# Diamond drilling in extreme weather

## Drillers' guide

Epiroc



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# Introduction

Heavy rainfall, storms and extreme temperatures all contribute to the challenges of performing a job safely and efficiently.

# What drillers need to know before braving the elements

If you're a diamond driller, you know that extreme weather conditions are part of the job, from severe heat during summer months, to brutal cold in the winter. Each brings its own challenges to drilling, whether it be the safety of drillers or changes to drilling equipment. This guide will provide some useful tips on how to use your drilling equipment in extreme weather, and how to stay safe.



# Cold weather - Dangers of extreme cold

In cold weather conditions, a little prevention and foresight can protect drilling crews and save time.

Working in an environment of about 22 degrees Celsius (73F), with 45 percent humidity is comfortable for the majority of people. If physical labour is involved, workers can easily tolerate and prefer lower temperatures. However, there is more involved than simply measuring the temperature. Other factors will affect how the body perceives the cold, and the biggest culprits are humidity and wind chill.

Cold weather combined with high levels of humidity makes you feel colder. If humidity levels are very high, the moisture in the air can saturate clothing, making a cold environment feel even colder. There is also wind chill which measures the rate of heat loss caused by exposure to wind. The body will feel colder as the wind increases.

## The hazards of extreme cold

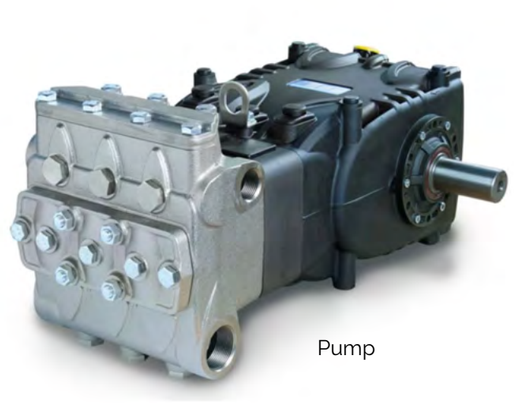
Beyond discomfort and inconvenience, cold temperatures can pose serious threats to drillers' health. Frostbite and hypothermia are the most common ailments due to cold. Frostbite occurs when your skin or muscle tissue freeze from exposure. The early signs include tingling, stinging, or an aching feeling in the exposed area that is then followed by numbness. Frostbite is treated by covering affected areas with dry, soft, clean cloth bandages. Avoid massaging the area as it can worsen the damage to the tissue.

Hypothermia is a more serious and potentially fatal condition that requires immediate medical attention. The body temperature falls and presents symptoms such as shivering, the inability to perform complex motor functions, mild confusion, and lethargy. If the temperature falls drastically, loss of consciousness and heart failure can occur. The symptoms of ailments related to the cold can be easy to miss. Drillers should know how to identify the conditions and treat them effectively. A prevention and treatment program should be in place.

## Keeping the drill shack warm

The drill shack has limited space but must accommodate the driller and drill station while offering enough room for the helper to empty tubes, maintain equipment and perform other tasks. Although it is a small space, it can be hard to heat because while you can try to keep it enclosed, it is almost impossible to keep all the cold air out.

The helper's job includes bringing in core boxes, rods, or other equipment from outside, moving full core boxes to the outside, checking the supply pump, and more. To do that, he is repeatedly opening the door and allowing cold air to enter. Complicating matters, there are holes in the shack. There is a large hole in the roof where the mast from the drill rig pokes through. The mast can be covered with a tent-like structure, or the hole may be blocked off with plywood or hinged doors, however, neither of these will work if you are using a rod handling system. There is also another hole in the shack floor that allows passage of the drill rods and casing. This hole allows cold air to enter from below the drill rig and is appropriately referred to as the "pneumonia hole".



Pump

Sometimes the radiator fan on the diesel engine can be used to change the temperature inside the drill shack. In winter it can be turned so that it draws hot air into the drill shack. In the summer months, it can be turned the other way to exhaust the hot air out of the drill shack. Ideally, supplemental heat must be added in cold weather, usually the kind of heater used in construction.

## Water heaters

Core drilling demands a constant source of water. Winter brings the challenge of frozen water lines, broken pumps, ice buildup from leaky lines and components and a host of other issues. The key to preventing freezing is to keep the water moving. Water will not freeze if a constant flow is maintained. However, long distances will require a coil heater to warm the water enough to keep it from freezing as it travels from your water source to the drill rig. Many drillers will use snow as a way to insulate the water from the cold air, but this can't be done until snow has fallen. The temperatures can dip into the freezing zones even in the absence of snow.



