

10.0 Hazardous Material

Hazardous material includes items or commodities that pose an undue risk to any of the following:

- Health
- Safety
- Life
- Environment
- Personal property

Whenever a suitable non-hazardous alternative product is available, use it in preference to using a hazardous material. Hazardous materials generally include gases, liquids, powders, and solids that are one or more of the following:

- Toxic
- Flammable or combustible
- Corrosive
- Asphyxiating
- Radioactive
- Reactive
- Explosive

Even at the prospecting stage, most exploration activities use commodities that are defined as hazardous. However, once in the drill stage, or at any stage in large remote camps, the volume of hazardous material used is appreciable, and specific procedures and training in their use become mandatory.

To mitigate risks that come with these hazardous materials, pay close attention during any exploration program to:

- Transportation
- Storage
- Handling
- Disposal

By following specific procedures at all stages, even if only small amounts of hazardous materials are involved, the impact on the environment will be lowered. In addition to their effect on the environment, hazardous materials can cause harm to human life.

Do not allow the use of hazardous materials to compromise the health and safety of any worker associated with the exploration program (or any inhabitants in the work area).

The hazardous materials that are covered in this e-toolkit include:

- Fuels and petroleum products
- Propane and other LP gases
- Explosives
- Solvents and paints

- Drilling Fluids
- Pesticides and herbicides
- Acids y bases
- Antifreeze
- Dust

Note that hazardous waste is a by product of the use of hazardous materials. As waste products, these materials are likely no longer of use, but they are probably still hazardous materials and need to be treated as such.

10.1 Fuels and Petroleum Products

Of all the hazardous substances that exploration programs consume, the most common are fuels and other petroleum products. Use these products only for their intended purpose and as recommended by the manufacturer.

Most jurisdictions have specific and detailed regulatory requirements for the handling and use of petroleum products. It is the company's responsibility to be aware of those that apply to its work, and to abide by them.

All petroleum products present obvious fire hazards. Additionally, all have the potential to degrade the environment through contamination of water and soils and thereby place local plant and animal life at risk. Given the risks of fire and spills, it is important to have emergency response plans in place to adequately deal with these, should they occur.

However, good practice involves minimizing the potential for fire or spills in the first place. In the subsections following, there are guidelines to lowering the risk of fires or spills in the storage, transport, and handling of fuels and petroleum products. Products covered here are those most common to exploration activities, which include:

- Gasoline
- Jet fuels and kerosene
- Diesel
- Lubrication oils
- Transmission oils
- Hydraulic oils
- Waste oils

Propane and other liquefied gases are covered in a separate section.

With respect to their fire hazard, all fuels and petroleum products must be handled with care. Never permit smoking or any work with open flames in their presence. There are differences in the potential for fire hazard between different fuels and petroleum products, and they are divided into flammable and combustible groups with each group divided into sub-classes. (Note that in some English usage, and in French and Spanish usage, "inflammable" is the same as "flammable".)

These divisions are based on the flashpoint - the flashpoint is the lowest temperature at which the vapour above a liquid can be ignited in air. The divisions are:

Flammable. These are termed Class I liquids and have a flashpoint below 37.8 °C. They are further sub-divided into Class IA, Class IB, and Class IC liquids, depending on boiling points. Class IA liquids are the most hazardous, with boiling points below 37.8 °C (e.g., propane). Class IB liquids have boiling points above 37.8 °C, and of these the most important to explorationists is gasoline. Class IC liquids have higher boiling points and are mostly alcohols of little concern to exploration.

Combustible. These have a flashpoint above 37.8 °C and are further divided into Class II and Class III liquids. Class II liquids have flashpoints between 37.8 °C and 60 °C and include diesel, fuel oil, jet fuel, and kerosene. Class III liquids have flashpoints above 60 °C and include ethylene glycol antifreeze.

The subsections that follow contain information on the storage, transportation, and transfer of fuels and petroleum products.

10.1.1 Storage Site Setup

Almost all exploration projects require some fuel storage, whether it is a few cans of oil, or large tanks of diesel to support a drill program. The greatest hazard in storage is fire or explosion, so never store fuel or oil in tanks or containers exposed to the air where the temperature could rise to the liquid's flashpoint. Always place ample warning signs against smoking or using any open flames in or near storage areas.

