut off switch)
- Automatic wire line spooler (level winder)
- Safety pictograms (warning signs, decals)
- Proper secure stairs on all exits
- Fire extinguishers (20 lb)
- Fall arrest, guards, rails
- Lockout system for maintenance

Minimum safety equipment that should be present at the drill:

- Fire extinguishers – 20 lb on drill, at pumps, generators, fuel storage. 10 lb may be acceptable on each vehicle and truck. The 20 lb size may exceed the requirements of the AHJs but it provides better protection.
- Emergency contact telephone numbers (ERP)
- Communication system – appropriate for location, terrain, in good working condition
- First aid kit – approved for job, contains sufficient and appropriate supplies for drilling incidents
- Back board (spine board)
- Stretcher basket
- Blankets
- Splints
- Neck brace
- Spill kit
- MSDS sheets (WHMIS)
- Eye wash station (appropriate size)
- Appropriate signage – "equipment working" warning signs

21.0 ADVANCED EXPLORATION SITES, TRENCHES AND ACCESS ROUTES

Introduction

As exploration progresses to more advanced stages, the activity level at a project site and its footprint usually increases significantly. Work on advanced projects typically includes building access routes, trenching, bulk sampling, constructing drill pads and exploratory drilling – which frequently require blasting and the use of heavy equipment and may involve considerable ground disturbance. This work is usually done by contractors. Before hiring a contractor, an exploration company should carefully evaluate the contractor's safety program, incident statistics and compliance history. Generally, an exploration company geologist should be on site to monitor the contractor's work, the contractor should provide a supervisor who is responsible for compliance with the authorities having jurisdiction (AHJs), such as occupational health and safety (OHS) and Mines Acts and Regulations and environmental regulations.

Before work commences, the exploration company should inform the contractor of site hazards and environmental issues, which may require a site visit. Good communication between the company project manager and the contractor is essential in order to develop teamwork and implement site specific safe operating procedures (SOPs) and emergency response plans (ERPs). It can be challenging to get contractors and their employees to follow the exploration company SOPs, wear personal protective equipment (PPE) and attend scheduled safety meetings. Some companies advocate scheduling a regular evening safety meeting in a relaxed setting with an agenda aimed at generating discussions about various safety issues. By making these meetings as inclusive as possible and promoting active participation by all attendees, all site employees (drillers, driller helpers and camp support workers) will find it productive to attend. Also, it is a good idea for supervisors to have a safety meeting each morning to discuss the day's work and develop any necessary additional job safety analyses (JSAs). Refer to Chapters 2.1.2 Safety Meetings and 2.1.4 Job Safety Analyses.

Exploration companies often use their own employees when constructing access routes only requires clearing vegetation and minimal tree felling. At sites where workers are employed directly by the exploration company, the site geologist (site supervisor or project manager) is usually ultimately responsible for environmental, health and safety considerations. For information, refer to Chapters 5.6 Chainsaws and 11.4 Line Cutting Safety, and review the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit. The company site supervisor or geologist (and the contractor's supervisor if there is one) must be aware of all permits issued for the project and make sure the project is in compliance with them.

Note: This section of the PDAC Health and Safety Guidelines is not intended to replace heavy equipment manufacturers' operator manuals and the proper training of operators. It is intended as guidance for exploration site supervisors and geologists to help assess the safe operation of heavy equipment by trained personnel and reduce the likelihood of accidents for all workers at advanced exploration sites.

21.1 | General Risks and Hazards

Severe injury or death may result from accidents when operating heavy equipment such as back hoes, excavators and dozers. Some of the risks and hazards include but are not limited to:

- Injury or death caused by improper operation of equipment due to lack of operator training and/or certification, lack of adequate supervision
- Injury or death caused by moving heavy equipment or moving parts of equipment, careless operation of equipment
- Slips, trips and falls caused by working on uneven, slippery or disturbed ground, on ice, falls into excavations
- Potential suffocation or crushing burial of workers caused by the collapse of excavations, falling debris during excavations or clearing activities
- Asphyxiation caused by toxic gas accumulations from the exhaust of gasoline and diesel motors (CO, SO2, H2S)
- Breathing difficulties and potential development of respiratory diseases caused by inhaling dust
- Collisions caused by poor visibility from the presence of dust, snow or whiteout conditions, heavy rains
- Hypothermia or hyperthermia caused by working in temperature extremes

21.2 | Responsibilities (Due Diligence) and Advanced Exploration Sites

Exploration companies and their employees may have additional due diligence obligations at advanced exploration sites. For general information, refer to Chapter 1.2 Due Diligence with Respect to Safety. Consider the appropriate allocation of responsibilities as guidelines.

Exploration Companies

- Protect the health and safety of employees at every work location.
- Comply with occupational health and safety (OHS) and Mines Acts and Regulations of the jurisdiction. This means that hired contractors should be held accountable for compliance with permits and regulations of the authorities having jurisdiction (AHJs).
- Develop standard operating procedures (SOPs) that address operations around heavy machinery, trenching and excavations, use of explosives, general employee safety at advanced sites and specific issues such as working alone. Include environmental precautions relevant to the site.
- Develop emergency response plans (ERPs) that address potential general and site specific emergency requirements.
- Hire competent contractors and qualified employees to carry out work. Provide the contractor with specific details of the required work so the appropriate equipment and trained and certified operators can be hired. Inform the contractor of the known health and safety risks and hazards at the site. Make sure they can provide the appropriate equipment and fulfil maintenance requirements.
- Make sure the contractor has an appropriate health and safety program or tie the contractor to the company's health and safety plan. Check that the contractor is in good standing with the jurisdictional Workers' Compensation Board.
- Make sure that the contractor has the site specific programs in place that require any daily permits as required by AHJs (e.g., confined space entry, lockout).
- Training: Verify with the contractor that employees have appropriate training by qualified personnel (trainers) to use the site equipment and that they know how to mitigate site risks and hazards. Specific training is necessary when working on ice.
- Hire supervisors who are competent and trained; check that they provide appropriate supervision of company employees on site. Exploration company supervisors should not be in the position of supervising the contractor's employees.
- Provide sufficient and appropriate equipment, including PPE as required, to enable employees to work safely.
- Establish clear roles and responsibilities for any required reporting to AHJs including accident and spill reporting.
- Carry adequate insurance (e.g., comprehensive liability, vehicle, jurisdictional Workers' Compensation Board coverage).
- Confirm that the contractor has adequate insurance coverage for both injuries and environmental damage. Establish exactly who is responsible for reporting accidents to the jurisdictional Workers' Compensation Board authority that require specific forms.
- Maintain regulatory requirements and remain in good standing with the jurisdictional Workers' Compensation Board authority in Canada or wherever work is carried out.

- See that required inspections and maintenance schedules for equipment are carried out.
- Keep appropriate records: Records should include those required by AHJs. Keep any additional records that demonstrate due diligence such as the site safety plan, contractor safety plan, safety committee and safety meetings/minutes, equipment maintenance, accidents, incidents and near misses, employee certifications and training, and inspections. Inspections of work areas should include excavations such as trenches and pits, access routes and bridges. If using ice roads for access, keep records of ice thickness and other testing procedures.

Project Supervisors

- Carry out risk assessments and job safety analyses (JSAs) at the site. Develop plans to mitigate the risks based on the outcomes of the risk assessments and JSAs.
- Develop written site specific SOPs and ERPs as required that address the risks and hazards identified in the risk assessment and JSAs. The ERPs should take into account the number of people on site and the types of emergencies that may occur. Carry out practice drills.
- Make sure employees understand and follow company and site specific SOPs and use PPE.
- Make sure employees are adequately trained for the job.
- Check that contractors carry out their jobs safely. Hold safety meetings that include all site workers including contractor employees.
- Carry out appropriate inspections and verify compliance with SOPs and safety regulations.

Employees

- Be aware of the risks and hazards associated with the site and the job.
- Follow training provided by the supervisor, follow the company SOPs and wear PPE.
- Attend and participate in safety meetings and practice drills.
- Work responsibly. Carry out daily safety checks, report unsafe conditions to supervisors and look out for the safety of co-workers.

Contractors

- Carry out work in compliance with permits issued by the AHJs.
- Provide evidence that they will supply trained and qualified employees for the required work. This includes certificates of competency, certificates or licenses to operate equipment, first aid certificates, blasting certificates etc.
- Provide proof of liability insurance coverage for injuries and environmental issues etc.
- Follow the established procedure for reporting accidents and incidents to the Company and the jurisdictional Workers' Compensation Board or equivalent using the appropriate forms.

- Keep jurisdictional Workers' Compensation Board payments up-to-date and be in good standing with the Board or equivalent.
- Have site specific procedures in place for work that requires daily permits required by AHJs (e.g., confined space entry, lockout).
- Inform their employees about the risks and hazards at the site.
- Provide qualified supervisors for employees. It is preferable for a contractor to provide their own qualified health and safety personnel (with specific experience related to heavy equipment use) in addition to the exploration company qualified health and safety person(s).
- Make sure their employees follow the exploration company's SOPs.
- Make sure their employees wear appropriate and required PPE.
- Direct their employees to attend the site induction meeting, regular safety meetings and participate in practice drills.
- Inform the exploration company staff of any site specific safety requirements regarding the equipment used on site. Only permit certified and trained employees or those under supervised training to operate heavy equipment.

21.3 | Heavy Equipment

Advanced exploration work often requires the use of heavy mechanical equipment to excavate trenches, collect bulk samples, build access tracks, or construct winter and ice roads. Heavy equipment may include large drills, excavators, loaders, graders, backhoes, bulldozers, or haul trucks etc. Each type (and model) of equipment has inherent risks and hazards associated with its operation so it is very important for operators to be certified and trained to perform their jobs safely.

> All employees who work around heavy equipment must remain vigilant at all times. Operators often have a restricted field of view and cannot see in all directions.

21.3.1 | Specific Risks and Hazards

Risks and hazards associated with the use of heavy equipment include:

- Death or injury of workers and/or loss of equipment caused by the unsafe operation of equipment
- Death or injury of workers on foot or in small vehicles caused by the impact of equipment (run over or crushed), or when hit by falling vegetation or debris pushed by machines
- Impact or entanglement injuries caused by contact with unguarded moving parts of machinery
- Injury or equipment damage from rollover caused by unstable loads; working on unstable or steep terrain such as cliffs or swamps

- Injury or equipment damage caused by working in conditions of reduced visibility such as heavy rains, snow or near blizzard conditions or dust
- Drowning or cold water immersion hypothermia caused by equipment breaking through ice
- Hyperthermia and/or dehydration caused by working in high temperatures and/or humid conditions without adequate cooling breaks
- Hypothermia or frostbite caused by working in cold temperatures without adequate clothing, insufficient warm-up breaks
- Stranding caused by equipment breakdowns, communication breakdown
- Electrocution and/or serious burns or explosion caused by an arc flash or contact with overhead power lines, or ruptured or damaged underground cables or pipelines
- Equipment damage caused by improper operations, operating in extreme temperature conditions

21.3.2 | Training

Company and contractor employees should receive training to emphasize the dangers of working around heavy equipment and why it is critically important to follow all company safety policies and procedures. Unsafe practices by equipment operators or workers on foot or in smaller vehicles can result in accidents with a high likelihood of severe injury or fatality. Training should be reinforced and augmented with discussions of work procedures around heavy equipment at safety meetings, which should include all employees (i.e., the exploration company employees, contractor's employees, equipment operators, drillers).

Training should include:

- General and site specific SOPs and ERPs regarding working around heavy equipment
- The use and maintenance of appropriate PPE
- Specific communication procedures and signals to use between heavy equipment operators and other workers. Use radio contact as appropriate. Use standardized and universally accepted hand signals that have been discussed and verified between all parties.
- Lockout procedures for hydraulic and electrical systems during equipment maintenance and repairs. Refer to Chapter 18.4.6.2 Lockout Tag Out.
- Special training as appropriate (e.g., working near power lines, working on ice)
- Heavy equipment operators may be semi-skilled in countries where certification is lacking. Plan to train operators in safety procedures they are not familiar with.

21.3.3 | Prevention and Preparation

- Operate heavy equipment according to the manufacturer's specifications. Operators should be familiar with the manufacturer's operator manual. Do not overload or over stress heavy equipment.
- Contractors' employees should attend the pre-program induction safety meeting, regular site safety meetings and daily safety briefings.
- Establish an "exclusion zone" where workers on foot may not enter. Install traffic signage or barricade work areas to designate established routes for heavy equipment. This may prevent collisions, control speed and keep small vehicles, pedestrian workers and the public out of dangerous areas.
- Place barriers to keep workers away from areas where material is ejected (e.g., drill cyclones, high pressure air hoses for RC drills, pressurized water hose releases).
- Use machinery appropriate for the job; use an excavator rather than a bulldozer for trenching.
- Use extra caution when using heavy equipment during high winds, storms, snow etc. Do not work when weather conditions are very unfavourable, especially during lightning storms and whiteout conditions. Refer to Chapters 9.2 Lightning and 9.3 Whiteouts.
- Only expert equipment operators should operate heavy equipment near cliffs, at high altitude, on steep slopes, or when conditions are dangerous. Assess the risks carefully and mitigate the hazards to an acceptable level; avoid operating equipment in dangerous circumstances unless it is an emergency.
- Use extreme caution and do not exceed the permissible load limits when crossing streams and river beds or using ice roads and ice bridges.
- Employees should not use the contractor's equipment without explicit permission and training and certification, as required.
- Use caution when excavating or working near possible buried utilities or pipelines and power lines. See Chapter 21.3.4 Working Near Power Lines.

Personal protective equipment (PPE)

- Site workers should wear high visibility clothing, safety glasses, hard hats, steel toed boots, hearing protection, respiratory protection, as required. Equipment operators should wear appropriate PPE. Although in certain circumstances wearing some PPE may not be required (e.g., wearing a hard hat while riding in a pickup cab) PPE must be worn when employees leave the protection of the cab.
- Do not wear loose fitting clothing, jewelry, drawstrings on hoods or jackets that might become entangled in rotating parts of machines. Carefully confine long hair.

Safety tips for heavy equipment operators

Every operator is responsible for operating heavy equipment in a safe and reliable manner. Be vigilant and watch out for workers on foot and those driving light trucks, ATVs and snowmobiles.

- Only properly trained and certified personnel may operate heavy equipment. Operators must be authorized by the contractor and/or project manager to run the equipment.
- Carry out a circle check at the beginning of each shift and again before starting the machine when it has been left unattended to make sure there are no unknown hazards.
- Communications: Use standardized and universally accepted hand signals that have been discussed and verified between all parties involved for communication between operators and workers on the ground. Alternatively, use radio contact. When underway, operators should slow down or stop in a safe location before using radio communication for a sustained conversation. It is easy to be distracted when using radios or cell phones. It is essential to stop when using a satellite phone.
- To prevent falls, maintain a three point contact when climbing into and out of heavy equipment.
- Do not allow workers to ride on heavy equipment or accompany the operator unless there is a work related reason and the equipment is designed to carry passengers safely.