For best results when pumping from a lake, river, or reservoir, set up a steel shack on skids at the source of the water. This mobile shack should contain the pump, diesel engine (with a heavy-duty alternator to generate a little more power to accommodate lights and power the oil burner), a battery and the coil heater.

Drillers can choose between two types of heaters. The first is a diesel-fired coil heater that is fitted with an oil burner exactly like the furnace in a house. This is often the best choice as diesel is already needed for most of the equipment on-site, including the drill, pump, and mobile equipment. The second option is a propane burner equipped with a thermo-coupler that will turn the gas off if the flame is blown out, which is a must for safety.

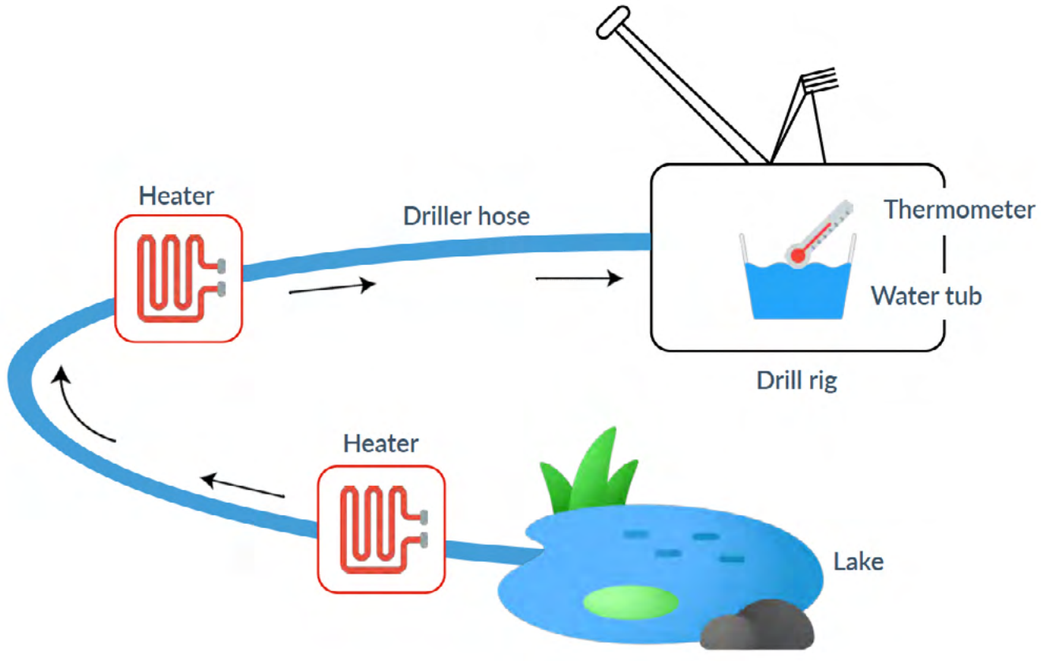
Keep in mind that propane can be problematic in cold conditions. Propane contracts when it's cold. In extreme cold the volume of propane inside the propane tank will shrink, creating a loss of pressure.

To counteract this, drillers will hook up a series of 100-lb tanks, allowing more of the available propane in each of the tanks to be used. Coil heaters have an inlet and an outlet, and water is pumped through the coil on the inside of the heater. A flame from an oil or propane burner is forced through the center of the coil, heating the water as it flows through.

The pump will draw the water from a nearby lake, river, reservoir, or beaver pond, push it through the coil heater, and from there, through the water hose to the drill rig. It is important to use a driller hose for this purpose as lay-flat hoses are not suitable for these longer distances. This process ensures that the water stays above the freezing point for the trip to the drill. However, in extreme cold, the suction line remains vulnerable. One trick is to tape the hot water line from the exhaust port of the coil heater to the suction line of the pump, all the way back to the source (usually a hole in the ice). The two lines can be insulated so that the heat from the hot water line will keep the suction line from freezing.




Water heater




If the distance that the water is travelling is very far and the temperature is too low, there is a chance the water may freeze along the way. In this case, another coil heater can be installed along the way. It can also be wise to have a thermometer in the water tub in the drill so the water temperature can be monitored, and action taken before a complete freeze-up occurs.