The most likely hazard is not fire, but spillage of fuel or oil. This risk can be mitigated by following good fuelling procedures, using well-designed tanks, and building containment areas to prevent a major spill from escaping the storage area.

The first step in fuel and oil storage is selecting the site. Locate storage areas at least 100 m from:

- A flood area or high-water line
- Power lines
- Public roads
- The recharge area of a water well

Locate the storage area closer than 100 m to the water, if it is intended to supply boats or float planes. However, the storage area still must be above the high-water mark.

Choose a storage site with:

- Low traffic and a buffer zone from traffic
- A slope of not more than 5%
- Minimal dead vegetation, grass or other combustible material that could present a fire hazard

Storage Tanks Selection

Generally speaking, for exploration programs there is no need to bury storage tanks, so they can be set up above ground.

Ensure that storage tanks are:

- Double-walled if available (particularly in wet climates)
- Vented according to manufacturer design

- Not thin-skinned or plastic bladders
- Protected from corrosion with paint and sealant
- Marked to show contents and capacity



Figure 40: On this drill site in Brazil, combustible fluids are stored separately on a metal pan filled with sawdust to absorb any inadvertent drips or spills. The sawdust can be disposed of safely at the end of the program. © Servitec.

Preparing the Containment Area

The chances for spills of all sizes will be minimized by locating the storage area in a favourable location. However, there is always the possibility of a spill, and if there are tanks with more than 50 L combined capacity, it is necessary to have a sump or containment area capable of controlling a spill.

Design and construct the containment area such that:

- It is on ground of not more than 1% slope
- It has walls that are located the greater of 3 m, or half the tank height from the outer wall of the nearest tank
- It has dikes, berms or walls with interior heights of at least 15 cm, with capacity to hold 110% of the maximum amount of fuel or oil that can be stored within the containment area
- The containment wall is at least 60 cm thick at its top, with a horizontal to vertical wall slope ratio of 2:1
- The base of the containment area is impermeable and made of either:
 - 40 cm compacted clay
 - 30 mil plus High Density Polyethylene (HDPE) liner
 - Solid masonry
 - Other solid, impermeable material
- There is a simple method for removing water from inside the containment area

- Spill kits, fire extinguishers, and first aid kits are available at all storage areas (keep the fire extinguisher no closer than 10 m and no further than 25 m from the containment area)

Make provision to prevent vehicle impacts by using:

- Berms
- Steel or concrete posts

If there are small amounts of fuel or oil to be stored (e.g. lube oil) which do not require a containment facility or sump, place the storage containers on oil absorbent material, sufficient to immediately capture spills and leakage.

Once the storage area is in use, give someone the responsibility of inspecting the storage area and containment facility daily for leaks and spills. Train this person to immediately address any problem he/she sees. This person is also to ensure good housekeeping at the site, by clearing the containment area daily of any trash or plant debris, to lower the fire hazard.

Installing and Maintaining Tanks

Once the proper tanks and a containment area to hold them have been identified, the tanks must be installed properly. This will ensure that there is minimal opportunity for fire, rupture or spills, whether the tanks are being filled or discharged.

When installing tanks:

- Separate tanks by one-sixth the sum of their diameters or 1 m, whichever is greater
- Separate fuel or oil tanks from liquefied petroleum gas containers by an even greater distance of at least 6 m
- Install all piping with protective coatings or wrappings
- Place fill and discharge lines such that they enter tanks only through the top, and so that fill lines are sloped toward the tank
- Only install tanks on a foundation of concrete, masonry, piling or steel to minimize settling and prevent corrosion
- Use concrete, protected steel or masonry – which are all fire-resistant – as supports to anchor tanks to their foundations, placing them so as to provide an even load distribution, rather than subjecting some small portion of the tank to a high stress load
- Put a roof over the tanks in areas of high rainfall, to prevent them from getting wet and corroding
- Inspect the tanks and hoses daily for leaks or spills
- Inspect tanks internally every 10 years

10.1.2 Use of Drums and Other Containers

For smaller jobs with low fuel requirements, a few 205 L drums or even a few portable 20 L containers might meet storage needs. However, although these are small containers, it is still necessary to take precautions against fire or spills. In the case of 205 L drums (when storage needs are less than 2,000 L) the containment area requirement is the same as for larger storage tanks.