Safety tips for employees working near heavy equipment

The safety of workers on foot is the responsibility of both workers and heavy equipment operators. Stay a safe distance from heavy equipment as some operators may wear hearing protection and/or have a restricted line of sight so they may not hear or see workers on foot.

- Always be fully observant of mechanical equipment operations. In addition to observing the "exclusion zone":
  - Stay out of the swing radius of the arm and bucket of an excavator or backhoe etc.
  - Stay out from under suspended loads.
  - Know the equipment travel patterns and avoid these areas.
  - Do not stand downhill from heavy equipment in case it rolls or knock debris downhill.
- Never approach heavy equipment unless you are absolutely certain that the operator knows where you are, what you intend to do and/or where you intend to go. Approach from the front in full view of the operator. Never approach heavy equipment from where the operator cannot see you (the blind side or blind spot). Never assume the operator knows your intentions; you must make them clear either by hand signals or two-way radio. If you cannot see the operator, the operator may not be able to see you.
- In addition to site safety guidelines, follow SOPs regarding the use of light trucks, ATVs and snowmobiles. Refer to Chapters 13. Vehicles, 14. All-Terrain Vehicles and 15. Snowmobiles.

Figure 21.1: Do not stand or work downhill from heavy equipment in case it rolls or knock debris downhill © Matt Turner

Safety devices for heavy equipment

Employees should not tamper with safety devices and equipment on any mobile equipment or vehicles. Safety equipment should meet the requirements of AHJs.

- All mobile equipment should be required to have a back-up alarm, a flashing roof light and operate with the headlights turned on at all times.
- All trucks, ATVs, utility vehicles, snowmobiles etc., that work around heavy equipment should be equipped with a flashing roof light and/or a buggy whip with a flag and light at the tip.
- Brakes: Keep the brakes in good operating condition. There should be a secondary emergency stopping system.

- Mount an easily accessible fire extinguisher near the cab to help the operator escape from a fire. A 9 kg (20 lb) ABC extinguisher is recommended.
- AHJs generally require heavy equipment to have an adequate rollover protective structure (ROPS) such as an overhead protection cab or screen on power-driven cranes, shovels, forklifts, frontend loaders and excavators. Also, an enclosed cab must have a functioning escape hatch when working on ice. Many jurisdictions require that ROPS are labelled and certified to meet standards such as those of the Society of Automotive Engineers (SAE) and the Canadian Standards Association (CSA). References for applicable standards include the publication SAE J1040 and the CSA Standard B352.0-95.
- Place a rear view mirror on machines in a position so the operator can see behind the equipment when that view is limited.
- The windshield should be made of safety glass. Keep it clean to provide unobstructed vision for the operator.
- Protect workers with guards or cages around exposed rotating or moving parts and belts (e.g., crushers, conveyer belts, rotating drill rods, drum hoists on drills). Follow guarding requirements of the AHJs. Make sure they are replaced when maintenance is completed.
- Provide heavy equipment with tow chains, towing poles, cables and/or ropes for emergencies.

Figure 21.2: Guards and cages protect employees from moving parts of this rock crusher. © Ron Breadmore

Inspections

It is advisable to develop and use checklists for heavy equipment inspections.

- Inspect all heavy equipment at the start of each shift. Do not operate the machine if it is unsafe and needs repairs.
- Check that all safety devices are in place and operational (e.g., windshield wipers, batteries, defrosters, guards).
- Check that there are no fuel or hydraulic fluid leaks.
- All brakes, gears and controls must operate correctly.
- Tires should be in good condition and properly inflated.
- All lights should work.
- Check that required equipment is present (e.g., first aid kit, survival equipment, fire extinguisher, emergency tools).
- Tag out any equipment with safety defects and report it immediately so it can be repaired.

Maintenance

Keep machinery in good mechanical condition. Note that equipment is more likely to break down in very cold and/or very hot weather.

- Follow the manufacturer's maintenance schedule and procedures and keep appropriate records. Use qualified mechanics.
- Use seasonally appropriate oil and lubricants, antifreeze agents and additives.
- Keep spare parts, hoses and appropriate tools available for emergencies.
- Do not work on equipment when components are only suspended by hydraulic pressure. Only work on equipment or components that are safely blocked or secured to prevent movement.
- Only maintenance workers or operators under the direction of a maintenance worker should move equipment into and out of a maintenance shop. Perform maintenance tasks during daylight unless a shop has very good lighting.

Parking heavy equipment

- Park equipment in a safe place, clear of other traffic and according to manufacturer's and project SOPs. Never leave heavy equipment unattended with the engine running.
- Lower the forks, bucket or blade to the ground; never leave a suspended bucket or load unattended even for a short time.

- If equipment is disabled, use flashing lights, reflectors, traffic cones or triangles etc., to warn approaching traffic.
- At night, park equipment in an area that is easy to access if inclement weather is anticipated (snow, heavy rains).

Safety tips for vehicles and heavy equipment with loads:

- Establish an exclusion zone to prevent access where mechanical equipment is working with suspended loads (e.g., cranes, buckets).
- Do not pass a suspended load over workers; workers should never walk under suspended loads or lifted blades or shovels.
- In addition to endangering workers, suspended loads that are accidentally dropped can cause damage to other equipment – for example, when the heavy object is being loaded into an aircraft. Objects should only be lifted by parts and materials designed for that purpose and known to be solid.
- When loading, truck operators should remain inside the cab to prevent being hit by falling material. However, if the operator may be in danger during loading, he or she should vacate the vehicle and move away from the immediate area.
- Break large rocks into smaller pieces to increase stability during transportation. Load material to minimize spills.
- Sound the horn before moving mobile equipment or a truck and wherever visibility is poor (e.g., a blind corner, a dangerous intersection, approaching the blind crest of a hill).
- Use a spotter to direct and warn the operator when the machine must operate in reverse, where there is limited visibility, when carrying an oversized load, or when there are overhead power lines nearby.
- Cranes are the best equipment for lifting loads but some jobs can be done by excavators. Follow regulations of the AHJs when using an excavator for lifting a load and use the following precautions:
  - The operator and rigger should be qualified for the job.
  - Make sure the excavator has the rated capacity to lift the load safely. Make sure the lifting point or engineered attachment for attaching the slings is rated for the full capacity of t he excavator.
  - Establish work procedures to minimize the risk to workers near the boom or bucket. Never lift, lower, or move a load if there is any possibility that a worker may be struck.
  - Follow the manufacturer's safe operation procedures and calculate the weight or make a test lift. Have applicable load charts available for the operator in the excavator cab.

21.3.4 | Working Near Power Lines

Always notify the appropriate authorities well in advance when moving equipment, drilling, or commencing any planned excavations or other work where there is a risk of coming in contact with any type of power lines, underground utilities or pipelines. Contact with either overhead or underground power lines may result in severe injury or death from electrocution, explosion or fire.

Underground power lines can easily be snagged and broken during digging if one does not know exactly where they are buried. Overhead power lines are not insulated sufficiently to prevent shock if the equipment or person comes too close or contacts the lines. It is important to be aware that an arc flash may occur when a person, tool, or equipment does not maintain a certain distance known as the "minimum clearance distance" or the "limits of approach"[7] from the power lines. This distance depends on the voltage rating of the power lines in question. When people, tools or equipment enter within the minimum clearance distance, an electric current may arc from the wires and electrocute the person or energize the equipment. All metal, all humans and many objects are conductors that provide an easy path for electric current. If you, the ground, the machinery or tools are wet, the ability to conduct electricity and the risk of shock or electrocution is greatly increased.

Information in this section is based primarily on the WorkSafe BC document Working Safely Around Electricity.

General safe procedures

- Perform a risk assessment of the site and identify the potential hazards before starting work. Notify the contractor and all employees of the potential risks and hazards if they must work near power lines.
- Develop SOPs that address working where there are power lines and train employees appropriately. Have an ERP in place with procedures to address potential injuries including electrocution and burns caused by contact or arc flash, explosions or fires.
- Follow all regulations of the AHJs regarding notification of power companies before (1) commencing work near overhead power lines, (2) excavating near underground utilities, cables and pipelines, or (3) when it is necessary to carry out work closer than the minimum clearance distance required for overhead power lines or underground utilities, cables and pipelines.
- If it is necessary to operate within 20 m of overhead power lines, arrange a site visit with the power company and for them to barricade, de-energize or move the power lines. Obtain written confirmation of the preventive actions that will take place.
- Place warning signs in the work area so employees are warned of the presence of overhead or underground hazards.
- Only workers directly involved with work in progress should be in the area when equipment is working near power lines. Others should stay at least 10 m away.
- Stop the equipment when it is necessary for a person to approach the equipment.

[7] "Limits of approach" is a typically Canadian term and "minimum clearance distance" is used in the United States, United Kingdom, and Australia. Minimum clearance distance is used in this publication.

Prevention and preparation regarding overhead power lines

Careful planning is required to keep employees a safe distance away when working near overhead power lines. Always maintain the minimum clearance distance from low and high voltage power lines. It is safest to always use the greatest required clearance distance for all types of power lines, as it may be difficult to distinguish between low voltage and high voltage power lines.

- The table below indicates the minimum clearance distance, which is the distance required between power lines and the worker(s) and equipment at full extension. This means the total height of equipment plus the height of the employees plus their tools when all are fully extended – for example, an employee working on a drill mast or someone standing with tools extended in a bucket truck. Extra clearance distance is advisable when moving tall equipment over rough ground or when it is windy. Uneven ground may cause machinery to sway and lurch so that the normally safe clearance distance is reduced.

Table 21.1: An example of jurisdictional minimum clearance distance requirements when working near overhead power lines

VOLTAGE RATING OF POWER LINES	MINIMUM CLEARANCE DISTANCE (LIMITS OF APPROACH)
Over 750 V to 75,000 V	3 m (10 ft)
Over 75,000 V to 250,000 V	4.5 m (15 ft)
Over 250,000 V to 550,000 V	6 m (20 ft)

- Verify the following each time it is necessary to work near overhead power lines. Power lines expand and then sag with changes in temperature and are swayed by winds.
    1. Verify the required clearance distance with the AHJs.
    2. Verify the height of the equipment, worker(s) and tools at full extension.
    3. Verify the height of the power lines.
- Make sure the maximum height of a load, boom, dump box, or drill mast will not operate within the minimum clearance distance, especially when loading or unloading. Always check that the body of the boom, dump box or drill mast etc., is fully lowered before moving away from the site.
- Use a spotter to watch while equipment is operating in an area where it may enter or come close to the minimum clearance distance. It is the spotter's job to alert drivers and workers to potential dangers if the equipment approaches the minimum clearance distance. The spotter should stand at least 10 m away from the equipment or vehicle to be safe in case inadvertent contact occurs; contact will also energize the surrounding ground. (High voltage usually dissipates by 10 m from the spot on the ground where contact is made if the current is less than 60,000 V.)

- The operator should be on the vehicle or equipment while it is operating. If this is not possible, the operator should stand at least 10 m away from the machine and operate it by remote control. Then, if contact is made, the operator should be outside the zone affected by the electrical discharge.
- Employees should wear shock-resistant footwear when they work near power lines and there is any risk of contact. Boots are only resistant and do not offer complete safety.
- Do not store materials beneath power lines. If storage is unavoidable, post warning signs to prevent workers from using lifting equipment to move materials.
- Do not fell trees near power lines. Hire specialists in consultation with or through the power company to trim or remove trees near them. Secure appropriate permission before proceeding with the work.
- Maintain at least 6 m from power lines when moving heavy equipment parallel to them.
- Do not move heavy equipment at night as poor visibility increases the risk of contacting overhead power lines. If moving equipment at night is necessary, secure appropriate permission from company managers and AHJs, as required, and follow extra precautions.

If power lines are contacted:

- When equipment contacts power lines, the entire machine becomes energized – all parts, all accessory equipment, all cables etc. Anyone on the ground must stay at least 10 m away and NOT touch any part of the energized equipment, including lines, cables, buckets etc. Always notify the utility company whenever contact has been made as damage to the lines may have occurred. Request them to immediately shut off the power, if necessary. The operator should attempt to move the equipment away to break contact with the power lines, if possible.

Procedures when it is impossible to break contact with the power lines and the power cannot be shut off:

1. The operator must stay inside the cab or on the machine that is energized. Other workers must stay at least 10 m away and not contact the machine or energized ground.
2. The operator must only leave the safety of the cab or machine if they are in imminent danger (e.g., an uncontrollable fire).
3. The safe method for escape: You must get off the equipment without touching both the machine and the ground at the same time. Never step down or you will be electrocuted. You must jump off a short distance, 45-60 cm (1.5-2 ft) from the equipment and land with both feet together and touching and with your arms at your sides. Do not reach back, fall back onto, or touch the energized equipment or you will be electrocuted.
4. Once safely off the equipment, you must shuffle your feet and move along the ground for at least 10 m (30 ft) before taking steps. To shuffle: keep both feet together and touching and move one foot a few centimetres at a time so that your heel never passes your toes. Alternatively, make small hops for at least 10 m while keeping your feet together.

Note of explanation: When your feet are in contact with each other, there is very little voltage difference between the spots where your feet contact the ground. Therefore it is unlikely that electricity will seek a path through your body. If your feet are separated or you touch the energized equipment and the ground at the same time, your body will provide a path for electric current to flow from a higher potential to a lower potential and you may be electrocuted. For high voltage up to about 60,000 V, the voltage usually dissipates within 10 m from the contact spot on the ground. For higher voltages, this distance may increase to as much as 32 m (105 ft).

Additional safety tips regarding overhead power lines:

- If any accessory equipment is operating at the time of contact, that operator must (1) remain on the equipment and (2) not touch the ground. To be safe, the operator must follow the same procedures in #1-4 above.
- Never touch downed wires as it is difficult to determine whether they are "live". Only rarely do they shower sparks and move about on the ground. Stay at least 10 m away. Inform the local power company about downed wires as soon as possible.
- Consider installing an alarm to indicate when heavy equipment has contacted overhead power lines. Electrocutions sometimes occur when an operator leaves the equipment to investigate a problem and is unaware that contact has been made.

Safety tips for underground power lines, cables and pipelines

When working where there are underground utilities, cables or pipelines, it is essential to precisely locate them before commencing excavations, digging post holes or even driving long stakes into the ground.

- Comply with regulations of the AHJs regarding permits, notification time requirements, permitted excavation methods, blasting plan submissions, supervision by the utility company etc.
- Carry out a risk assessment and establish SOPs for employees and contractors to follow. Have an ERP in place that addresses potential electrocution, electrical burns, fire and/or explosion.
- If contact is made with underground power lines, follow the same safe procedures #1-4 as for overhead power lines (above) to prevent injury to the operator and workers. Notify the local power company immediately.
- If gas lines are jarred, pulled, or otherwise disturbed or if the smell or sound of gas is evident, immediately do the following:
    - Extinguish and remove all sources of ignition including lit cigarettes, cell phones, power tools and other equipment.
    - Move workers away and upwind if possible.
    - Notify the gas company immediately and do not attempt repairs or backfill the excavation.