A water heater can heat the water from the reservoir to the pump and the borehole. Suppliers offer various water heaters, either oil or propane fired. Epiroc's standard version comes with an Easy Flow Coil system that eliminates high pump pressures and ensures maximum heat exchange for excellent efficiency and easy draining. Make sure the unit you select has a heavy-duty base and roll cage. This will help make the unit portable, easy to handle and will provide added protection.



# Drilling in permafrost

In certain situations, drilling will occur in arctic-like conditions where the temperature is much colder than the crews have experienced in the past. Once you are below 15 feet in depth, the ground temperature is always 12 degrees Celsius, unless you are in permafrost where it will be colder. When drilling in permafrost, special considerations need to be taken to prevent water freezing.

## Treating the water

Once water gets to the drill, the challenge is to keep it from freezing on its way down the rods and back up the hole. In areas of permafrost, this can be a serious challenge. Some drillers add salt to the drill water. The presence of salt in water reduces the freezing point of water. The more salt in the water, the lower the freezing point will be.

It's important to note that drilling additives do not offer the same results when salt water is used. If salt water is used instead of fresh water, two or three times the usual amount of polymer may have to be used to obtain the same results. Another option is a product such as Slo-Freeze, a fluid that extends the freezing time of water and does not contain alcohol or glycol.

Calcium chloride can also be added to water. Calcium chloride generates heat as it dissolves, and this forms an ice-melting brine. Calcium chloride is relatively harmless to plants and soil and as a de-icing agent, it is much more effective at lower temperatures than salt. A potential safety issue is that calcium chloride can irritate the skin so drillers must be sure to have their protective personal equipment (PPE) with them when using calcium chloride.





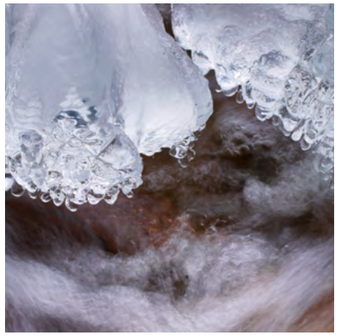

# Drilling on ice

The drill site should have procedures for working on ice. Drillers should be aware of changing weather conditions as these will have an impact on the ice. Additionally, the drill rig floor should always be free of ice as well as the grab on mast. Some drilling sites can be directly on the ice of a frozen lake or other body of water. Companies must develop a Best Practices Plan to ensure the safety of workers and equipment. The ice must be thick enough to withstand the weight of all the equipment that will be positioned on the ice.

This calculation must account for permanent equipment such as:

- Drill rig
- Drill rods
- Consumables
- Drillers themselves
- Core
- Any other equipment that will be required

When drilling on ice, environmental regulations must also be respected. Drill sites must be cleaned so no oil or drill cuttings can be left behind.



One thing that is certainly not impacted by cold weather, is the heat down at the bottom of the hole. Make sure that you are cooling your diamond core bit sufficiently at all times. The core bit doesn't care how low the temperature goes on the surface, if a continuous flow of drilling fluid is not maintained, the diamond tools will suffer immediately. Operations may have to stop if water freezes and causes equipment to become stuck in the hole. Keeping everything warm is a full-time job so make sure you plan ahead!