Take the following precautions when using drums and smaller containers:

- Only use metal drums designed for storage of flammable liquids

- Store 205 L drums on their sides, with the bung halfway up, to ensure that the seal does not dry out and that rainwater will not penetrate the seal
- Never put more than 10 of any 205 L fuel drums in the same containment area
- If using portable containers, use only those designed to transport flammable liquids and equipped with spouts to prevent spillage while pouring
- Where possible, do not use portable containers made of metal that hold more than 20 L, or plastic containers that hold more than 4 L
- Avoid stacking containers or drums, but if this is not possible, then place sufficient support between levels, to provide stability and relieve stress on the containers or drums
- If placing small containers inside a building or in a locker (which must be well marked), ensure there is adequate ventilation to remove the risk of vapour buildup
- If fuel and oil storage needs are for less than 50 L, place the containers holding the liquids on impermeable or oil absorbent material. For drums or other containers which in sum hold more than 50 L of fuel or oil, refer to the section on **Containment Areas**

10.1.3 Refuelling Operations

Any time fuel or oil is moved from one tank to another, or from a small container (e.g., an oil can), there is the risk of spillage and fire. Preventive measures must be taken against spills, even when doing something as simple as pouring oil into a crankcase. Use a funnel, and be sure the vehicle or motor being serviced is on an oil absorbent mat or an impermeable foundation.

There are bigger risks when pumping larger quantities of fuel. Some preventive measures to lower risk are:

- Only refuel at designated locations
- Always have operators stop their engines and get out of their vehicles or aircraft during fuelling
- Clearly post signs prohibiting smoking and open flames in areas used for fuelling
- Ensure that the dispensing hoses do not exceed 15 m in length
- If using powered dispensing nozzles, they should be of the automatic-closing type, with devices (e.g. a switch or circuit breaker) to shut off the power in an emergency
- Mount dispensing devices (e.g. pumps) on a concrete island, or ensure they are buffered by steel anti-collision posts

If there is a spill during fuelling, replace the filler caps on the vehicle and clean up spillage before starting the engine. Liquid fuels and oils that cannot be handled by pump should be in portable containers with pouring spouts, to minimize the chance of spillage.

There is a major risk of igniting vapours through static discharge, when loading and unloading large tank vehicles. While the risk is less with fuelling smaller vehicles, there is still a risk, so while pumping flammable liquids, take the following precautions:

- Post prominent "No Smoking" signs at the fuelling location.
- When loading or unloading tankers and other large vehicles, provide protection against static sparking by connecting a wire from the pump to the tank being filled. This can be easily facilitated by permanently connecting one end of a metal wire to the fill stem, or to some metal part of the fuel rack structure. Then, prior to pumping fuel, the operator connects the other end of the wire to some metal part of the vehicle being filled. Attach a clamp to the free end of the wire, to make this easier for the operator.

- If pumping to a small vehicle, make sure that, prior to touching the pump handle at any time, static is released by touching metal away from the pump handle or vehicle tank. Alternatively, a grounding wire can be used, as discussed above.

10.1.4 Transporting Fuel and Petroleum Products

The greatest chance of a serious fire or uncontrollable spill exists from even a minor accident, when transporting fuel or oils. The best preventive measure is to use well-trained and rested drivers.

Some additional precautions to observe are:

- When moving small amounts of fuel or oil, use only portable tanks or cans that are made of metal or approved plastic, which have tight closures with screw or spring covers, and which are equipped with spouts or other means to allow pouring without spilling
- Never use leaking tanks or containers to transport fuel or oil
- Secure fuel tanks to prevent slipping or rotating, or fuel tanks being jarred loose
- Place fuel tanks and cans on the vehicle so as to minimize the chance that an impact would cause them to rupture (e.g. do not mount a gas can on the rear of a vehicle)
- Make sure that if a fuel can is placed in a compartment on a vehicle, that the compartment is vented
- Place tanks and cans with fuel in locations on the vehicle where there is minimum exposure to heat
- If it is necessary to place the fuel container near an engine or exhaust system, shield the container against the heat

10.1.5 Handling Fuels and Oils on Water

Since any spillage of fuel or oil is difficult to contain when working on water or ice, it is necessary to take special precautions in these situations.