21.4 | Access Routes to Advanced Sites

Good planning is crucial when constructing access routes to exploration sites. Well planned and well constructed access routes are (1) safer to use, (2) require less maintenance, (3) make less environmental impact, and (4) reduce the time and cost of rehabilitation. Depending on location and climate, access may be gained through year round or seasonal tracks or routes. In difficult terrain it is advisable to perform a cost evaluation, as it may be less expensive to use aircraft to access and supply a project site than build a track or road. For example, in the north it may be cost effective to move materials by helicopter and, when necessary, build a winter ice road for seasonal use. Access routes should be built to be safe and yet at the same time minimize environmental impact. Try to confine construction to the dry times of the year. Make sure all required permits are obtained before starting construction.

For detailed information, refer to the following sections and appropriate subtopics of the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.

- 5.5.1 Road and Track Design
- 5.5.3 Bridges and Crossings
- 5.5.3.2 Types of Crossings
- 5.7 Special Terrains

21.4.1 | Specific Risks and Hazards

In addition to the risks and hazards of working around heavy mechanical equipment, employees should be aware of:

- Slips, trips and falls caused by working on uneven slippery ground, steep terrain, cliffs, or slippery surfaces (e.g., sand, mud, ice and snow)
- Crush or pinch point injuries caused by moving equipment (e.g., conveyer belts, rock crushers, drill rods, winch drums, auger parts)
- Transportation related injuries or death caused by collisions, seasonal and terrain hazards, operating on uneven ground, steep slopes, near water or on ice, inadequate rider training and/or operating skills (ATVs, snowmobiles)
- Impact injuries or death caused by dangerous objects, including trees, loose rocks, unstable stumps
- Drowning or cold water immersion hypothermia caused by falling into water, falling through ice, failing to follow SOPs regarding travel on water or working on ice
- Stranding due to equipment breakdown, running out of fuel
- Equipment damage, equipment breakdown caused by road surface hazards (e.g., hidden cracks, ruts, washboards, meltwater or slush), extreme temperature conditions

21.4.2 | Safety Tips for Access Routes

Construction safety tips

- Comply with permit requirements. Plan and construct access routes according to specifications of the AHJs. Exploration companies should inform the construction contractor of their environment, health and safety (EHS) standards for construction.
- Use good engineering practices to design safe trails, tracks and winter roads. This may require contracting out the design and construction to specialists familiar with the location and hazards. Whenever possible, avoid steep grades to minimize vehicle handling issues. There should be adequate pull outs (plowed in winter) and signage to indicate important information and hazards (e.g., slide areas, potential flood areas, speed limits, radio frequencies and protocols for track or road usage).
- Use appropriate heavy equipment for the job; a tracked excavator creates less environmental impact than a bulldozer. When working on ice, use the lightest possible equipment that can perform the job.
- Schedule construction when rainfall will not increase erosion and impact the safety of workers (slips and falls). Heavy rains increase the likelihood of mud and rockslides on access routes. Working in very wet terrain can stress equipment.
- Remove debris where it will impede workers (e.g., rocks, roots, stumps). Identify and mark remaining hazards and mitigate them as much as practical.
- It may be advisable to disguise the entry point to an access track to discourage use by local recreational vehicles. Where appropriate, discuss access trail construction with local communities, as they may have an interest in the trail either being rehabilitated or left for their use. Refer to the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit.
- Use permissible dust control to increase visibility and protect workers' health, as necessary.
- When clearing is required, clearly mark the route so all employees and the contractor know the location and width of access tracks. When trees must be cut, inform all employees so they know where cutting will take place and when to keep clear.
- Remove foliage and vegetation that obscures visibility around dangerous curves and at junctions, keeping in mind the objective of minimal environmental impact coupled with safe operation. When constructing access trails, bear in mind alternatives that will enhance vegetation recovery after trail use ceases.

Safety tips for employees

- Comply with company SOPs and guidelines, be trained in ERP procedures and wear appropriate PPE.

- Develop a reliable communication system. Communication is essential between heavy equipment operators and workers who are on foot, in light vehicles and at the project base.
- Road condition hazards: Be aware of road or track hazards and drive/ride safely through difficult ground such as potholes, washboard areas, washouts, temporary bridges, steep slopes and switchbacks. Be aware of weather and environmental hazards including sudden whiteouts, high winds, heavy rains, floods, sandstorms, mud and possible mudslides.
- Training: In addition to general safety training, workers should receive additional training if they work with chainsaws, on ice, or near cold and/or deep water. Refer to Chapters 5.6 Chainsaws, 11.4 Line Cutting Safety, 15.10 Working on Ice, 17.12 Water Survival, and 21.4.3 Winter Access Routes (below).
- Use traffic controls (cones, barricades) to prevent access to dangerous areas (e.g., blasting, heavy traffic, cliffs).
- Take into account relevant wildlife issues such as migrating herds or dangerous animals.

21.4.3 | Winter Access Routes

Winter roads provide an effective means of transportation in the north when ice is thick enough to safely bear the weight of vehicles and heavy equipment. Access to drill sites and winter drilling programs on ice are a normal part of exploration and require safe access routes for drill pad preparations before drilling operations begin. Planning programs requires accurate information regarding ice conditions. It is essential to verify that the ice is thick enough to support the intended load, whether it is a person on foot, snowmobile, vehicle, drilling equipment or an aircraft.

Employees should never be permitted to test or work on ice alone; they should never use any method of transportation on untested ice. Ice thickness should be measured at appropriate spatial distances and at regular (or appropriate) time intervals. For example, it may be necessary to make daily measurements early in the season and then less frequently as the winter progresses. However, it is essential to measure the thickness of ice whenever there may be potential changes to the thickness (e.g., after a sudden temperature change, a heavy snowfall or heavy rains). The first people who test the ice are at greatest risk because the least information about ice conditions is available.

Information in this section is based primarily on the following documents, which should be referred to for detailed information:

- *Best Practice for Building and Working Safely on Ice Covers in Alberta*;
- *A Field Guide to Ice Construction Safety*.

For detailed information regarding working safely on ice on foot and with snowmobiles, refer to the following sections of these Guidelines:

- 15.10 Working on Ice: for ice terminology and features, hazards related to ice, equipment lists, and guidelines for initial safe ice crossings and ice testing procedures on foot and by snowmobile
- 15.11 Cold Water Immersion Hypothermia – Falling through Ice: for self-rescue and rescue procedures when a co-worker has fallen through ice
- 9.9 Cold Injuries: for recognition and treatment of hypothermia and frostbite
- 20. Drilling Sites: for information about drilling on ice

Ice Safety Plan

As discussed in 15.10.5 Planning and Preparation for Working on Ice, it is strongly advised that companies develop an ice safety plan that incorporates risk assessment, mitigation of hazards and a site specific emergency response plan with rescue procedures. Guidance is available specifically directed toward developing an ice safety plan and relevant emergency response procedures in *Best Practices for Building and Working on Ice Covers in Alberta*.

21.4.3.1 | Specific Risks and Hazards

In addition to those associated with working in cold conditions and on slippery surfaces, the following risks and hazards are specifically related to winter access routes:

- Equipment breakthrough on ice caused by:
  - Miscalculations:
    - Using the wrong tables to calculate the load bearing capacity for ice, applying too high a risk factor when making calculations (A-value in Gold's Formula), applying inadequate hazard controls in conjunction with the A-value selected in Gold's Formula
    - Inaccurate measurement of the ice thickness, inaccurate measurement of the total weight of a vehicle, a load and/or equipment
  - Inadequate monitoring of the ice cover for ice thickness, cracks, and after temperature changes
  - Travelling at too great a speed for the ice thickness and depth of water under the ice, travelling or parking too close to the windrows where ice is thinner
  - Unrecognized variable thickness of ice, which is often due to underwater currents, temperature variations or the presence of subsurface features
  - Crossing pressure ridges, undetected cracks (covered by snow)
  - Pushing the limits: not following SOPs, going onto ice too early or too late in the season
- Ice failure caused by equipment breakdown so that a moving load becomes a stationary load
- Drowning or cold water immersion hypothermia caused by not wearing a floater snowmobile suit or PFD, lack of training in rescue procedures, inability to escape from equipment that breaks through ice

21.4.3.2 | Planning and Preparation for Winter Access Routes

As a minimum, employees who work on ice should have appropriate knowledge and training to work safely. As part of the ice safety plan to assist managing and mitigating risks, employees should be trained to recognize risks and hazards, be familiar with ice characteristics, know how to correctly measure ice thickness and how to carry out all relevant emergency response procedures. Designated employees must be trained to correctly calculate the safe load bearing capacity of ice using allowable load tables and ice bearing capacity charts.

Training

In addition to training described in Chapter 21.3.2, employees who work on ice should receive training regarding:

- Safe operating procedures (SOPs) that include:
  - Safe testing of ice thickness on foot, when using a snowmobile, and when using heavy equipment, as appropriate
  - Required personal protective equipment (PPE): In addition to regular PPE, employees should wear a flotation snowmobile suit, a personal flotation device (PFD) or a life jacket as long as there is a risk of ice failure during the initial testing phase. Carry a hypothermia kit and know how to use the contents.
  - Never wear a seat belt while operating a vehicle or equipment on ice.
  - Required safety and survival equipment for vehicles, ATVs and snowmobiles, heavy equipment
- Emergency response rescue procedures should include as a minimum (1) self-rescue procedures, (2) procedures to rescue a crew member who has fallen through ice, (3) escape procedures when a vehicle breaks through ice, (4) escape and rescue procedures when equipment and a driver break through ice, and (5) procedures to treat cold water immersion hypothermia. See below.
- Knowledge of the physical properties and characteristics of ice so workers understand why it is essential to adhere to safe load limits and comply with safe speed limits.

Training for Emergency Response Procedures

Except for #4, the emergency response rescue procedures listed above are presented in Hypothermia, Frostbite and Other Cold Injuries: Prevention, Survival, Rescue, and Treatment by Dr. Gordon Giesbrecht and James A. Wilkerson. Refer to this book for comprehensive information regarding self-rescue procedures, rescue procedures for a co-worker who has fallen through ice, how to escape from a vehicle (below), and for treatment of hypothermia and cold water immersion hypothermia. Projects where employees routinely work in cold conditions or on ice should consider keeping a copy of this book on site.

If your vehicle breaks through ice:

- Try to escape as fast as possible – before it sinks. The vehicle should remain afloat for a short time – up to two minutes depending on how airtight it is.
- Exit through a side window to escape. Break them if necessary using a sharp object like a centre punch or a ResQMe tool. Many vehicles have power windows and locks that should operate for a short time under water. Open the doors only if the vehicle has just partially broken through the ice or the water may rush inside. As the vehicle sinks, water pressure may trap a person between the vehicle and partially opened door.
- If the side windows will not open, try to break out of the windshield or rear window. Use your feet or shoulders if there is no sharp object.
- Vehicles with the engine in front will often sink and come to rest on the roof if the water is deeper than 4.5 m (15 ft). It is very difficult to escape when submerged so get out as fast as possible.

Hypothermia and cold water immersion hypothermia

It is very important for hypothermia and cold water immersion hypothermia victims to be treated gently and receive appropriate care. For summary information, refer to Chapters 9.9.3 Hypothermia, 15.11 Cold Water Immersion Hypothermia – Falling Through Ice and 17.12.3 Cold Water Immersion Hypothermia.

Ice Characteristics

Many risks and hazards associated with ice are related to the physical characteristics of ice and the conditions under which it initially forms. Ice deflects (sags) under the weight of a load. When the load is moving, the depression creates a dynamic wave that travels away from the load through the ice and in the water under the ice. The faster a vehicle (load) moves, the steeper the wave becomes and if the vehicle speed is about the same as the speed of the dynamic wave, the ice is much more likely to fracture even when the load is theoretically well within the load limit the ice can bear. Ice may also rupture when a dynamic wave encounters shallow water or a subsurface feature (a shoal) or the shoreline – even when the ice is theoretically thick enough to support the load.

The load bearing capacity of ice is determined by numerous factors that include but are not limited to: ice thickness, air temperature during initial ice formation, type of water (salt or fresh), snow cover, the presence of cracks, extreme temperature changes, features – shoals, sand bars, rocks, subsurface water currents, inlets and outlets warm springs, bridge abutments and other manmade structures, and vehicle speed on the ice.

For a summary of terminology and ice features, refer to Chapter 15.10.2 Ice Terminology and Features and the Glossary in *Best Practices for Building and Working on Ice Covers in Alberta*.

Ice Thickness Records and Calculations for the Load Bearing Capacity of Ice

- Ice Thickness Records: Local authorities (AHJs) normally require companies to keep ice thickness records in a log book. If an accident occurs, the documentation may be critical in a subsequent investigation. Record the sample site location, all ice measurements, temperature, hazards, and additional information for the duration of work on ice. Record all ice thickness measurements in terms of the "effective ice thickness" (refer to #5 in Chapter 15.10.5.1 Guidelines for Testing and Assessing Safe Ice Thickness). Specific record keeping requirements may vary by jurisdiction. For some examples, refer to *Best Practices for Building and Working on Ice Covers in Alberta*.
- Load Bearing Capacity of Ice: When calculating the load bearing capacity of the ice cover, it is essential to (1) base calculations on the thinnest ice measurement in the test area and (2) use the correct allowable load tables and ice bearing capacity charts. Load bearing tables and charts for moving loads are different from those for stationary loads because ice beneath a stationary load will deform continuously until it fails. In addition, engineering expertise may be required to evaluate and compute the safe ice thickness required for stationary loads.

  For moving loads: Use the correct system of units for calculations. Do not confuse metric and imperial units. Some ice bearing capacity charts for moving loads have two separate scales with different units on the same chart. Carefully note the weight specifications of the equipment. Confusion may result, especially with the term "ton or tonne". It is easy to miscalculate: a "short ton" does not equal a "long ton" does not equal a "tonne".