# Drilling at high altitudes

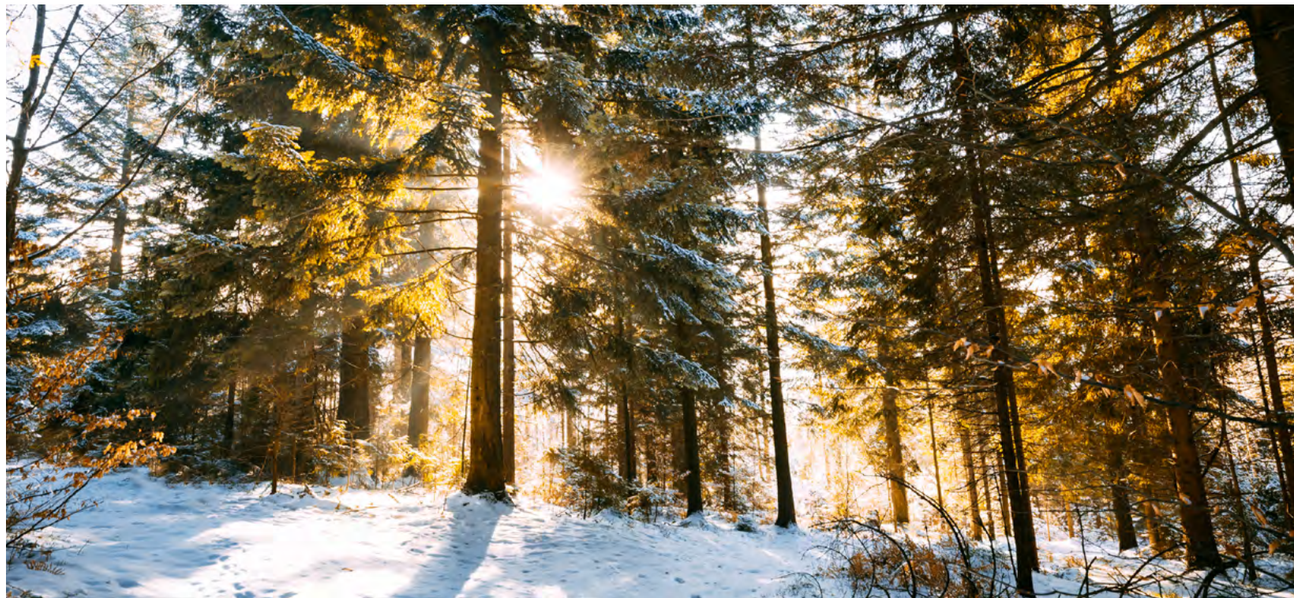
Cold weather is not just related to geographical location. Drillers may have to deal with cold weather combined with a high altitude. Drilling that is performed at altitudes that are higher than 15,000 feet is considered high altitude drilling and drillers will encounter adverse conditions that can affect their health and safety.

Additionally, these conditions will affect how drilling equipment performs. At altitudes greater than 10,000 feet, getting enough oxygen becomes a challenge not just for drillers but for the engine and hydraulics as well. Safety issues for drillers include lack of oxygen and altitude sickness.

## High altitude effects on equipment

Lack of oxygen will also affect your drilling equipment and machinery. A diesel engine will not run properly when oxygen is depleted as the air will be too thin. The engine will be starved for air and you will see a loss of power with a fluctuating torque output.

The loss in horsepower can be as much as 3% for every thousand feet above sea level. In addition to power loss from the engine, your hydraulic system can also be affected. You will notice this in your rotation and feed pressure. Rotation and feed pressure can also be affected. If possible, get a high-altitude kit for your engine, and pressurize your hydraulic reservoirs to ensure proper functioning. Mountainous conditions also mean that the rock or ground will be in poor condition so drilling fluid additives will probably be needed.



### High altitude effects on drillers

Lack of oxygen at high altitudes affects people differently, and it is not always related to the fitness level of an individual or their body type. Symptoms can include fatigue, shortness of breath, nausea, headache, dizziness, lack of appetite and problems sleeping. It can be like trying to run with someone on your back and their hand over your mouth. Altitude sickness, also known as mountain sickness, occurs when the pressure of the air (barometric pressure) changes.

Symptoms are usually noticed within 12-24 hours of reaching higher elevation when the air pressure drops and there is less oxygen available. The body needs time to adjust to new air pressure and if it exposed too quickly, altitude sickness happens. Pressure chambers will re-acclimatize the body, but diamond drilling sites are not equipped with them. The best way to deal with altitude sickness is to get down to a lower elevation. You should try to sleep at lower elevation to lessen the stress on the body.

When you are working at higher altitudes, try to go up for shorter times and come back down to get your body used to the higher elevation. Other tips include drinking lots of fluids, eating regular meals and staying away from alcohol: simple but effective advice. Be aware that mountain conditions can change suddenly.

The day could start with manageable temperatures that can suddenly drop so always be prepared. If it is determined that a helicopter cannot reach the site, then work has to stop and drillers should take shelter in the shack until the conditions improve. Have a medical test beforehand and bring cold weather gear. Be aware of mountain sickness symptoms and get down to lower elevations if necessary.

## Drilling in extreme heat

Workers in drilling industries may also be required to work for long periods of time in intense heat. Often the impact of extreme heat on the body is minimized or ignored. Heat-related illnesses are realities that occur when your body temperature increases to dangerous levels.