When drilling on ice:

- Park vehicles and equipment off the ice if possible
- If parking on the ice, place oil absorbent mats below each vehicle
- Make daily inspections for leaks and spillage

When drilling from a barge:

- Have a company representative who is capable of dealing with a spill, present during refuelling or oil changes
- Transport fuel to the barge in clean, sealed containers on a service vessel capable of containing any spill
- Transfer fuel to the barge using a hose enclosed within another hose
- Make sure the barge has a "lip" and collection tanks, to prevent fluids on deck from escaping into the water
- Store fuel below decks or in double-walled tanks
- Anchor an oil absorbent boom around the barge at all times
- Have the boom towed by a separate boat and readily available during moves

10.2 Propane and Other Liquefied Petroleum Gases

Liquefied Petroleum (LP) gases are Class IA liquids, highly flammable, and require precautionary measures. These gases include:

- Propane
- Propylene
- Butane
- Butylene

The precautionary measures discussed here apply to propane (the most common member of the family), but they apply equally to the other flammable liquefied gases.

When using propane:

- Make sure there is adequate ventilation during use or for storage.
- Only use propane that has been odorized, with an agent of such character as to indicate positively (e.g. by distinct odour) the presence of propane gas. Technically, the odour must be noticeable at a propane gas concentration in the air of not over one-fifth the lower limit of flammability.
- Ensure that, when in use, propane tanks and their first stage regulating equipment are located outside, not within, buildings.

When storing propane:

- Do not store tanks of 500 L to 2,000 L less than 10 m apart. Smaller tanks may be placed adjacent to each other.
- Do not place tanks that are installed for use on top of each other.
- Transport and store propane tanks in an upright position, with valves closed and capped.
- Secure propane tanks in place with brackets or straps.
- Separate propane cylinders from cylinders with oxidants (e.g., oxygen).
- If a tank or cylinder valve freezes, thaw it in warm air or water and dry. Do not try to thaw valves in high heat or with an open flame.
- Move a leaking tank away from anything flammable.

As part of general good housekeeping, clear areas around tanks to keep them clear of weeds, long dry grass or rubbish that could easily burn.

10.3 Explosives

Explosives used in the field are defined as those products specifically designed to create a useable force, through an almost instantaneous high-speed chemical reaction. Explosive articles (e.g., blasting agents, ammunition, explosives, detonators, fuses) contain one or more explosive substances.

Explosives are frequently required for blasting in exploration to:

- Build roads and drill pads
- Excavate trenches or pits
- Open exploration adits

In addition, there may be instances where explosives are used to free stuck drill rods.

Always use extreme caution in handling, transporting, storing, and disposing of explosives. It is important to recognize that all of them have varying degrees of sensitivity, stability, and toxicity. Never treat any explosive material as a toy.

Although the science of manufacturing explosives has advanced considerably, there is still an element of unpredictability in their behaviour. Ensure that any persons using explosives in exploration programs are properly trained and licensed professionals, who are fully qualified for the specific explosive materials to be used and the job required.

Most jurisdictions have regulations that apply to explosives transport, storage, and use. It is important to be aware of, and abide by, the applicable regulations and acquire the necessary permits for explosives use.

10.3.1 Transport and Storage of Explosives

The transport and storage of explosives is commonly governed by regulations and the conditions of explosives permits. Companies must ensure that they and their field crews are familiar with these regulations and conditions and abide by them.

When transporting or moving explosive materials, always take the following precautions:

- Do not transport explosives, blasting agents, and blasting supplies with other materials
- Never leave a vehicle transporting explosives unattended
- Transport blasting caps (including electric) in a different vehicle from other explosives
- Use vehicles for transporting explosives that are in good mechanical condition, and sturdy enough to carry the load without difficulty
- When using an open-bodied vehicle for transport, mount the original manufacturer's container for transporting the explosives securely to the vehicle bed
- Check that the vehicle has tight floors, and that the container holding explosives cannot be exposed to any sparks, whatever the source or cause
- Equip all vehicles transporting explosives with a fully-charged fire extinguisher that is in good condition, and verify that the driver is trained in using the extinguisher
- Remove explosives, blasting agents or blasting supplies from a motor vehicle before taking the vehicle into a garage or shop for repairs or servicing

When storing explosives:

- Store blasting caps, detonating primers and primed cartridges in a separate magazine from other explosives or blasting agents
- Enforce a ban on smoking and open flames within 15 m of explosives and detonator storage magazines

Powder Magazines

You must keep all explosives in storage facilities which are

- Properly constructed
- Secured, and
- Barricaded

You must ensure that these facilities, generally termed "magazines", are always under the supervision of a responsible person with the authority to enforce safety precautions.