Table 21.2: Comparison of weights in different units of measurement

UNITS OF MEASUREMENT	TON OR TONNE	KILOGRAMS	POUNDS
U.S. Customary Units	1 ton (short ton)	907.2	2,000
Imperial Units	1 ton (long ton)	1,016	2,240
International System (Metric)	1 tonne (metric ton)	1,000	2,204.6

- The most stringent and conservative standards for the safe load bearing capacity of ice are recommended by the PDAC Health and Safety Guidelines. For the safety of employees, it is best to work on ice thicknesses greater than the minimum thickness recommended by charts and tables.
- Cracks: When cracks are present, follow the guidance of best practices, the recommendations and regulations of AHJs and reduce the load accordingly. While dry cracks may not pose a problem, load reduction may be required when they are close together and of a specified width. Wet cracks usually require load reductions or special actions such as repairs or a detour because they indicate that ice has cracked entirely through to the water. When cracks are parallel to an ice road, it indicates the ice has been stressed and it is advisable to detour around them until the cracks heal. Radial cracks indicate ice is overloaded and the load should be removed. When circumferential cracks join radial cracks around a load, ice failure is imminent. For definitions and information about cracks, refer to Best Practice for Building and Working Safely on Ice Covers in Alberta.
- Temperature changes may require adjusting work schedules or the load permitted on the ice.
  - An extreme drop in temperature can cause the ice to become brittle so the strength is severely compromised. The ice may not be safe to use for at least 24 hours.
  - An extreme rise in temperature can cause the ice to thin unexpectedly and dramatically even when the temperature does not rise above freezing. Under such circumstances, it is imperative to carefully test the ice each day in order to monitor the thickness. Underwater currents may rapidly erode the lower ice surface after temperature changes.
  - If the temperature rises above freezing for six of the past 24 hours, the load capacity is diminished.
  - When the temperature stays above freezing for 24-48 hours, ice will rapidly lose strength and the safe ice bearing capacity charts and tables may no longer apply. The ice may no longer be safe despite the thickness.
  - For additional information, refer to Chapter 4.1.4 Effect of Sudden and Extreme Temperature Changes in Best Practice for Building and Working Safely on Ice Covers in Alberta.

21.4.3.3 | Construction of Winter Access Routes

Whenever possible, avoid constructing roads and tracks over land in the Arctic due to the environmental impact. When construction is necessary, winter roads are the best choice. Heavy equipment should be appropriate for the job. Construction methods should preserve the permafrost and make as little impact as possible on topsoils and vegetation. It is preferable to use lightweight, wide tracked, low ground pressure vehicles or tracked vehicles on snow covered tundra and frozen muskeg, as their weight is distributed over a wider area of the land. Do not count on wide tracked equipment to be safer than narrow tracked equipment for use on ice because the critical factors are the condition of the ice and the total weight of the load on the ice rather than the size of the footprint of the load.

Safety is the most important factor when designing and constructing ice roads and ice bridges. It is advisable to contract construction of winter roads to specialists. Contractors should have experience building ice roads in the same region. When possible, use ice profiling equipment that uses ground penetrating radar (GPR) to gather accurate information regarding ice thickness and general ice conditions. If a GPR ice profiler is unavailable, ice must be tested by hand.

For information about selecting routes and constructing ice roads and ice bridges, refer to Best Practice for Building and Working Safely on Ice Covers in Alberta.

Figure 21.3: Light truck with track conversion towing ground penetrating radar (GPR) ice profiling equipment © Iain Mitchell

Figure 21.4: Wide tracked Sno-cats are used to clear ice roads and runways on ice. © Iain Mitchell

Safety tips for operating heavy equipment on ice:

- Know the total weight of the equipment when fully loaded – the Gross Vehicle Weight (GVW) + fuel + driver + equipment (gear, tools etc.). Weigh the mechanical equipment on a scale, if available. Otherwise make a best estimate of the total weight and add extra for a margin of safety. If there is any question about safety, measure the ice and use the thinnest measurement to calculate the safe load bearing capacity of the ice.
- Use extremely light tracked or amphibious vehicles when testing ice thickness early in the season. When ice is too thin for heavy equipment (a truck with a plough), it may be possible to use a machine such as a small sit-down tractor with a snow blower to clear routes. The rider should wear a flotation snowmobile suit or PFD until the ice is unquestionably thick enough to support heavier equipment.
- When using a SNO-CAT or other equipment with a closed cab, make sure there is a fully functioning escape hatch in the roof. Consider removing the hatch entirely or securing it in the open position for additional safety.

- When plowing roads and air strips on ice, plow the full width in one shift the first time the ice is cleared. After the initial clearing, plow new fallen or windblown snow out to the windrows but never plow into the windrow or across them. There is increased risk of breakthrough near windrows because the ice is usually thinner there. This is due to (1) the weight of the snow, (2) the insulation properties of snow that prevents the ice from freezing to the same thickness as ice in contact with cold air and (3) potential hidden cracks under the snow. An ice road or airstrip should become progressively narrower as plowing continues and the season advances.
- Establish a routine check-in time and maintain radio contact throughout work and/or travel on ice. This is essential in order to inform others if there is an emergency, such as a breakthrough or a whiteout.
- Clearly mark the limits of the safe route on ice once they are defined. Require equipment operators to stay within the marked boundaries.
- Do not store materials and goods on ice; do not park vehicles and machinery on ice, especially near a drill pad. The added weight may stress the ice cover to the degree that it fails.
- To prevent ice from melting, do not lay a heat source directly on ice; allow sufficient room underneath a heat source to circulate cold air.

Figure 21.5: Measure the thickness before using heavy equipment on ice, especially on frozen rivers and streams where ice thickness is always variable. © Steve Millar

Safe driving/riding procedures on ice:

- Be familiar with and follow the applicable SOPs and safety guidelines including those in Chapters 13. Vehicles and 15. Snowmobiles.
- Fully equip all vehicles and train all drivers and passengers. They should be able to carry out emergency rescue procedures and use the survival equipment. Stranding is always a possibility due to breakdown or adverse weather conditions. Carry extensive survival equipment and a satellite telephone where radio or cell phone contact is not dependable. Carry sufficient fuel to make a return trip with fuel to spare. Know appropriate survival skills for the terrain. Refer to Chapters 8. Survival and 15. Snowmobiles for equipment lists.
- Leave written details of your route and estimated time of arrival/return with the person in charge. Maintain radio contact at specified check-in times. This is essential to inform others of your location if an emergency occurs during ice road travel. Help will be dispatched if you do not check in as required according to the ER procedures.
- Strictly adhere to rules, speed limits and weight restrictions on ice roads. If there is no posted speed limit, it will be necessary to compute a safe speed taking into account the total weight of the vehicle and load, the ice conditions, the water depth below the ice, and the bottom and shoreline configuration. Unless ice road procedures and speed limits are followed, the dynamic waves of oncoming or overtaking traffic may converge and amplify, which stresses the ice so that it may rupture. The dynamic wave of a speeding truck may cause extreme stress to the ice so that it cannot support the load that follows.
    - Never wear a seat belt while travelling on ice. Keep a window punch tool immediately available to break a window to escape and carry rescue ice picks on your person to help haul yourself up onto the ice surface.
    - Secure loads with extra restraints as ice roads and portages can be very rough and slippery.
    - Inexperienced drivers should be teamed with experienced drivers.
- Drive close to the centre of an ice road and not near the banks (windrows) where cleared snow is plowed. The ice is usually thinner and/or weaker near the windrows.
- Vehicles should travel in tandem or in convoys with adequate spacing. Park vehicles or equipment a minimum of two lengths from an equivalent piece of equipment and for no more than two hours. Do not park near windrows.
- Maintain a safe stopping distance that allows for rough, slippery surface conditions, blind corners, wild animal encounters etc.
- Carefully pass any oncoming traffic and overtake with caution (if permitted). Visibility may be obscured when the draft from moving vehicles creates swirling snow.
- Be alert for signs of stress and deterioration in the ice. These include the presence of cracks, water, bubbles, potholes or pressure ridges. Inform the person in charge or supervisor immediately if these features are unexpectedly encountered.
    - Pressure ridges are dangerous and can develop suddenly. Try to develop a route around

them. Do not build a ramp bridge across a pressure ridge unless there is no alternative. Drive across ramps with utmost caution and do not cross them if planks are lifted or twisted out of place.
    - Watch for the presence of water (especially when approaching shore), which indicates dangerous conditions and the immediate potential for breakthrough. Try to approach the shore at 45° as it is safer than directly approaching shore at 90°.
- It is advisable to carry chains for emergency use. Chains should only be used when permitted by AHJs, as they cause severe deterioration to the ice surface.
- For additional information refer to resources provided by The Tibbitt to Contwoyto Winter Road.

Figure 21.6: To create a thicker safer ice road, the ice is flooded to create "lifts" that freeze solidly within 12 to 24 hours. © Chris Pederson

21.5 | Trenches and Pits

Trenches and pits are open excavations that pose potentially deadly risks and hazards to employees who work in or near them. Some trenches or pits are dug with hand tools (mattocks, picks, shovels), but often excavation is carried out using backhoes or excavators. Depending on the climate, weather and ground conditions, some trenches may require engineering expertise to guarantee safe and correct wall support. Trenches and pits should be designed and constructed according to AHJs to prevent the walls from collapsing and burying workers.

21.5.1 | Specific Risks and Hazards

Specific risks and hazards associated with trenches and pits depend on the depth of excavation, equipment used, ground conditions, the local weather and employee behaviour. They include:

- Crushing burial, suffocation and injuries caused by wall collapse, falling debris from waste piles, and/or improperly benched or sloped wallsDeath or serious injury when struck by heavy equipment
- Injuries from hand tools caused by the lack of training, lack of or improper use of PPE, using the wrong tool for the job, working too near a co-worker
- Asphyxiation from toxic gases caused by the build-up of exhaust from generators or motors used in or near trenches or pits
- Electrocutions, burns, explosions and/or fires caused by contact with buried power cables, pipes, gas lines or overhead power lines
- Death from drowning or burial caused by flooding, water permeating or saturating the wall material causing collapse – despite shoring and benching
- Injuries caused by employees behaviour, which include not following SOPs, lack of training, not wearing PPE, lack of inspection before entry, lack of supervision of employees in excavations

21.5.2 | Jurisdictional Regulations

Exploration companies should secure all required work permits and certifications for excavations in order to be in compliance with occupational health and safety (OHS) legislation and Mines Acts and Regulations of the AHJs. Require contractors to (1) check for potential buried pipelines and cables before starting an excavation and (2) acquire any required trench design certification, which may depend on the location and depth of the proposed excavation.

In places where no legislation exists, companies should develop their own safe operating procedures and safe excavation standards based on best practices elsewhere and enforce them.

Plan for compliance and safety

Adhere to or exceed the requirements of the AHJs. The following procedures reduce the risks and hazards of working in trenches and pits and should be required by AHJs.

1. Obtain all required permits, permissions and certifications.
2. Carry out a risk assessment to determine the risks and hazards including the location of overhead power lines or buried cables, pipelines etc. Remove or mitigate hazards before excavation begins.
3. Assess the soil type, which greatly influences the strength and stability of excavation walls, in order to calculate the depth, cut back, slope, and wall support requirements to prevent collapse. Consider any additional conditions that affect the stability of trenches, lithologic and soil structures, potential vibrations, potential presence of water or wet weather, and the weight of the excavated spoil and equipment present. Plan for potential shoring and benching requirements from the beginning to save time and costs before the sidewalls must be cut back (benched or battered) or adequately supported to prevent collapse.
4. Plan for the requirements for backfill, topsoil management and erosion control. Refer to Chapter 5.4.2.1 Trenches and Pits and sections on various types of terrain and environmental zones in the Driving Responsible Exploration (DRE) Environmental Stewardship Toolkit for detailed information regarding the safe and correct way to (1) remove top and subsoil, (2) create drainage and (3) replace material when the trench is no longer used. Follow the excavation setback distances suggested for specific areas such as Riparian zones.
5. Carry out inspections. Inspect the excavation before each shift, before any workers enter, after a substantial rainfall, after blasting (which may affect the stability of the soils or rocks adjacent to a trench), and any time someone reports a concern or a danger sign in the walls or area surrounding the excavation. Address or eliminate all potential hazards before any workers enter.

21.5.3 | Prevention and Preparation

Choose appropriate equipment for the job. Whenever possible, use excavators and backhoes to dig trenches; they can excavate a trench more accurately and cause less environmental damage than a bulldozer.

Training

- Employees must be trained to recognize the dangers of trenches and pits, especially the potential for (1) collapse and (2) confined space.
- Training should include site specific SOPs, ERPs, and rescue procedures if a trench caves in or a co-worker collapses in a trench for no apparent reason.
- Employees should be trained to use tools correctly, refer to Chapter 5. Field Equipment Safety.

- PPE requirements should include:
    - Safety glasses – at all times
    - High visibility vests – when working in a trench or pit and around heavy machinery
    - Hard hats should be worn at all times – even when a trench is shallow to protect from impact injuries and flying debris, especially if hand tools are used.
    - Steel toed boots should be worn when working in a trench or pit with hand tools that might cut through a boot and when sampling when rocks might be dislodged and fall onto feet.
    - Gloves help prevent cuts, blisters and infections that may result from contact with soils and sharp rocks.

General employee safety

- No employee should enter a trench if they feel the trench is unsafe for any reason. Employees have the right to refuse unsafe work.
- No employee may work alone or remain alone in a trench or pit, even for a short period of time.
- Employees may enter a trench or pit under the following circumstances:
    - The trench has been inspected and declared safe to enter.
    - There is a person on the surface at all times to monitor employees in the trench.
    - The trench walls or floor show no signs of instability.
    - If the trench is deeper than 1.2 m (4 ft), it must be in solid rock or the walls have to be widened, sloped or benched properly according to jurisdictional regulations. If there are no jurisdictional requirements, the company should develop and implement SOPs that address procedures for safe entry, supervision and rescue to protect the health and safety of workers.
- Remain vigilant at all times. Be very cautious near the edges to prevent falling in and/or being struck by excavation machinery. It is very easy to forget and step behind the moving machinery or in the path of the bucket. Never approach heavy equipment from a position where the operator cannot see you (e.g., the rear or the blind side or spot). Stay out of the "exclusion zone", as previously described in Chapter 21.3.3.
- Samplers should be aware of their surroundings to prevent being struck (or striking others) with tools or deflecting rock. Watch out for loose debris that might fall from above. Do not work on the benched or sloped sides above or below other employees.
- No one should be permitted to work or take samples while standing or sitting in the bucket of an excavator or backhoe. Take samples from the bucket when the bucket is resting on the ground.
- Never work underneath loads that are being lifted or transported by an excavator

Trench configuration and safe practices

Be aware of and follow the jurisdictional requirements and environmental best practices regarding trench placement, particularly on slopes, within buffer zones, or when creating drainage to counteract erosion. Follow these tips in addition to those in Chapter 21.5.2 Jurisdictional Regulations.

- Avoid digging deep narrow trenches; they are especially dangerous when excavated in poorly consolidated material.
- Place tools, heavy equipment and material excavated from trenches and pits (spoil) at least one metre back from the trench to help prevent cave-ins or workers being hit by falling objects. For trenches greater than one metre in depth, the excavated material should be placed as far back from the edge as the planned depth of the trench. Spoil should be piled at least 30 metres away from a lake or watercourse if no buffer zone exists, unless a different distance is specified in the permit.
- Remove or secure any trees, rocks or other objects from the edges of trenches or pits to prevent them falling onto employees.
- Access and egress: Ladders should be placed as close as possible to the work area. They should be secured and placed within 7.5 m (25 ft) of the workers and extend a minimum of 1 m (3 ft) above the top of the trench. A trench should have at least one end with a gentle slope for easy exit should a worker, an animal or other person fall in. Employees should not carry tools up and down with them when using ladders; place them in a container and hoist them.
- Inspections: Keep a record of all inspections. Develop and use checklists to cover specific and appropriate trenching requirements. Make sure various safety factors are covered on inspection forms.
- Danger signs of sloped or benched walls of trenches and pits:
  - Material bulging from the walls or sides
  - Small clumps separating from the walls or sides
  - Cracking in excavated walls
  - Ground surface tension cracks developing parallel to the trench
  - Water accumulations on the floor of the trench or behind shoring that may cause undermining and wall collapse
- Place barricades (fencing if necessary) and warning signs around open excavations. Protect workers from falls, falling loads and mechanical equipment. Open excavations also pose a hazard to the curious public, visitors, or wildlife and/or livestock. Erect barricades and post warning signs in the local language or even in graphic symbols if non literate people are likely to be at risk.
- Keep generators or combustion engines at least 10 metres away and preferably downwind and down slope from a trench – never locate them in a trench.
- Check for snakes and other wild animals before entering. Animals or venomous snakes or insects may use the trench at night or to shelter from hot sun.