Contributing risk factors that can cause or worsen these conditions include:

- High temperature and humidity
- Low consumption of fluids leading to dehydration
- No air movement
- Direct exposure to the sun with lack of shade
- Use of heavy protective clothing and equipment
- Physical exertion
- Radiant heat from motors, machinery, etc
- Lack of acclimatization to hot workplaces

### High altitude effects on the body

**Heat Stroke**: The most serious condition related to heat which occurs when the body is unable to cool itself and body temperature rises to more than 104F. Symptoms include confusion, loss of consciousness and seizures. It is considered a medical emergency requiring an emergency call. While awaiting medical help, move the worker to a shady, cooler area, remove clothing, cool the body with cold water and circulate air to speed cooling.

**Heat exhaustion**: Occurs when body temperature reaches over 100.4F and requires a trip to a clinic. Symptoms include headache, nausea, dizziness, weakness, confusion, thirst, heavy sweating and irritability. Recommended treatment is to move the worker to a shady, cooler area, remove clothing, apply cold compresses to head, neck, and face and provide liquids to drink.

**Heat cramps**: Muscle pains are caused by physical labour in hot environments because body salts and fluids are lost during sweating. To prevent heat cramps, drink water or carbohydrate/ electrolyte replacement drinks every 15-20 minutes.

**Heat rash**: This common occurrence is caused by sweating that appears as a cluster of blisters or pimples, usually on the neck chest or in body creases. To treat the rash, provide cooler less humid environment. Keep the rash area dry with powder if necessary.

### Tips to prevent heat related illness

Ensure that all workers who may be exposed to extreme heat are aware of symptoms and how to treat them.

- Provide personnel with plenty of water and remind workers to drink frequently, at least 6 ounces every 20 minutes but no more than 12 quarts within 24 hrs.
- Provide weather protection such as tents for shade and cool rest areas. Schedule frequent rest periods and water breaks.
- Adjust schedules so that physical work in done during cooler parts of the day.
- Allow workers to acclimatize to hot work environments.
- When possible, allow cool clothing and avoid non-permeable protective clothing.

### Other hot weather considerations

### Sun exposure

Diamond drillers often spend a lot of time outdoors, and in the summer, this means a lot of time will be spent in the sun. When your skin is exposed to excessive sun it responds by turning red, hot and becoming painful to the touch. If you burn severely, your skin can peel and blister as well. You are more likely to burn if you are in direct sun during the peak times between 10:00 am and 3:00 pm. For those who work outdoors, this is impossible so the need for protection against sunburn is vital. Luckily, sunscreen is an easy solution.

### Mosquitos

As people who work outdoors for long periods of time, mosquitoes can be a nuisance for diamond drillers, but with outbreaks of West Nile virus infection, which can lead to serious disease, and and Zika virus, protection against mosquitoes is important. Protection can include the use of insect repellents, mosquito repellent clothing and netting and mosquito repellent devices such as coils, candles and ThermoCELL products.





## Other extreme weather conditions

### Lightning

The possibility of electrocution from lightning is rare but possible for anyone who works outdoors. Storms can arrive suddenly bringing thunder and lightning conditions. In these conditions, drillers should shut down the drills and get off the site quickly. The steel mast and steel pipes in ground can all attract the lightning making it dangerous.

### Underground drilling

Underground drilling can bring its own set of dangerous conditions. Underground mines in certain places of the world are extremely hot and have poor ventilation. It gets hotter the deeper you go and this is exacerbated by the fact that there is also heat that radiates from the machinery and motors. Extreme humidity is another problem in underground drilling. This humidity can lead to equipment rusting very quickly so care needs to be taken. Try to store equipment in cases and only take it out when it is needed. Some regions in very hot climates have implemented special work protocols, such as working for 15 minutes and then taking 20 minutes to cool off. Make sure you familiarize yourself with the drill site's protocols.

## Conclusion

Diamond drilling happens outdoors, and extreme weather can be difficult as drillers have to deal with uncomfortable conditions. A good safety program, the right equipment and advance planning can help ensure that your drilling operation is successful and that everyone remains safe. As weather can change very quickly, moving from acceptable to dangerous, drillers need to be alert and monitor the changes so protective measure can be taken.

Our technical support team is always available to help and has a lot of experience to share. Don't hesitate to contact them to provide guidance and tips.

At Epiroc, our goal is to improve drilling performance and accelerate the transformation of our industry.

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