Specifications for your magazines depend on the quantity of explosives you will be storing. There are two classes of magazines and you will generally need at least 1 of each type, as outlined below:

- Class I magazines are usually required because this is the class of facility needed to store more than 20kg of explosives and if you are using explosives you will likely have at least this much.
- Class II magazines have less stringent specifications, are small enough to easily moved, and are for storing explosives when you have less than 20kg of material. These are generally sufficient for storing your blasting caps and primer cord, which you always keep, separated from the primary explosives.
- Class II magazines are also frequently used for very short-term storage near the site where they will be used. In this case the magazine must be placed at least 50 metres away from the work area. Class I magazines are always in separate structures while Class II magazines may be placed inside warehouses if placed not more than 3 metres from a door to the outside at ground level.

In all other cases in siting your magazines you should:

- Clearly post the area with "Danger Explosives" or similar signs.
- Ensure that the ground around the magazine slopes away from it.
- Keep the area around the magazine clear of brush and dried vegetation for a distance of at least 10 metres
- Separate magazines with barricades and the following minimum distances depending on the amount of explosives to be stored:
 - 6 metres apart for up to 50kg of explosives
 - 10 metres of apart for 51 to 500kg of explosives
 - 30 metres of apart for 501 to 5000kg of explosives
- Natural in the form of a dense stand of trees or hill.
- Manmade and constructed of dirt or rocks with a width of at least 1 metre along its entire length.

You must be sure you have proper barricades not just between magazines, but also between magazines and buildings, highways and railways. A barricade can be:

- Natural in the form of a dense stand of tree or hill
- Manmade and constructed if dirt or rocks with a width of at least 1 metre along its entire length

Your barricades around a magazine must be of such a height that it is impossible to see from the top of the magazine the adjacent:

- Magazine,
- Building,
- Highway, or
- Railway.

You should construct your magazines such that they are:

- Bullet resistant,
- Fire resistant,
- Weather resistant, and
- Ventilated.

If they are heated, this should be with hot-water radiators located such that no part of the radiator can come into contact with explosives. They should be lit by electric safety flashlights or electric safety lanterns.

Additionally, you should construct your Class I magazines with:

- Walls of masonry, wood, or metal with the outer and inner walls separated by at least 20cm filled with sand or bricks.
- A covering of galvanized sheet metal or aluminium on the outer wall if that wall is made of wood.
- Sand trays covering the entire surface of the roof except for an anti-spark screened opening for ventilation.
- Floors of wood which are placed on a substantial foundation.
- A door of the minimum size to permit entry and exit with explosives and which you can secure to prevent unauthorized persons from getting into the magazine.

In the case of Class II magazines, your construction can be with wood or metal. You should:

- Make your wood magazines with 5cm thick hardwood, well braced and covered with sheet metal, and countersink all nails in the interior.
- Line metal magazines with 1cm thick plywood and a cover that overlaps the sides by 2cm.
- Put strong hinges on the covers and install latches that you can lock.
- Clearly mark the magazines on all sides with "Explosives -Keep Fire Away".
- Install wheels or casters for easy removal in case of fire if you plan on putting the magazine in a warehouse.

Within the magazine you should

- Place packages of explosives flat with the topside up.
- Not stack the explosives against the wall.
- Separate black powder from your other explosives, and stand black powder kegs on end with the bung side down or on their sides with the seam side down.
- Group your explosives by type to minimize confusion on what is being used.
- Always use the oldest explosives first.
- Never unpack or repack explosives inside the magazine.
- Never use tools in the magazine that could cause sparks.

If you think you have deteriorated or unstable explosives (for example you see leaks of any type), you should immediately contact an expert to remove and destroy the suspect explosives.

10.3.2 Handling of Fuses and Blasting Caps

Materials used to initiate a blast have the potential to do serious harm. They must be treated with the same respect as the explosives themselves.