- To prevent falls, fill in test pits and trenches as soon as work is completed. This is required in some jurisdictions and may be a condition of the work permit.

Figure 21.7: Trenches should have one end with a gentle slope for easy exit. © Lorne Burden

Figure 21.8: Pile the excavated material at least one metre back from the edge of the trench. © Lorne Burden

21.6 | Explosives

Explosives may be used at advanced exploration sites for building access routes, drill pads, for excavating trenches and pits, or to blast portals and exploration adits. Seismic surveys may utilize explosives. While explosives are normally handled by contractor's employees, the site supervisor should verify that all AHJ regulations regarding explosives are followed by everyone at the site and that those who use explosives are properly certified.

21.6.1 | Specific Risks and Hazards

- Severe injury or death of employees or the public caused by entering a blast zone at any time as well as during blasting, inadequate training or qualifications, lack of or not following SOPs
- Unplanned detonation and fires caused by misfires, inadequate training or qualifications, lack of SOPs
- Property and or environmental damage due to poor planning, not following SOPs, poor communication procedures, inadequate training or qualifications
- Inhalation of toxic gases from blasting by-products caused by lack of planning, not following SOPs
- Potential fines or imprisonment for conviction of explosives offenses due to non-compliance with AHJs

21.6.2 | Jurisdictional Regulations

Exploration companies are responsible for following jurisdictional regulations (federal, provincial, territorial, state) regarding permits, use, handling, storage and transportation of explosives.

- Only certified and licensed employees may handle and use explosives.
- Follow government regulations regarding the safe disposal of all unused, expired or deteriorating explosives. It is a criminal offence to abandon any type of explosives in Canada and the USA.
- In many jurisdictions it is very difficult to obtain and use explosives due to concerns about public security and their intended use.

When companies operate where the use of explosives is not regulated, they should develop and enforce their own safe operating procedures and requirements based on best practices elsewhere for the safe use of explosives.

21.6.3 | Prevention and Preparation

- Appoint a blast supervisor with appropriate certification to be responsible for all blasting activities. It is the responsibility of the supervisor to establish the limits of the danger area, appoint guards, oversee all communication and blasting signals, including communication with the blaster, request for radio silence, warning signals, "all clear" signals and the resumption of radio communications.
- Place the correct warning signs in a blasting area to indicate the presence and use of explosives. Have a code for blasting signals in place that everyone at the area is familiar with and can hear.
- Access routes should be guarded to prevent employees or the public from inadvertently gaining access to the area while blasting is in progress. Employees must obey posted signs and guards.
- No smoking or open flames are permitted within any blasting area, magazine or within a vehicle transporting explosives. AHJs usually stipulate that no smoking or open flames are permitted within 15 m of magazines or a day box. Post "No Smoking" and "Danger Explosives" signage as appropriate.
- Blasting procedures should take into account the potential for toxic gases to develop, which may depend on the mineralization in the rock.
    - In certain circumstances blasting rock with sulphide mineralization may result in deadly levels of sulphur dioxide, carbon monoxide and other toxic gases.
    - Oxides of nitrogen are always an issue when blasting in confined areas, including trenches, pits, portals and adits.
- Do not handle explosives when an electrical storm is approaching. Require employees to leave

the magazine area and move to a location where there is no danger from an unplanned explosion due to a lightning strike.

- Keep records of explosives inventory and be able to account for all explosives at all times.
- Remove all materials (explosives, wires, detonators/caps etc.) from the site after blasting activities are completed.

Transportation of explosives

Transport explosives in a vehicle that meets specifications of AHJs and in compliance with dangerous goods legislation.

- Always transport detonators and explosives in separate vehicles that are in good mechanical condition. The vehicles must travel separately.
- No smoking or open flames are permitted within 15 m of the vehicle and no combustible material, compressed gases or flammable liquids may be carried in any vehicle that is transporting explosives.
- Label the transport vehicles appropriately according to AHJs.
- Load and unload explosives with the vehicle engine turned off.

Storage of explosives – magazines

Build explosives magazines that conform to all standards and specifications of the AHJ. Magazines are subject to inspections at any time.

- Store explosives and detonators in separate magazines, unopened and in their original packaging until they are used.
- Explosives may be stored in a day box for up to 24 hours. Mark the day box conspicuously on all sides with the words “EXPLOSIVES”.
- Locate an explosives magazine at the base of a high bank in areas where severe electrical storms are a risk. It is advisable to ground the magazine as well. When a thunderstorm approaches, close the magazine and require employees to leave the immediate area.

22.0 ABANDONED AND OLD SITES

Introduction

Mineral exploration may take place in regions where there are abandoned mines that can provide valuable geologic information when re-evaluated or re-explored. However, abandoned surface and old underground mine workings (including old exploratory drifts) are among the most hazardous places where exploration geoscientists may work. Primary risks include the potential collapse of ground and confined space, which is defined as any enclosed space having a single point of entry and exit. Confined spaces may have a potential to concentrate toxic gases such as carbon dioxide, methane, or hydrogen sulphide, or they may contain insufficient oxygen to support life.

It is tempting for geologists and prospectors to enter old mine workings, especially where they are horizontal adits and light is penetrating from outside some distance into the entrance. Often the best outcrops of mineralization are in old adits. However the dangers are considerable.

An exploration company should have written safe operating procedures (SOPs) in place before permitting exploration work at abandoned surface or old underground mine sites. Careful assessment, planning and preparations are necessary. Employees should be familiar with the general and site specific risks and hazards, the company SOPs and emergency response plan (ERP), and have appropriate training to carry out the exploration work safely. They should not venture into abandoned surface or old underground workings without specific company and jurisdictional permission to engage in such activities.

Some hazardous sites may not be easily recognized. For instance, there is evidence that numerous sites, particularly in Eastern Europe and the former USSR, may be contaminated with hazardous chemicals or radioactivity. Exploration programs undertaken in such areas require special preparations to determine whether these potential hazards are present.

It should be borne in mind that hazards similar to those of abandoned or old mine sites may also exist under other circumstances. For example, there are documented fatalities caused by accumulations of toxic gases that were encounter while monitoring a closed mine site where tailings or waste rock piles were generating hazardous gases that migrated and concentrated in buildings constructed at the toe of the tailings or waste pile. See Chapter 22.4.3 below.

Some information in this chapter is based on text from Berkman, D. A., 2001. *Field Geologists' Manual, 4th edition*, Chapter 11.2 pp 364-366, (The Australasian Institute of Mining and Metallurgy: Melbourne). The information is adapted with the permission from The Australasian Institute of Mining and Metallurgy.

Acronyms

ACGIH – American Conference of Government Industrial Hygienists
AHJ – Authority Having Jurisdiction
ERP – Emergency Response Plan
HEPA – High Efficiency Particulate Air
OHS – Occupational Health and Safety
PFD – Personal Flotation Device
PPE – Personal Protective Equipment
ppm – Parts Per Million
SCBA – Self Contained Breathing Apparatus
SOP – Safe Operating Procedure

22.1 | Risks and Hazards

Death and injuries may result from numerous risks and hazards at old or abandoned sites. They include but are not limited to:

- Asphyxiation, suffocation or illness from oxygen deficient atmospheres due to:
  - Insufficient underground ventilation
  - Oxidation of carbonate and sulphide waste rock in underground passages or in tailings piles
  - Carbon monoxide in exhaust caused by incomplete combustion of fuel used in motors or engines in trenches, underground, or in other confined spaces
  - Breathing toxic fumes, dusts or mists that originate from toxic waters or waste rock
- Slips, trips and falls due to rough, slippery or collapsing ground; collapse of structures covering old adits, winzes or ore passes; failure of old infrastructure; wearing inadequate footwear, not wearing fall arrest PPE
- Injuries or death sustained from:
  - Falls of rock, collapse of ground
  - Failure of old infrastructure (e.g., ladders, manway covers, timbers)
  - Water covering hazards, inflow from surface waters, unexpected underground flooding
- Burns or death from fire or explosions due to the presence of methane, old blasting materials

- Exposure to diseases (e.g., tetanus, leptospirosis); potentially from inhaling guano residues: histoplasmosis (bird and bat guano) and rabies (bat guano)
- Wildlife encounters with snakes, bats, rodents or larger mammals
- Confined spaces: See Chapter 22.11 below for specific risks and hazards.

Figure 22.1 Residues in drums of unknown, unidentifiable chemicals © Courtney Mitchell

22.2 | Responsibilities (Due Diligence) with Regard to Old or Abandoned Sites

As presented in Chapter 1.2 Due Diligence with Respect to Safety, companies should be able to demonstrate due diligence with respect to safety any place their employees work.

Exploration Company Responsibilities

- Make sure the health and safety of each employee is protected, including during the investigation of abandoned surface or old underground workings.
- Comply with occupational health and safety (OHS) legislation, Mines Safety Acts and Regulations and those of any other authority having jurisdiction (AHJ), including permissions.

- Perform risk assessments to identify the risks and hazards that must be addressed before exploring old or abandoned sites.
- Prior to developing work plans within old or abandoned sites, safe operating procedures (SOPs) guidelines or a manual should be in place that addresses the findings of the risk assessments.
- Develop written emergency response plans (ERPs) and training procedures that cover the risks, hazards and potential accidents that could occur.
- Make sure employees and contractors doing exploration of old and abandoned sites are trained and qualified for the job.
- Provide all necessary safety equipment and personal protection equipment (PPE).

Supervisor Responsibilities

- Make sure employees are trained in the SOPs and ERPs and that they are implemented by everyone participating in the exploration of old or abandoned sites work programs.
- Carry out a job hazard analysis of both surface and underground tasks (e.g., sampling, ventilation).
- Provide appropriate supervision of employees who explore old or abandoned sites.
- Make sure the employees who explore or work in old workings follow their predetermined exploration or work plan and do not deviate from it without notifying and confirming the changes with support people on the surface.

Exploration Employee's Responsibilities

- Be aware of the risks and hazards at old or abandoned mine sites.
- Follow company policies and SOPs developed for the safe exploration of old or abandoned sites.
- Be familiar with and participate in training programs to acquire skills to follow the ERPs, especially mine rescue procedures.
- Wear all required PPE. Carry and know how to use the safety equipment supplied by the company.
- Follow and do not deviate from the predetermined exploration plan without notifying and confirming any changes with support people on the surface; "plan the plan and follow the plan".
- Report any unsafe conditions you observe to co-workers.

22.3 | Guidelines and Preparations for Exploring Old or Abandoned Sites

Each company, their employees and contractors should maintain an extraordinarily cautious attitude toward personal safety and that of their co-workers when entering or exploring old mine workings. Always adhere to safe practices. No one should proceed with work at old surface or underground workings if conditions are judged to be so hazardous that they cannot be mitigated or avoided through safe work techniques. In general, experts in safety in mine workings should be involved.
Company plans: Management, as they are ultimately responsible, should have an overall plan in place before any surface or underground exploration occurs at old or abandoned sites. Plans should include but not be limited to the following measures:

1. Compliance: See comments under company responsibilities above.
   - Information: Gather all available mine plans, sections and mine records. Obtain local knowledge and information that will make the exploration safer. In some regions it is important to check for the possible presence of hazardous chemicals or radioactive wastes at the site.
   - Risk assessments: Complete risk assessments and use the observations and conclusions to mitigate the hazards by developing a site specific exploration plan and SOPs for the proposed investigation.
   - Requirements: Set requirements for the use of PPE and training (e.g., mine rescue, use of gas detection equipment, first aid, SOPs, ERPs).
2. Complete a risk assessment of the potential work area:
   - Surface hazards include but are not limited to:
     - Pits and highwalls
     - Openings to underground workings including shafts, raises, stope workings that might be hidden by vegetation or old, deteriorated covers
     - Deteriorated buildings and machinery
     - Scrap metal, scrap wood with exposed nails
     - Undetonated explosives and blasting caps
     - Hazardous chemicals
     - Unstable rock
     - Water hazards include filled or partially filled raises of unknown depth, flooded pits
     - Wildlife
   - Underground hazards include but are not limited to:
     - Oxygen deficient atmosphere, toxic atmosphere
     - Deteriorated metal and wooden support materials
     - Unstable rock

    - Water hazards include water-covered timber or steel plates on floors of tunnels that hide winzes or ore chutes and flooded passages at depth. Raises may be water-filled and in very cold climates they may be frozen at the bottom due to partial thawing.
    - Unseen holes and/or ore passes

3. Procedures: An exploration company should develop safe operating procedures and emergency response plans.
    - Safe operating procedures should be based on the results of risk assessments. They should also address required equipment, training and safe behaviour. General SOPs should be part of a company plan that addresses safe exploration at old and/or abandoned surface and underground sites. Site specific SOPs should be developed as required before any exploration occurs at a chosen site.
    - Emergency response plans should address potential accidents, potential injuries, potential rescues and communication breakdowns etc. Plans must include a list with required contact information and numbers in case a rescue is necessary.
4. Training: Sufficient and appropriate training is essential. Anyone exploring surface or underground sites should be trained to recognize and evaluate the potential hazards. Training should include:
    - Education of employees that they may refuse work considered unsafe
    - Hazard recognition: Both surface and underground hazards may impact jobs. A job hazard analysis should be carried out (e.g., sampling, ventilation, dewatering).
    - Confined space recognition and safe procedures
    - First aid, mine rescue training
    - Operation of: gas detection equipment, self rescue breathing apparatus, and/or self contained breathing apparatus (SCBA)
    - Fall protection requirements for surface or underground, as required
    - Evacuation procedures if going underground to work
5. Safety equipment: Determine the requirements for safe operation in the hazardous area. Provide and require employees to wear or use all PPE, gas monitors and have available all necessary mine rescue equipment.
6. Communications: Have a system in place to communicate between crews exploring on the surface or underground and people in charge of potential rescues.
7. Develop contingency plans to follow while exploring old or abandoned sites. Employees should submit a detailed written plan with proposed exploration procedures for management approval before commencing work. They should “plan the exploration and follow the plan”.
8. It should be a requirement that employees are always accompanied underground by a person who has experience working underground on the property under investigation.

22.4 | Surface Hazards at Old Workings

22.4.1 | Abandoned Surface, Pit or Strip Mines

- Be vigilant when working at the base or top of a highwall or rock face. Make a habit of shouting "Rock!" to alert co-workers to any falling rock. Do not stand below someone who might dislodge loose rock.
- Highwalls that remain following mining operations are more dangerous than natural cliffs because of potential collapse. Minor movement, water saturation or vibration may initiate a slide of loose or unconsolidated material.
- Rock slopes formed by blasting are prone to rock falls, especially after freezing and thawing.
- Beware of climbing on broken rock piles. It is easy to dislodge large masses of rock that may be resting in a precarious position.
- Try to avoid collecting samples on unstable or precipitous slopes. Look for the safest exposed areas to collect samples.
- Wear PPE, including a hard hat, proper footwear and eye protection.

Figure 22.2: Unstable loose rock above a pit wall, dangerous footing, and a risky place to sample. © Courtney Mitchell

22.4.2 | Surface Structures and Machinery

- Never enter old buildings unless it is absolutely necessary. Unmaintained structures at old mine and mill sites can be extremely dangerous as they may easily collapse. Be aware of potential encounters with wildlife (e.g., snakes, skunks). Old buildings may trap gases under certain circumstances.
- If you must enter, examine and look for the following:
  - Foundations – signs of structural failure
  - Stability of walls and strength of the floor or stairs. Check for rotten wood by testing the floor with a large object before placing your weight on it. While it may support rodents and snakes, it may not support you.
  - Slope movement from above and below
- Never go on the cover over a shaft or other vertical opening. It is difficult to determine whether it is safe or not.
- Watch out for explosives and blasting caps left in old buildings. Do not touch, step on or try to detonate them. Deteriorating dynamite is very unstable. Because dynamite contains nitro-glycerine, touching explosives may affect the heart rhythm and breathing in some people.
- Watch out for subsidence around headframes and shafts.
- Avoid walking on or around machinery. A tangle of sharp and rusted machinery parts can cause severe injury if they whip back or one falls on them. Tetanus may be contracted from cuts received from old dirty metal.
- Stay far away from headframes and tramlines during a lightning storm. The charge from a lightning strike may travel along metal cables for more than a kilometre.

22.4.3 | Tailings and Water-Filled Areas

- Tailings that are incompletely dewatered may not support your weight. Dry tailings may release harmful dust (including heavy metals or chemicals) when you climb or sample them. Wear an appropriate dust mask to sample dry, dusty tailings to avoid inhaling airborne particles.
- Tailings or waste rock piles may be steep and unstable.
- Be careful and observant when exploring near tailings and waste rock dumps. Sulphide and/or carbonate minerals may react to produce an oxygen deficient atmosphere and toxic gases within or in the immediate area of the oxidizing rock piles. Factors such as soil cover and air temperature may limit the mixing of escaping gases so they concentrate within the piles. If air and water circulation patterns cause the gases to be forced out of the rock piles at the toe of the dump, they may accumulate in monitoring stations or natural depressions, which may in effect become "confined spaces" that contain toxic atmospheres with potentially deadly consequences.

- Water may fill old surface workings and conceal various hazards. While water may appear shallow, it may conceal shafts, trenches, pits, machinery, illegally dumped material or sharp rocks etc. Do not wade across surface waters to collect samples. Be especially careful if it is necessary to sample the walls of a water-filled pit or depression. Wear a personal flotation device (PFD) and/or a full-body harness with shock-absorbing lanyard if there is any doubt about your safety.
- In very cold climates, abandoned raises or shafts may be filled with water in summer and yet have an ice plug remaining at the base. Should the ice melt, it might suddenly flood the lower levels while exploration is underway.
- In winter, the ice formed on tailings ponds may not freeze sufficiently to support your weight. Waters may contain chemicals that interfere with ice formation; there may be drainage or undetectable currents that cause ice to be thinner than normal despite very cold air temperatures. Gases liberated from organic sediments covered by tailings may also cause localized zones of weakness in tailing pond ice. Always measure the ice thickness before an initial crossing and on a regular basis. Work with a partner and follow recommendations in Chapter 15.10 Working on Ice.

22.4.4 | Surface Subsidence

- Watch for subtle signs of subsidence that indicate instability around shafts, raises and stopes that approach the surface. Weathered rock may collapse easily and vegetation may obscure holes, and depressions. A depression may indicate the presence of a shaft, a raise, a pit or excavation that has been backfilled, or subsidence over a stope. If the stope was worked upward to just below the surface, sometimes only a minimal crown pillar or sill may remain.
- Near shafts, watch for loose material that slumps into the shaft. Material may form a funnel-shaped crater surrounding the shaft. Look for cracks in the ground surface some distance from the shaft that indicate slumping is in progress. It is very dangerous to approach a slumped shaft.
- Do not enter slump craters to obtain samples unless you are absolutely certain that the bottoms are solid. They may overlie a shaft, ventilation raise, or other underground working. Use a full-body harness with shock-absorbing lanyard if there is any doubt about safety and stability.
- To determine if a crater overlies a shaft or a pit, look for evidence that indicates whether the area was used as a shaft. Usually a shaft can be recognized by the presence of dump material, machinery, old timbers, and foundations of a headframe.

Figure 22.3: Slumping ground on the surface above underground mine workings © Courtney Mitchell

22.4.5 | Explosives and Chemical Hazards

- Always assume that any explosives are dangerous; deteriorated explosives become unstable and they may detonate with only a slight disturbance. Leave them alone and report them to local authorities or a certified explosives expert.
- Explosives sometimes remain in holes and muck piles where the mine was last worked. There may be blasting caps in unexpected places. Watch out for blasting caps in old buildings and underground passageways. Do not step on them.
- Old nitro-glycerine based explosives should not be handled, but if it is absolutely necessary, wear rubber gloves. Explosives leak and/or sweat over time; these escaping volatiles may cause headaches and affect the heart rhythm and respiratory rate of some people if they are handled or if dust containing the compounds is inhaled.
- Hazardous chemicals may be present and may include reagents used for milling, separation processes or fuelling or lubricating old equipment. Beware of equipment such as mercury retorts, old transformers containing PCBs, decomposing bags of chemicals and leaking drums or boxes etc. Beware and keep away from anything that smells strongly of chemicals.
- Abandoned mines may have been used for illegal dumping of hazardous wastes. Be wary of all deteriorating containers whether labelled with toxic contents, or unlabelled.

- Seek immediate medical attention if you suddenly feel ill or develop respiratory or skin reactions after visiting old workings.
- In the southwestern USA, tracts of land on which old mines occur may have been used for military target practice. You risk encountering undetonated military explosives in these areas. Never touch anything that might be a military explosive device

Figure 22.4: Old chemicals. The contents may not be identifiable. © Lisa Dyer

22.4.6 | Wildlife

- Watch out for snakes, spiders, and scorpions that may live around and in old mine workings. Snakes favour protected ledges and holes. Bees and wasps favour building nests near old mine entrances and cliff faces.
- Dens: Coyotes and other wildlife (even bears) may use mine portals or culverts for dens.
- Diseases: Some animal-borne diseases are directly associated with old mine workings.
    - Histoplasmosis, a respiratory disease that may be difficult to diagnose, is caused when fungus spores associated with bat droppings enter the lungs. If you must enter an area with a large quantity of bat droppings, it is essential to wear the proper PPE. This includes disposable clothing, gloves and a respirator equipped with a high efficiency particulate air (HEPA) filter capable of filtering particles down to two microns in size. The respirator needs to be fit tested and the wearer needs to check frequently that it functions properly. For additional information, refer to the [Canadian Centre for Occupational Health and Safety](#).

- Leptospirosis is a bacterial infection spread to humans by contact with water or soil contaminated with infected animal urine. Leptospirosis may potentially be contracted by people working at mine sites, especially when rats or other rodents are present. Refer to Chapter 12.8.5.8 Leptospirosis.
- Hantaviral diseases may be contracted if humans come in contact with or inhale dust containing saliva, urine or droppings of some species of rodents. Refer to Chapter 18.6.5.3 Hantaviral Disease.
- Rabies may be contracted from the bite of a bat and perhaps very rarely by breathing air contaminated with the rabies virus. Foxes, raccoons, and skunks are well known for carrying rabies. Refer to Chapter 12.8.5.12 Rabies.

Figure 22.5: Coyotes den in these abandoned pipes. Other animals may also be present. © Courtney Mitchell

22.5 | Preparation Requirements to Enter Old Workings

No one should explore old workings unless they have sufficient safety training plus the experience and knowledge to accurately judge the risks and hazardous conditions at the site.

22.5.1 Exploration Team Requirements

Make sure the party is large enough and each member has all the required training and equipment to do their job safely. Exploration of old underground workings should involve a team of at least three and preferably five members. The number should depend on the condition of the mine and how far the exploration proceeds. For safety, always have enough people in the party even if the country where you work does not have mine safety legislation of this nature.

- There must be at least two persons per underground team. Each team going underground should be under the supervision of at least one person who is trained to determine (1) ground conditions – scaling (barring) and sounding, (2) ground support mechanisms and (3) ventilation quality and how to use gas detection equipment. This person should be an experienced underground miner, a mine geologist or a mine engineer, preferably one familiar with the site.
- Members of the team going underground should be required to stay together. No individual should ever work alone underground. Every team member going underground should have training in mine safety techniques. The more training – the safer the investigation should be.
- One person must always remain on the surface and not enter the old workings. This person acts as liaison for those underground and any mine rescue or authorities who might require notification should problems develop. This person should have continuous access to any communication equipment necessary for this job, which may require a satellite phone.
- The team going underground should bring a mine plan with them and they should leave a plan or good sketch map showing the parts of the mine to be explored with the person remaining on surface. The team members who remain at the surface are required to know where the underground team is going and the expected time of return. Those going underground should follow the saying "plan the exploration and follow the plan". Do not change the plan while underground. If changes to the plan are necessary, return to the surface and make changes to the plan with the full understanding of the person(s) at the surface. Then, return underground and follow the revised plan.
- Make sure each individual (underground or surface) has all necessary equipment (see the next section). Do not share equipment between teams.
- During exploration, rope off unsafe areas and place flagging tape across the entrances of drifts etc., that your team is NOT taking. This mine rescue practice makes it easy to follow the route in case emergency evacuation is necessary. A lost individual will be found sooner.

22.5.2 | Equipment

Each person going underground should be trained and equipped with the following safety equipment:

- Hard hat
- Safety boots
- Eye protection
- Gloves
- Cap lamp (with fully charged batteries)
- Alternative light source (e.g., halogen or LED flashlights)
- Spare fully charged batteries and light bulbs
- Safety belt and line (for horizontal work)
- Full-body harness and shock-absorbing lanyard (for work in or around vertical openings), as required
- Hammer
- Spray paint or flagging tape
- Self-rescuer (oxygen producing type). It is recommended that all initial exploration be done with self contained breathing apparatus (SCBA).
- Communication devices (e.g., two-way radio approved for underground use, satellite phone at the surface, as required)
- Wrist or pocket watch – to keep track of time underground and progress of the exploration plan
- Pocket knife

Each team should carry:

- Two (2) scaling bars
- Shovel
- Airflow testing device, as required
- Gas measuring equipment:
    - Oxygen detector
    - Toxic gas detector
    - Flammable gas detector
- Wire rope-type ladders
- First aid kit
- Safety line or rope (20 metres)

Those remaining at the surface should be equipped with all necessary rescue equipment:

- Rope
- Winch
- Stretcher
- Self contained breathing apparatus (SCBA)
- Communication equipment
- First aid kit

22.5.3 | Tests and Procedures Prior to Entry

- Assess the ground stress conditions – both before entering and continuously while you are in the workings.
- Assess the ventilation requirements. Carefully follow government regulations and company guidelines.
- Always test the mine atmosphere before entering, as there may be insufficient oxygen and/or dangerous levels of harmful gases present (see Chapters 22.6 Ventilation and 22.7 Gases). Do not enter until the workings have been flushed with fresh air if there is any doubt about the safety of the mine atmosphere.
- Devise an evacuation plan. Ideally, all members of the team should be familiar with and capable of executing the rescue plan. Take into consideration the equipment and personnel available for rescue. People who remain on the surface should be trained in mine rescue techniques or have a plan to promptly obtain the help of trained mine rescue personnel. Rescue personnel should be capable of retrieving a person from the mine who may be overcome by deadly gases. This may require a winch and stretcher in addition to emergency SCBA. Rescuers will need lengths of rope and the ability to tie appropriate knots for rescue work.

22.5.4 | Underground Lighting

Use the best quality approved lighting equipment available. You will need to see well to avoid hazardous conditions underfoot and around you. Maintain your equipment in good condition; a life may depend on it. When in coal mines, use only equipment approved for use in coal mines.

- Only use approved equipment for the type of mine being explored.
- Use belt-mounted, rechargeable battery packs with focussing headlamps.
- If only a brief underground examination is planned, halogen flashlights may be acceptable. Always carry this type of flashlight for emergency backup lighting.
- Always carry spare, fully charged batteries and bulbs.

22.6 | Ventilation

Carefully follow all government regulations and company guidelines for testing ventilation before entering any old workings or confined spaces. Improve the ventilation system wherever necessary.

- Check underground workings for any natural ventilation. Test all exhaust airways for harmful gases.
- Forced ventilation will be necessary whenever the mine atmosphere contains insufficient oxygen or unacceptable concentrations of hazardous gases. Forced auxiliary ventilation may be necessary if an extensive exploration program is planned. This type of system should have sufficient capacity (correct sized fans) to deliver fresh air to all planned work areas. Complete any necessary inspections of a forced ventilation system before venturing into work areas.
- It is always advisable to use self contained breathing apparatus (SCBA) during the first tour of exploration in an old or abandoned underground site, even when the ventilation has been inspected and found to be acceptable.
- Anticipate dangerous levels of radon in unventilated mine workings in granites, granodiorites or similar felsic volcanic rocks. If there is insufficient natural ventilation, flush out old workings with fresh air before entry, use SCBA and wear dosimeters (see Chapter 22.7.8 Radon).
- If the mine ventilation system is questionable, each and every team that goes underground must be fully equipped with an oxygen meter and gas detection equipment to detect toxic and explosive gases in addition to their self rescue breathing apparatus. Do not share equipment between crews.

22.7 | Gases

Many abandoned and old mine workings contain toxic, flammable or asphyxiating gases or an oxygen deficient atmosphere. Toxic gases may accumulate when ventilation ceases in old workings. This allows gases to concentrate and settle, especially in dead end drives, raises, or winzes. Follow the guidelines above in Chapter 22.6 Ventilation.

- It should be mandatory to carry and be trained in the use of gas detection equipment (e.g., Drager Multigas tubes, single or multiple gas monitors, explosion meters) whenever an employee enters any area with no perceptible air movement. If your equipment detects dangerous gases or oxygen deficient atmosphere, abandon all exploration activities and plans and EVACUATE THE WORKINGS AT ONCE.
- Choose gas detection equipment that is suitable for the type of gas that may be encountered. Gas monitors should have an audible alarm that sounds at certain gas levels and the equipment should have an "ON" switch that cannot be turned off accidentally.