When working with fuses, observe the following guidelines:

- only use safety fuses where sources of extraneous electricity make the use of electric blasting caps dangerous
- Never use a fuse that has been hammered or injured in any way

- Do not hang a fuse on nails or other projections, as this will cause a sharp bend in the fuse

When using caps, consider the following:

- Never dispose of unused caps or capped fuses by placing them in a hole to be blasted
- Never make up primers or cap fuses in a magazine, or near any possible source of ignition

When working with detonating cord, follow these guidelines:

- Prohibit anyone from carrying detonators or primers of any kind on their person.
- Be sure a safety fuse for blasting is at least 70 cm long and sized to provide an ample margin of safety at its burning rate. This will give personnel sufficient time, with a margin of safety, to reach a secure place.
- Be careful to avoid damaging or severing detonating cord during and after loading, and after hooking up.
- Check that all detonating cord trunk lines and branch lines are free of loops, sharp kinks or angles that could direct the cord back toward the oncoming line of detonation
- Do not bring detonators for firing the trunk line to the loading area, and do not attach them to the detonating cord, until everything is ready for the blast.

10.3.3 Blasting

On projects involving blasting, it is necessary to have a code of blasting signals that all personnel are familiar with. Personnel must be able to correctly follow the intended warning of the signal. In addition, post the codes in conspicuous locations and put up danger signs around the blasting area.

Some precautions to take with blasting include:

- Sound a loud warning signal before firing a blast
- Have the blaster in charge ensure that all surplus explosives are in a safe place, and all employees, vehicles, and equipment are at a safe distance, or under sufficient cover
- Station flagmen on either side of the blast area to stop traffic, if a highway or footpath passes through the blasting zone
- Disconnect the firing line from the blasting machine immediately after the blast has been fired, and if using power switches, lock them in the open or off positions
- Wait for smoke and fumes to clear following a blast (at least 15 minutes underground) before returning to the blast area
- Before workers are allowed to return to their work areas, make sure the blaster checks the blast area and surrounding rubble to verify that all charges have exploded, by tracing all visible wires in a thorough search for unexploded charges

If a misfire is found, restrict access to the blast area only to those personnel required to remove the hazard. In particular:

- Do not attempt to extract explosives from a charged or misfired hole; insert a new primer and reblast the hole. If referring presents a hazard, remove the explosives by washing them out with water or, where the misfire is under water, blowing them out with air.
- If there are any misfires while using cap and fuse, keep all personnel clear of the blast area for at least 1 hour. Do not permit drilling or digging until all misfired holes have been detonated.

10.4 Solvents and Paints

It is necessary to inform employees about any hazardous chemicals they are working with, including solvents and even paint. Employees need to be trained to work safely with these chemicals, and to know about the hazards that are involved with their use.

When toxic solvents and paints are used, take 1 or more of the following measures to safeguard the health of employees exposed to these chemicals:

- Use the safest solvent available for the job, one that is the least toxic and least flammable. Better yet, find a water-based or solvent-free substitute. In particular, avoid methylene chloride strippers for paint removal, as breathing methylene chloride can damage the central nervous system, and contact with eyes or skin can result in burns.
- Use the smallest amount of solvent that will get the job done. The intent should be to not store any solvents, but if solvent storage is necessary, make the amount minimal.
- Ensure that employees do not have access to solvents to wash their hands; solvents can clean difficult stains from skin, but only at great risk. Provide a waterless cleaner, soap or detergent - anything but solvent, as none are safe for the skin.
- Use solvent-resistant gloves, aprons or goggles when using solvents and paints, to prevent contact with eyes and skin.
- If clothes get wet with solvent, remove them and wash them with soap or detergent.

When storing solvents:

- Store solvents and paints in clearly labelled containers that have been well secured against spillage and which are designed for flammable materials
- Eliminate the risk of having solvent-soaked rags combust spontaneously by storing them in closed containers designed specifically for such materials. Do the same with waste solvent.

Clean up spills immediately, and keep the workplace tidy.