- Follow the manufacturer's instructions for the model of gas monitor that is used.
- Calibration: Calibrate all monitors frequently and calibrate them on-site, whenever possible. An external authority should calibrate some monitors at prescribed intervals. Take into account the effects of relative humidity and altitude when reading the monitors.

- Never smoke, light a fire or use a gasoline engine underground. Fires consume existing oxygen and may ignite explosive gases. Gasoline engines emit deadly carbon monoxide. Even the use of a diesel engine underground requires the approval of a qualified mines inspector and will require a system of forced ventilation.
- Exposure limits: The recommended exposure limits in this chapter are taken from the current Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices published by the American Conference of Government Industrial Hygienists (ACGIH). Some jurisdictions enforce more stringent limits.

22.7.1 | Oxygen (O_2)

Normal O_2 concentration is 20.9% in the atmosphere. To function properly, the human body needs oxygen in concentrations close to this percentage. Any concentration below 19.5% is considered oxygen deficient. Use an oxygen monitor that sounds an alarm when O_2 concentrations fall to 19.5%, and leave it turned on whenever you pass through or work in an area with no fresh air flow. In a confined area, it is possible to consume enough oxygen in 10 minutes to diminish the O_2 concentration by 2%. If more than one monitor is carried and one monitor sounds an alarm, heed that alarm and leave the area immediately. Recalibrate the monitors to determine which one produced an erroneous reading.

Symptoms of exposure to an oxygen deficient atmosphere: A person will breathe more rapidly at 17% O_2 concentration. At 15% O_2 concentration, a person will experience dizziness and headaches and unconsciousness will soon follow.

The following causes contribute to oxygen depletion in mines:

- Oxygen may be diluted by the build-up of nitrogen, methane and/or carbon dioxide.
- Old workings sometimes contain piles of broken sulphide-rich rock within the mine. Gradual oxidation of these wastes may consume the available oxygen or produce sulphur dioxide (SO2).
- Ground water depleted in O_2 will absorb oxygen from the atmosphere.
- Dry rot etc., which causes timber to decay, requires atmospheric oxygen. Oxygen depletion will be more rapid if the air is hot and humid and if timbers are crushed.
- Rusting iron pipes, rails, rock bolts etc., and other iron materials abandoned in mines will utilize atmospheric oxygen.
- Lack of air flow contributes to an oxygen deficient atmosphere.
- The atmosphere in confined spaces may become "layered" if there is no air movement.

Tests for oxygen depletion

- Use an oxygen monitor to test for oxygen depletion. Always use an oxygen monitor and keep it turned on when (1) there is any question about the oxygen content of the atmosphere at the work area, and (2) if the work area or transit route has limited or no air flow.
- If symptoms of oxygen deficiency develop and an oxygen monitor in not available, leave the area and do not return until you secure proper oxygen testing equipment and ventilate the area.
- An oxygen test using a candle or a match is not a good test. Disposable cigarette lighters and carbide lamps will continue to burn in low oxygen atmospheres. Never depend on them as indicators of oxygen depletion.

22.7.2 | Carbon Dioxide (CO_2)

Carbon dioxide is a colourless and odourless gas. CO_2 is classified as an asphyxiant because it may dilute or replace the oxygen required to breathe. CO_2 is heavier than O_2 so it sinks, displaces oxygen and accumulates in low areas.

Exposure to CO_2

- Exposure to CO_2 should not exceed 5000 ppm. This level of concentration can build up in old mine workings especially in low areas with no air flow.
- Symptoms of carbon dioxide exposure: You will breathe more heavily and deeply when you breathe CO_2 concentrations at a low level. This effect is accentuated by exertion. An acid taste develops in your mouth when you breathe CO_2 concentrations at a moderate level.

Sources of CO_2

- Mine fires and the slow combustion of timber release CO_2.
- The breakdown of carbonate ores and some sulphide ores releases carbon dioxide, which may displace oxygen in the atmosphere; this may cause death in confined spaces, see Chapter 22.11 Confined Spaces below.
- Standing water in old mines and biochemical action in moist confined spaces liberate CO_2
- Blasting releases CO_2.

Tests for CO_2

- The only reliable test of CO_2 content is to use a CO_2 detection instrument or detection tubes.

22.7.3 | Carbon Monoxide (CO)

Carbon monoxide is a colourless, odourless and tasteless gas. It is very toxic in very low concentrations because it actively replaces oxygen in red blood cells and starves the brain of oxygen. Humans will die of asphyxiation no matter what the atmospheric oxygen concentration when enough oxygen in the blood is replaced by CO (carbon monoxide poisoning.) Mechanical ventilation systems are necessary when diesel engines are used in any mine situation and gasoline engines are prohibited due to the CO produced and carried in the exhaust. Exhaust from engines operating at the surface must not be allowed to enter mine ventilation systems.

Exposure to CO

- Exposure to CO should not exceed 25 ppm.
- Exposure to 1200 ppm or higher is immediately dangerous to life and health.
- Symptoms of carbon monoxide poisoning begin with a headache. Confusion, staggering, nausea and death will quickly follow. If you suddenly encounter high concentrations of CO, you may collapse with no prior symptoms. Employees should be trained to recognize the symptoms of carbon monoxide poisoning and understand how rapidly it can kill.

Sources of CO

- Incomplete combustion produces CO (e.g., smoldering or slow burning mine fires)
- Blasting operations
- Combustion by-products from fuel burning engines, motors, heating sources
- CO is commonly present in coal mine atmospheres.

Tests for CO

- The only reliable test for CO is to use instruments designed to detect the presence of CO (e.g., Drager Multigas Detector or a gas monitor).

22.7.4 | Hydrogen Sulphide (H_2S)

- Hydrogen sulphide is colourless, extremely flammable and smells initially of rotten eggs. You cannot smell high H_2S concentrations because the gas overwhelms the olfactory (smell) nerves. Like carbon monoxide (CO), H_2S can cause asphyxiation by replacing oxygen in the red blood cells when inhaled. Although this poisonous gas is rarely found in active mines, it is often present in stagnant waters in old workings.

Exposure to H_2S

- Exposure to H_2S should not exceed 15 ppm. More stringent limits may apply depending on local regulations. Exposure to 20 ppm may require breathing apparatus depending on the local regulations.
- Exposure to 100 ppm or higher is immediately dangerous to life and health.
- Exposure to 500 ppm can cause immediate collapse and death.

Sources of H_2S

- The reaction of acidic water with sulphide minerals produces H_2S .
- The reducing action of bacteria in acidic water produces H_2S .
- H_2S is associated with oil and gas operations or may accumulate in petroliferous rocks.
- H_2S may be released in dangerous quantities by disturbing waters in old mine workings because it is very soluble in water.

Tests for H_2S

- Use an appropriate detection instrument to check the concentration of H_2S
- If you encounter the slightest smell of hydrogen sulphide, DO NOT PROCEED. Evacuate the area immediately and stay out.

22.7.5 | Methane (CH_4)

Methane (natural gas) is colourless, odourless and tasteless. It is highly explosive in air in the presence of an open flame if the concentration is between 5% and 15%. Methane may dilute the O_2 concentration in air and cause asphyxiation. In a pure state it is lighter than air and it usually concentrates near the roof in a mine. If CH_4 mixes with carbon dioxide, the mixture sinks to the floor.

Exposure to CH_4

- Ambient air in a mine should have levels of methane below 1 to 1.5%. Use gas monitoring equipment to verify that the CH_4 concentration is below this level.

Sources of CH_4

- Methane is derived from coal seams, decaying timbers and organic matter in rock.
- Methane is most commonly found in coal mines, but it can also be present in metalliferous mines in sedimentary wallrocks.

Tests for CH_4

- Use instruments such as a Drager tube or an explosion meter calibrated for methane.

22.7.6 | Nitrogen Oxides (NO and NO_2)

These gases are very toxic and small concentrations can cause death. NO_2 (nitrogen dioxide) combines with body fluids to produce nitric acid in the lungs and it will replace the oxygen in red blood cells. Enough NO_2 to produce irritation in your nose and respiratory tract may be lethal. While one may not feel the effect for several hours after contact, it may be enough to be fatal.

Exposure to NO and NO_2

- Exposure to NO should not exceed 25 ppm.
- Exposure to 100 ppm or higher of NO is immediately dangerous to life and health.
- Exposure to NO_2 must not exceed 5 ppm.
- Even with an appropriate respirator, exposure to NO_2 must not exceed 20 ppm as that concentration is immediately dangerous to life and health.

Sources of NO and NO_2

- NO and NO_2 form during the detonation of explosives. Water down any dry muck pile where there has been recent blasting. This will convert any NO_2 to nitric acid and prevent people being overcome by NO_2.
- NO and NO_2 form during combustion in diesel engines.

Tests for NO and NO_2

- Use gas monitoring equipment to detect the presence of NO and NO_2.
- The odour of NO_2 is similar to burnt blasting powder. It is unlikely that a person would be able to smell NO_2 as the odour is usually masked by that of diesel or other blasting by-products. If you smell NO_2, DO NOT PROCEED. Evacuate the area immediately and stay out.
- Nitrogen dioxide has a reddish-brown colour. Nitric oxide gas converts to nitrogen dioxide on contact with oxygen.

DRIVING RESPONSIBLE EXPLORATION

22.7.7 | Sulphur Dioxide (SO_2)

Sulphur dioxide is a very poisonous, colourless, irritating gas that smells strongly of sulphur. SO_2 irritates your eyes and respiratory passages as it combines with body fluids to produce sulphuric acid in your upper respiratory tract. SO_2 is a more common problem in active mines rather than in old mine workings, as diesel engines produce the gas during combustion.

Exposure to SO_2

- Exposure to SO_2 should not exceed 2 ppm.
- Exposure to SO_2 of 100 ppm or higher is immediately dangerous to life and health.

Sources of SO_2

- SO_2 may result from spontaneous combustion (fires) in sulphide ore bodies.
- SO_2 may be produced during the oxidation of sulphide ores.
- SO_2 is a product of combustion from diesel engines.

Tests for SO_2

- Use a monitor to detect the presence of SO_2.
- SO_2 produces a suffocating, pungent sulphurous odour. If you smell it, DO NOT PROCEED. Evacuate the area immediately and stay out.

22.7.8 | Radon (Rn)

Radon and its decay products are a serious hazard to lungs because they are radioactive. Once inhaled, the radioactive atoms tend to remain in the lungs and emit alpha radiation, which destroys lung tissue. Flush old workings with fresh air before entering and always carry and use detection equipment (using this equipment may be a complex procedure). For extended work, consider the use of dosimeters. Respirators are needed when the concentration of radon gas and radon daughter products exceed recommended levels.

Sources of radon

- Expect dangerous levels of radon and decay products in the stagnant air in old uranium mines and any mine within granitic, granodioritic or felsic volcanic rocks. These rock types frequently contain radioactive minerals that decay and produce radon as daughter products.
- Radon levels can be high even though a mine has never produced uranium.

- Radon may be present in water in old mine workings in higher concentration than in the mine atmosphere. If you disturb the water you may release radon that was not initially detected.
- Avoid dust and smoke (cigarettes) as radon and decay products attach to smoke particles.

Tests for radon

- Use detection equipment to test the exhaust air of the mine. Continue monitoring the atmosphere while working in the mine unless the atmosphere is well flushed and the work is only for a short time.

Information about ionizing radiation risks can be found in 15.0 Guidelines for Radiation Protection during Exploration for Uranium on the Environmental Stewardship Toolkit.

22.8 | Shafts, Adits, Tunnels and Declines

Shafts

Exploration personnel should never enter old or abandoned vertical shafts without the project having first been examined and safety determined by appropriate mine engineers and safety personnel. It is beyond the mandate of these guidelines to cover safe entry or descent of mine shafts. Thus the PDAC recommends that no one enter such workings without professional mining staff involved (e.g., professional miners, mining engineers or specialists trained in mine remediation).

Adits, Tunnels and Declines

To investigate adits, tunnels and declines, there should be at least three (preferably five) fully trained and fully equipped members on the team. No less than two team members may enter the workings. The leader should be an experienced underground miner, a mine geologist or a mine engineer, preferably one who is familiar with the underground workings. At least one team member must remain at the surface to act as liaison for the underground team members and for any mine rescue or government authorities who might require notification should problems develop or if the underground team does not return by a pre-set time. Team members should follow the required preparation procedures as described in Chapter 22.5 Preparation Requirements to Enter Old Workings.

- Check for air movement. Do not enter abandoned workings unless there is a perceptible air current or you have flushed the workings with fresh air. If there is any doubt whatsoever, carry and use gas detection equipment, an oxygen monitor and SCBA.
- Portal: Carefully clear away loose rock and debris in front of the portal. Inspect the wall rock, back (roof) and any support material before entering. Rock falls commonly occur at the portal because it is commonly a zone of weakness. Before entering, check carefully for snakes, rodents and larger animals. Use the portable lighting equipment to inspect the interior before entering. Do not touch the back (roof) or ribs (sides), especially if entering a decline.

- Declines: Use extra caution. Some declines are steep and may require ropes and belays to enter safely. Bar down or scale as required before entry but do not touch the back (roof) or ribs (sides) unnecessarily, as this may dislodge material.

As you proceed:

- Scaling (barring): Check the condition of the back (roof) with a scaling bar. Check for the hollow sound of loose rock in the back. Never pass under “drumming” (hollow sounding) ground without scaling down. Never ignore this job. The experienced person present should scale and follow strict safety procedures while scaling. The entire roof may cave in if scaling is not done correctly.
- Watch out for slabs or rock that may break off the walls.
- Continuously watch for signs of loose ground. These may occur in areas of geologic weakness or where blasting has taken place. They include cracks, fractures, rock falls etc.
- Evacuate the area immediately if you hear a trickle of ground falling – however gently – from the back (roof).
- Evacuate the area immediately if you hear any loud snapping sounds. These sounds indicate a potential rock burst.
- Be wary of water that runs or trickles down passes or chutes as it may trigger a run of material.
- Never disturb hang-ups in chutes and ore passes under any circumstance. You may trigger a rock fall or cave-in.
- Watch out for open holes, winzes, chutes and passes. Secure yourself with proper fall protection equipment (including a full-body harness and shock-absorbing lanyard) whenever working near winzes, ore passes or other vertical openings.
- Mark the route clearly at each junction with spray paint or flagging tape. Place flagging tape across the drifts and openings that are not entered or explored. This mine rescue practice indicates to any followers the route that was not taken. Rope off any sections of the mine that are considered unsafe. Do not rely on old maps as they are often inaccurate or incomplete.
- Beware of abandoned equipment or objects that may stick out from walls (e.g., nails, wires and pipes, boards with nails or sharp rails).
- Do not unnecessarily touch any equipment, service ducting or valves that may be encountered.

22.9 | Common Hazards in Old Underground Workings

22.9.1 | Timbers

- The presence of underground support materials may give a false sense of security; these may be very weak even though they appear strong and well maintained.
- Stay out of old timbered areas and stoped areas, as it is impossible to determine the support strength of old timbers. Dampness will rot timber quickly, but dry rot can occur even when a mine is very dry.
- When you find the remains of timber, this may indicate a zone of weakness that required support at the time of mining. Anticipate that ground conditions will have further deteriorated.
- The condition of timbers may reflect the stability of the ground in the mine. Watch out for rocks sitting on timbers, crumpled or compressed tops of timber supports, and broken or compressed cribs and stulls.
- You could be injured or killed by falling timbers. Do not bump them or do anything to add to their load. Because it is impossible to determine how much weight timbers can support, it is only safe to assume that they are at their limit. One should be particularly suspicious of the strength of old timbers on the floors of tunnels and those found in shaft collars and adit portals. Dry rot may have weakened them; they may collapse when stepped on or jarred.

22.9.2 | Ladders

- Unmaintained ladders are extremely hazardous due to rust, which weakens the ladder and fasteners to rock. Wooden ladders may be rotted and unsafe to use. Use rope and belay techniques when using an unmaintained ladder the first time – and any time you are unsure of its safety. Use ladders only when there is no other choice.
- Before use, inspect the ladders to make sure they are properly affixed to the rock or to timber that is in good condition. Old ladders may show signs of deterioration (e.g., rusted metal nails, rotten timber, missing rungs).
- Never step off a ladder without checking that the landing is safe. Ladders sometimes end where staging has fallen away. Check that your footing is secure as loose rocks on landings may cause falls.
- As you descend, go slowly and carefully – one person at a time on the ladder. Hold on to the rungs rather than the sides of the ladder. Take care when placing your feet because there may not be much space between the rungs and the wall. Take care not to kick material onto someone below you. The first person down the ladder may be able to safely remove loose debris, but never knock anything down if there are people below.

- While descending, note the condition of the ladder and timber. If it deteriorates, do not descend further. Do not count on another exit route.
- Do not look upwards when ascending a ladder. Do so only if wearing safety glasses.

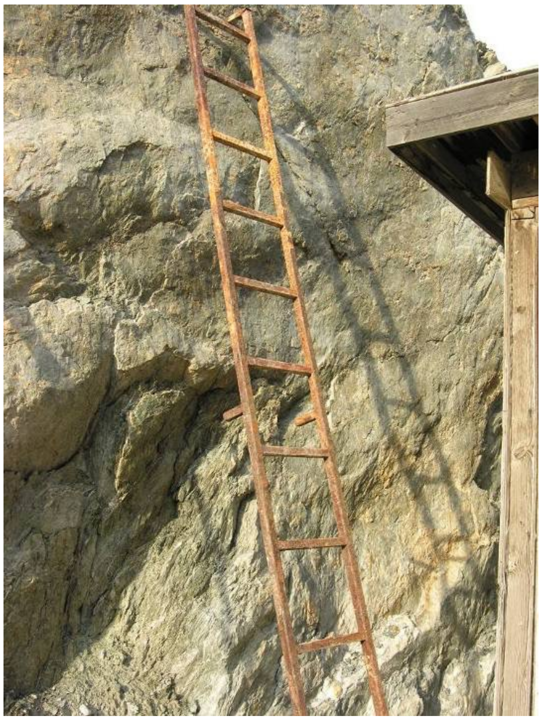


Figure 22.5: This ladder was removed due to its deteriorated condition. © Courtney Mitchell

22.9.3 | Water

- Do not proceed through old workings when the floor is under water until the floor is well tested with a probe. Water may conceal slippery, slimy surfaces. It may hide winzes, holes or pits, old machinery, sumps, rail lines, broken rocks etc. If you must proceed and there is any question of safety, wear a safety rope.
- Before walking on them, carefully test all boards, steel plates or timbers on the floor that cover pools of water. They may cover passes or winzes and may no longer have sufficient strength to support any weight.
- Disturb standing water as little as possible. Pools of water may contain dissolved H_2S or radon that may be liberated when people splash through them.
- Water may enter an old working and flood it or it may be an intermittent problem. It is never safe to enter unfamiliar old mine workings (or caves) in rainy weather, as nearby streams may overflow and enter shafts or other openings.
- Water may be alkaline or acidic and cause skin irritations.

22.9.4 | Muck Piles and Mine Fill

- Do not follow anyone up a muck pile. Wait for them to reach the top before ascending. Take care when descending not to dislodge material onto people below.
- Watch out for fine muck piles (particularly massive sulphide muck), as these may begin to avalanche if you step on them.
- Beware of wet slime that has accumulated as fill; it may retain its moisture content and not support your weight – you may sink into it. Coarse-sized mine fill is usually very sound and should support a person's weight.

22.10 | Sampling on Abandoned Mine Sites – Surface and Underground

- Before taking samples, complete a tour of the workings to determine if it is safe to do so. Use common sense. Never take samples from workings with unstable ground, collapsed timbers or where rock has fallen from backs (roofs), raises or chutes.
- Before taking samples, a trained person must carefully sound and scale (bar) down loose material with a scaling bar to test the back and sidewalls. Scaling is very dangerous and should only be done by an experienced underground miner.
- Do not take samples from shatter points caused by explosives or around old drill holes. The impact of your hammer may detonate any remaining explosives.

- Do not sample from underground equipment (e.g., scoop trams).
- Wear eye protection while sampling. Watch out for nearby effects – loosening of pieces of rock overhead and slabs on walls.
- Use caution when searching for core samples in old core storage areas. The supporting framework may have deteriorated and core boxes may be very unstable. Watch out for snakes or scorpions etc., that may inhabit old core boxes.
- Do not wade across surface waters to collect samples. Be especially careful if it is necessary to sample the walls of a water-filled pit or depression. Wear a personal flotation device (PFD) and/or a full-body harness with shock-absorbing lanyard if there is any doubt about your safety.
- Sampling on the surface near old abandoned shafts is very unsafe. Wear a safely anchored full-body harness with shock-absorbing lanyard.

22.11 | Confined Spaces

Confined spaces present special hazards to workers that include oxygen deficiency and/or toxic or asphyxiant gas accumulations, fires, flooding, falls and entrapment. The exact definition of "confined space" varies according to the type of industry and the jurisdiction, but the basic criteria for a confined space commonly include the following:

- There is a limited opening for entry and exit.
- There is limited natural ventilation with the potential for containing hazardous atmosphere.
- The space is not designed or intended for continuous occupancy, but is large enough for an employee to perform work.

All Canadian and US jurisdictions have regulations that address confined space entry although different jurisdictions use additional criteria to define a permit-required entry into confined space. It is extremely important for a company to identify any confined spaces and permit-requiring confined spaces that their employees or contractors may be required to enter.

Confined space fatalities: Almost 70% of confined space fatalities involve compromised atmosphere – victims die from lack of oxygen or are overwhelmed by toxic gases. Some studies indicate that about half of these deaths are would-be rescuers. Studies also indicate that the deadly conditions were pre-existing, which indicates that no testing and no ventilation of the space were carried out before the accident. The earth's normal atmosphere contains 20.9% oxygen and the oxygen level must be between 19% and 23% for safe entry into a confined space.

Risks and hazards of confined spaces that may be encountered by exploration employees

- Death or injury caused by atmospheric hazards:
    - Suffocation: The lack of ventilation, the presence of some oxidizing processes, the presence of some gases and/or water may all contribute to an oxygen deficient atmosphere causing death.
    - Asphyxiation: Some gases create a toxic atmosphere and poison the body (e.g., carbon monoxide, hydrogen sulphide). Carbon monoxide poisoning is frequently the cause of death when fuel powered equipment is used in an enclosed space (e.g., power washer, heating device, generator).
    - Agitation of stagnant waters, sludges and/or residues can liberate dissolved or trapped toxic gases.
    - Mineral decomposition processes may release toxic or asphyxiant gases that replace oxygen in the atmosphere.
- Difficult or dangerous rescue conditions:
    - Rescuers may be at risk due to oxygen depletion.
    - Restricted access may make a rescue very difficult.
- Slips, trips, falls caused by walking on uneven or slippery ground, stepping on material that collapses, wearing inadequate footwear
- Getting lost caused by poor visibility
- Thermal or chemical burns caused by fire and/or explosion:
    - Flammable gases may be present in dangerous concentrations (e.g., methane).
    - Too much O_2 in the atmosphere (over 23%) creates a fire/explosion hazard.
    - Restricted access makes escape very difficult if there is a fire.

Responsibilities Regarding Confined Spaces

Exploration Companies

- Develop written safe operating procedures for entry to and working in all confined spaces. Comply with requirements of the AHJs for entry into confined spaces. Develop a confined space safety program, as required. See the prevention and preparation section below.
- Make sure a risk assessment of any confined space is completed by a qualified person and the risk information is fully documented. The results should be communicated to supervisors and workers so they know what hazards to expect.
- Make sure supervisors and employees are adequately trained to safely perform their duties, use their PPE, and carry out potential emergency procedures related to the specific type of confined space.
- Supply all required PPE, such as gas monitoring and testing equipment, and make sure it is properly calibrated.

- Make sure that people are aware of confined spaces by posting signage and restricting access. Make sure employees conform to confined space entry requirements including the issuing of an entry permit, as required. Make sure safety measures remain in place.

Supervisors

- Develop site specific SOPs regarding confined spaces that conform to the elements of the confined space safety program, as required. Make sure employees are trained and that they understand and implement the SOPs.
- Make sure hazards are identified and evaluated each time before any employee enters a confined space.
- Make sure workers are aware of the risks and hazards associated with confined spaces and the requirements to enter a confined space if they are required to do so as part of their job.
- Develop a site specific ERP that addresses situations where there is potential for oxygen depletion and rescue when an employee collapses.
- Prevent access to confined spaces by unauthorized, unprepared people (workers, public, site visitors etc.).
- Make sure the correct PPE and equipment are used by any employee who enters confined spaces.
- Document all testing and/or entry permits and keep them for the required length of time.

Employees

- Follow all SOPs, training, and use all required PPE regarding confined spaces.
- Always test the atmosphere and document the test results. Continue testing while working in any confined space, as required.
- Follow all ERPs, especially regarding potential oxygen depletion situations if a co-worker collapses.

Although true “confined space” work is rare in the mineral exploration industry, there are circumstances when confined spaces may be encountered.

- Old or abandoned underground mine workings: These fit some of the general criteria and the most obvious hazards stem from potentially low oxygen atmospheres or toxic atmospheres due to the higher than normal presence of carbon dioxide and hydrogen sulphide etc. If diesel motors are used, there is the additional risk of carbon monoxide build up. Some old mine workings contain methane, which is a potential explosive hazard. Hazardous amounts of radon and hydrogen sulphide may be dissolved in underground water, which can be disturbed and liberated when workers splash through it. Any long narrow opening such as a tunnel may develop features of a “confined space” when air flow is limited.

- Unexpected confined spaces: Monitoring stations – a small enclosed building may, through its design, be an enclosed space. Be careful and observant when exploring near tailings and waste rock dumps. If the site contains a combination of sulphide and carbonate minerals in the waste rock dumps, tailings piles, tailings dams, ore stockpiles etc., the minerals may react to produce carbon dioxide and potentially produce a severely oxygen deficient atmosphere. Factors such as soil cover and air temperature may limit the mixing of escaping gases and cause the gases to concentrate within the piles. In addition, if temperature conditions combined with air and water circulation force the gases out of the rock piles at the toe of the dump, they may accumulate at a low point in a closed monitoring station. This can in effect become a "confined space" that contains toxic atmospheres – with potentially deadly consequences. This is a documented cause of death in the mining industry. At old mine sites it is also possible for heavy gases to accumulate in open spaces such as low lying depressions or sheltered ravines below dump toes etc.
- Trenches or pits: Their configuration and the use of gasoline or diesel powered equipment (even nearby on the surface) may cause exhaust fumes to drift and sink into the excavation and asphyxiate workers. This is a documented cause of death in the mineral exploration industry.
- Adits or shallow mine shafts: Any long narrow space may develop an oxygen deficient atmosphere if the space lacks ventilation.
- Tanks, sumps: Enclosed storage tanks for fuel etc., are typically considered to be confined spaces. Maintenance work on the inside of any tank would require a confined space entry permit (see the prevention and preparation section below). The presence of rust on the inside of a structure is an indication that oxygen has been absorbed from the atmosphere. This may result in an oxygen deficient atmosphere, which may not be obvious to people who are not trained in confined space safe work procedures.

Prevention and Preparations

- Identify any confined spaces that may be accessed by employees. Identification should include any possible confined spaces at old mine sites in the area that employees might be inclined to visit. Companies are advised to develop a policy regarding the entry to such confined spaces including possible access to those spaces when employees have recreation time.
- Training: Employees should receive training regarding (1) the recognition and identification of confined spaces and potential specific hazards, (2) the elements of the site confined space safety program, (3) the proper use of PPE, (4) the emergency response procedures should a co-worker collapse, and (5) confined space and/or mine rescue training, as appropriate.
- Carry out the following before each and every entry into a confined space:
  - TESTING is essential to determine if the atmosphere in the confined space is safe for workers to enter.

    - Check and calibrate (if necessary) all gas testing equipment according to manufacturer's instructions. Before use, make sure the correct sensor is in the air monitoring equipment. Keep maintenance records.
    - Rescue plans: Employees should be familiar with the requirements of the AHJs regarding rescue equipment that must be immediately available. They should be able to rescue co-workers and have all necessary means of communication and transportation to a medical centre in place.
- Carry out the following while working in a confined space
    - Continue testing while working in a confined space. Take measurements at high and low levels. Gases that are lighter rise and those that are dense sink. In an old drift, it is possible for one person can consume enough oxygen to deplete the atmosphere in about 10 minutes.
    - PPE: Employees should wear or have available all required PPE, which may include safety glasses, hard hat, appropriate safety footwear, gas monitoring and testing equipment, SCBA, a self-rescue breathing apparatus, and other items required by the company or AHJs. Only trained employees should be permitted to use SCBA.
- Confined space safety program: A confined space safety program should be developed as required by AHJs. The safety program should include the following elements as a minimum:
    - Confined space policy that clearly defines responsibilities
    - Confined space identification, warning signage
    - Written SOPs that apply before and during work, which may include a required entry permit system.
    - Personal protective equipment
    - Atmospheric testing and ventilation
    - Fire safety
    - How to control all hazards before and during work
    - Emergency response plans and procedures
    - Training program
- Confined space entry permit: The use of a confined space entry permit verifies that proper safety procedures are followed each time a worker enters a specific confined space. The permit identifies the location and type of confined space, the permissible duration of the work, details of the work performed, and the safety tests performed (e.g., atmospheric tests, precautions taken before entry, PPE requirements). The permit is filled out and signed by a person in authority and the entry workers; it should be kept as a record of compliance with AHJs.

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