Vapours can reach dangerous concentrations in areas of restricted air circulation, so take the following precautions:

- Work with solvents and paints only with good ventilation. This means getting fumes and vapours out of the work area, not just moving them around with fans. If a fan is needed to move fumes out of the work area, make sure it is turned on and in good working order.
- Make sure there are no open flames (e.g., pilot lights) on appliances when working with solvent-based paints. These could ignite fumes from the solvent, even in a ventilated building.
- Never enter a tank, vat or closed space that may be contaminated with solvent. Sudden death can occur from poisoning, explosion or lack of oxygen.
- Never smoke or do hot work near solvents or solvent vapours, even if the solvents are non-flammable. Non-flammable chlorinated solvents create very toxic fumes (e.g., phosgene) when heated.

Dirty or used solvent is hazardous waste that needs to be labelled and stored properly (see storage of solvents above). Dispose of this waste solvent properly - never pour it into plumbing fixtures or on the ground.

10.5 Drilling Fluids

Drilling fluids can be stored on a metal pan filled with wood chips to absorb any drips and spills. The chips can be disposed of safely at the end of the drilling.

Drilling fluids (drilling muds) of various types are used in all drilling operations, to carry drill cuttings up the hole, improve recoveries, lubricate the drill string and drill bit, and prevent lost circulation.

There are 4 principal types of drill fluids:

- Air blast
- Water-based
- Oil-based
- Synthetic-based

For purely technical reasons, oil-based fluids are superior to water or synthetic-based fluids. However, most mineral exploration programs, whether they use diamond, mud-rotary, or air blast drill methods, will have good performance with water-based fluids. Avoid oil-based and synthetic-based drill fluids and other petroleum products, such as:

- Diesel
- Petroleum-based rod grease
- Solvents

It is the company's responsibility to obtain data from the drill fluid supplier, to determine drill fluid suitability and provide proof that liquid or powdered additives are not harmful to animals, plants or the groundwater.



Figure 41: Note the pan filled with wood chips underneath the rig on this drill site in Brazil. Inadvertent drips and spills are absorbed by the wood chips and can be disposed of safely. © Servitec.



Figure 42: Drilling fluids on this project in Brazil are stored on a metal pan filled with wood chips to absorb any drips and spills. The chips can be disposed of safely at the end of the drilling. © Servitec.

10.5.1 Handling and Storage of Drilling Fluids

It is important to be aware that exposure to drilling fluids and additives may be harmful to a person's health. While the drilling contractor will generally be responsible for preparation of an additive package, there are circumstances in which the company may be required to assist in that process.

If this is the case:

- Use a respirator, goggles, gloves, and an apron when working with dry additives for drilling fluids
- Use special care when handling additives such as caustic soda that may cause severe burning or injury in minor amounts
- Store liquid additives such as industrial chemicals with good ventilation
- Handle each additive as recommended by the manufacturer, especially when labelled as hazardous
- Avoid skin contact with additives or inhalation of fumes emanating from additives

These measures are those that the drilling contractor and his employees should already be taking. It is the company's responsibility to inform the contractor if, in the company's opinion, there is a risk to health or safety due to the manner in which the contractor or the contractor's employees are preparing drilling additives. As a general rule, ensure that recovered drill fluid returns to the mud sump for re-injection.

10.6 Pesticides and Herbicides

Pesticides and herbicides are rarely used in exploration, except perhaps in very small amounts. These chemicals can be highly toxic, so explicitly follow the special storage and handling precautions recommended by the manufacturer. While this section addresses use of pesticides to treat areas outdoors, observe precautions even with minor pesticide application inside buildings.

Pesticides are typically used to control:

- Mosquitoes (particularly where there is a risk of malaria)
- Ticks
- Cockroaches
- Rodents
- Other disease-causing organisms

Time is critical with any pesticide poisoning. Become familiar with the symptoms of pesticide poisoning, which are often documented on pesticide containers. If anyone is poisoned, get immediate help from a local hospital, physician or the nearest poison control centre.

10.6.1 Handling and Storage of Pesticides and Herbicides

Given the often highly toxic nature of pesticides and herbicides, it is necessary to take precautions in their presence.

Never use, transport or store the following, which are especially dangerous pesticides:

- DDT
- Aldrin
- Chlorodecone
- Dieldrin
- Endrin

When working with pesticides and herbicides:

- Do not clean equipment used with pesticides and herbicides near any water supply
- Do not store any pesticide or herbicide where it may come into contact with food
- Never dispose of any pesticide or herbicide in a plumbing fixture

Where possible, only store pesticides and herbicides in a room:

- With no drains
- With good ventilation
- Secured with a lock

Never reuse a pesticide container for anything else, except as recommended by the manufacturer.

10.7 Acids and Bases

The handling and storage of caustic materials requires particular care. Caustic materials commonly used for exploration activities include hydrofluoric acid, hydrochloric acid and caustic

soda. All of these will cause injury if they come into contact with skin, eyes or lungs (through fume inhalation).

To minimize these risks:

- Store these materials in proper, approved containers, and only permit their handling by trained and experienced personnel
- Understand that certain materials may require fume hoods and special safety equipment, and that all acids and bases should be handled only while wearing gloves, aprons, masks, and safety goggles
- Obtain whatever special permits are required to transport these materials, which will depend on the quantities involved and the mode of transportation selected

10.8 Antifreeze

Antifreeze is used in the cooling systems of most water-cooled engines, particularly in either very cold or very hot environments. Although antifreeze is very commonly used, it is a toxic chemical and precautions must be taken to use and store antifreeze safely.

Small quantities (approximately 56 ml) of ethylene glycol antifreeze can kill a dog. It is important to ensure that anyone handling ethylene glycol antifreeze in the field and around a campsite uses the same care and attention as when handling other petroleum-based products.

Propylene glycol is a less toxic alternative to ethylene glycol. In the case of accidental spills, leaks or boil-over, propylene glycol will be less damaging to the environment.

When using antifreeze, take into account the following precautionary measures:

- When performing field vehicle maintenance, use dedicated, controlled sites where accidental spills can be easily cleaned up
- On large jobs, provide suitable storage space for the antifreeze used on-site
- Follow the manufacturer's instructions when storing antifreeze
- Do not store antifreeze in open containers, as animals may be accidentally poisoned
- Provide adequate ventilation in the storage area
- Store a suitable spill kit near the storage facility (see the later section on [11.7 Spill Kits](#))
- Recover used coolant and dispose of this waste at a facility capable of treating it

When storing large amounts of antifreeze (e.g., drums or tanks), it will be necessary to have a containment area to control spills. Refer to the earlier section on [10.1.1 Storage Site Setup](#) for descriptions of containment facilities.

10.9 Dust

Pneumoconiosis is a general term for diseases of the lungs (e.g., silicosis, siderosis) that are caused by dusts. Lung disease is the main hazard of exposure to mineral dusts.

Very fine dust particles - some of which are so fine as to be invisible to the naked eye and can enter the inner most parts of the lungs - are inhaled and accumulate in the lungs, ultimately resulting in lung disease. Additionally, there are lung tissue reactions, such as fibrosis and scarring, which result from the inhalation of certain dusts.

The hazard of breathing mineral dust depends greatly on the:

- Composition of the dust
- Concentration of the dust
- Dust particle size
- Duration of exposure

The presence of crystalline free quartz, chalcedony, opal or other silica mineral in dust can cause silicosis, a particularly disabling and irreversible variety of pneumoconiosis.

Air rotary and reverse circulation drillers, helpers, samplers, and loggers are subjected to deposits occurring in silica-rich rocks. Take particular precautions when drilling with air. There is a serious risk of silicosis with exposure to this kind of dust for a long enough period without taking precautions.

10.9.1 Managing Dust

Some simple precautions can be employed when drilling with air that will greatly reduce the dust hazard risk. Some of these also apply to the use of portable rock saws in trenches, which can generate substantial dust.

To maintain dust control:

- Place drill skirting on hole collars to prevent dust, which comes up the outside of the casing from being blown into the air
- Repair all leaks to the air system, particularly to the dust-laden return air system
- Drill wet if dry samples are not required

If at all possible, have the drillers, samplers, and geologists stand upwind of both the drill hole and the cyclone. If there is space on the drill pad and the hole is vertical, consider prevailing wind directions when setting up the drill. The same precautions apply to rock sawing.

As additional protection from dust:

- Do not use compressed air for cleaning equipment and clothes, although it is more expedient than using brushes
- Wear a clean, well-fitting respirator
- Use appropriate and adequate ventilation in all sample prep rooms.